Intra- and Inter-Generational Equity Effects of Irrigation Well Failures

Farmers in Hard Rock Areas of India

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Equity in access to groundwater is of concern as groundwater offers considerable potential to enhance land productivity. In addition to the existing inequity in landholdings, the inequity in access to groundwater further widens the skewness in assets and income distribution. The food security and equity was well provided by dug well irrigation. The failure of dug wells, shift to high water-high value crops and policy instruments like soft loans to sink wells and zero marginal cost for electrical power to lift groundwater, disturbed the equity in well irrigation, and paved the way for the use of expensive technologies for rapid harness of groundwater. As a result, the dug-cum-borewell and borewells contributed to inter- and intra-generational inequity, even though they increased the overall growth in agriculture.

THE value addition by groundwater irrigation has been significant in the Indian agriculture since the 1960s. In several regions it has richly contributed to food security. It is estimated that irrigation has contributed 60 per cent to the growth in the agricultural productivity.[1] In India' about 33 per cent of the net sown area is under irrigation,[2] where groundwater and surface water have equal share in the gross irrigation. A major portion of India's groundwater irrigation wells is in the hard rock areas,[3] where both recharge and discharge potentials are presently at stake. About two-thirds of India is composed of hard rock areas and the peninsular India is predominantly hard rock. These areas have hard non-porous rocks, the igneous and metamorphic rocks, expected to store not beyond 10 per cent of the annual rainfall.[4] In the hard rock areas, groundwater irrigation, due to its flexibility, has helped in commercialisation of farming through crop diversification and specialisation in high value crops, (low and high water intensive crops).

Groundwater in hard rock areas is abstracted from dug, dug-cum-bore, shallow bore and deep bore wells. Dug wells are open wells, typically with a depth of 30 feet and with a diameter of 25 feet. The dug wells may be lined by stone slabs in order to prevent the well caving, in some areas where the rock and soil strata are loose. For viability of dug well, the minimum yield of water should be 5,000 gallons per day according to NABARD. The water used to be lifted by traditional labour intensive lifts like 'yetha', 'kapile' or 'persian wheel' till the 1960s. Later the water was lifted by centrifugal pump sets of around three horsepower capacity. The dug wells continued to be the dominant structures of groundwater exploitation till the mid-1960s. In the early 1970s, one or more bores were drilled inside a dug well (which used to be called as dug-cum-bore well) in order to enhance the water yield. The inbore may have depth ranging from 30 to 100 feet and centrifugal pump was the chief mode of water abstraction. The dug-cum-bore wells were the dominant structures till the 1980s. Fromtheearly 1980s, surface bore wells with diameter of six inches and depth around 200 feet became popular due to the use of fast rig technology. For viability of borewell, the minimum yield of water should be 1,000 gallons per hour according to NABARD.

Not withstanding the hydro-geological thresholds of groundwater, intensive cultivation of water intensive commercial crops is growing unabated on an extensive scale ever since the 1970s. Due to the growing demand for groundwater, substitution of labour intensive water lifts by capital intensive eletrical irrigation pump sets(IPS), and due to increasing well densities and large-scale failure of dug wells, dug-cum-bore wells and even of bore wells has occurred. Historically, even though groundwater is an internal or local resource tapped from farmer's lands, it has now been transformed to an external and non-local resource, since electrical or diesel energy, which are external, have to be used to lift the water. With such a heavy pressure on the resource and the government policy of providing electricity to lift groundwater at zero price, there has been large-scale exploitation of groundwater leading to high rate of well failure and loss of investments in well irrigation. The aftermath of such losses provides a nightmarish scenario to planners and researchers, since farmers suffer from severe economic shocks and stresses. This has severe equity implications in a situation where farmers have little opportunity to earn their income from sources other than irrigated agriculture.

Equity in access to groundwater is of concern as groundwater offers considerable potential to enhance land productivity. In addition to the already existing inequity in the distribution of land holdings, the groundwater access inequity further exacerbates the predicament of small farmers.[5] By the very nature of the resource, groundwater development is largely by private initiatives of farmers. Their access to the precious resource is often conditioned by their size of holding, savings and investment capacities.

Ground water resource for irrigation in hard rock areas is presently showing increasing signs of scarcity, manifested in terms of raising real costs of abstraction of a unit of water. In an agriculturally dominant economy, it would be one of the obligations of welfare state to develop instruments for identifying deserving uses and users of groundwater resource aiming at Pareto-efficient solutions in order to improve equity in access to quality and quantity of groundwater across different classes of farmers. The inter-generational equity connotes the level of development which provides increase in the welfare of the present generation without decreasing the welfare of the future generation.[6] Karl-Goran Maler[7] referred to this concept as "Pareto Sustainability'.

DATA BASE

We have chosen our data base from Karnataka state, which is in the Deccan plateau of southern India for an analysis of equity implications. The state had about 50 per cent each of the irrigation dug wells and bore wells owned by small and large farmers. This scenario provides perfect equity in terms of absolute number of wells, though it does not indicate the equity in volume of groundwater used and the quality of groundwater. Early or premature failure of irrigation wells is largely a recent phenomenon and has several direct and indirect causes which are beyond the purview of this study. Hence, even though the numeral equity might exist, the differential effects of well failure across classes of farmers is a crucial aspect in the study of equity. The small and large farmers have differential capacities to bear the brunt of well failure depending upon the coping mechanisms they choose. In this study we make a modest attempt to focus on the interand intra-generational equity in access to groundwater for irrigation by small and large farmers. The hypotheses for this study are:

1 dug well irrigation provided food security, inter- and intra-gencrational equity in groundwater resource development;
2 failure of dug wells, shift to high water - high value crops and favourable policy instruments like soft loans to sink wells and zero marginal cost for electrical power to lift groundwater, disturbed the equity in well irrigation and paved the way for use of expensive technologies for rapid harness of groundwater;
3 dug-cum-borewell/borewells sprang as a result of (2) and contributed to inter- and intra-generational inequity even though it increased the overall growth in agriculture.

The data are drawn from 105 farmers for information on the costs, returns and other factors. Their response is supplemented from studies conducted in the same region, during the period when these typical well structures existed.[8] Besides the primary data, the oral history of farmer-respondents (who were aged) have been elicited pertaining to dug (open) wells and dug-cum-bore wells for analysing equity issues, as these structures are not currently in vogue in targe parts of eastern dry zone in the state.[9]

RESULTS

The equity in groundwater resource ownership assumes prominence in areas which have low land-man ratio and high demand for groundwater. First let us document the factors which highlight the equity concerns among dug well and dug-cum-bore well farmers (Table 1). The small farmers have less than five acres of land holding and large farmers have land holdings more than five acres. In our sample, 22 per cent were small fanners and 78 per cent were large farmers. The details of dug well ownership indicate that the average size of large farms owning dug wells is three times that of the small farms owning dug wells (Table 1). These dug wells were functional at least 20 years ago and are no longer in productive use at present.

The large farmers owned two wells. A majority of the small farmers, in spite of their small sized holding were able to own dug well because of the institutional finance which provided dug well loan on soft terms. A majority of the wells belonging to both the classes were located in the proximity of tank command. This has implications on the sustainability of groundwater recharge and supplies especially in the years of sub-normal rainfall. Both small and large farmers had their first bet in securing stable food supplies by allocating a greater proportion of the area under well irrigation to food crops. The interwell spacing followed is also well above the norm of 600 feet, permitting sustainable groundwater flows. The number of years served by the well is also comparable between the two groups and both groups had the same failure rate of 50 per cent, by not being able to serve for the expected life of the dug well of 30 years. The inequity existed in the case of the tree crop security which provided greater propensity for large farmers compared with the small farmers. The tree crops like tamarind and mango in addition to providing an annual regular income flow, also strengthen the farmer's needs especially for bulky one time investments like well irrigation. Largely, we can see that there was equity among small and large farmers with regard to the availability of groundwater resource. However, the inequity with respect to land holding was larger than the inequity with respect to groundwater resource.

The dug-cum-bore wells are the inbores within the traditional dug wells mainly to sustain the water yields of the dug wells, which were at stake due to declining groundwater table. Any commentary on the declining groundwater table will be tautological as the causes and effects are subsumed in each other. For instance, whether declining rainfall and number of rainy days are solely responsible, or the farmers' apathy towards tank de-silting practice or mushrooming number of wells in the cone of interference or the rapid exploitation of groundwater to support high value crops, the groundwater predicament has assumed great dimension. Tracing the dug well farmers who suffered well failure due to any of the above causes, we find that only 11 per cent of the small farmers who owned dug wells could invest in inbores, while 76 per cent of the large farmers could do so. The investment on inbores was around Rs 4,000 by small farmers who could drill to a depth of 45 feet (Table 2) while that for large farmers who could drill to a depth of around 100 feet, the investment was Rs 7,500. Apparent differences were observed in respect of annuity between small (Rs 1,000) and large (Rs 1,900) farmers. The life of the dug-cum-borewell indicated by the number of years served by the inbores was five and seven years respectively for small and large farmers. Except for sugar cane and a bit of vegetables, the crop pattern for small and large farmers under dug-cum-bore well irrigation was not very different.

The implications are that an insignificant proportion (11 per cent) of small farmers could venture into inboring even though the investment as a proportion of dug well investment was around 20 per cent for both small and large farmers. This shows the initial phase drop out rate of small farmers from the domain of well irrigation. Earlier, the impetus to dug well ownership by small farmers was clearly with the help of institutional finance from the co-operative banks. And the institutional finance for dug-cum-bore well portion of investment was not forthcoming to farmers who were defaulters of dug well loans. For instance, Venkataram (1979) reported that the percentage of overdue out of the amount repaid was 80 per cent for small farmers, while it was 48 per cent for large farmers.[10] The small farmers if they had ventured in irrigation would have reaped the same IRR (27 per cent) and pay back period (five years) as that realised by large farmers. In addition, the crop pattern also did not show any remarkable difference between small and large farms of dug-cum-bore well irrigation. The groundwater used per year by

Table 1: Dug Well Farm Details

Particulars	Small Farm (Less than 5 Acres)	Large Farm (More than 5 Acres)
Holding size (acres)	4.8	16.5
Proportion of farmers owning dug wells in the sample	37	63
Number of wells owned per farm	1	2
Net area under dug well irrigation (acres per well)	1.5	2
Gross area under dug well irrigation (per well)	3	5
Depth of dug well (feet)	36	45
Discharge (gallons per hour)	600	·900
Investment at historical prices (Rs)	21000	25000
Percentage of wells located in tank command	85	90
Percentage of area under food crops	80	70
Interwell spacing (feet)	700-800	700-900
Percentage of farmers availing institutional finance for sinking dugwells	80	95
Number of years served by the well	15	15
Percentage of failure (to serve the expected life of 30 years)	50	50
Area under dry land orchard crops (mango, tamarind ...) acres	0.5	3.5

Table 2: Details of Dug-cum-Bore Wells

Particulars	Small Farmers (Less than 5 Acres)	Large Farmers (More than 5 Acres)
Proportion of farmers owning wells who drilled in bores in the sample	11	76
Depth of inbore (feet)	45	100
Investment at historical prices (Rs)	4,000	7,500
Internal rate of return (per cent)	27	27
Pay back period (years)	5	5
Groundwater used per year (000 gallons)	700	1005
Annuity (Rs)	1,000	1,900
Number of years served by inbore (years)	5	7
Crop pattern (Proportion of area irrigated)		
Paddy (per cent)	20	30
Finger millet	38	25
Maize	20	15
Vegetables	7	10
Mulberry	15	15
Sugarcane	–	5

large farmers was around 10.05,000 gallons per year, while that for small farmers was 7,00,000 gallons.

The next phase of well irrigation is to venture upon borewell irrigation, which is quiet expensive. While only 11 per cent of the small farmers who had dug wells drilled inbores, about 50 per cent of the small farmers who had dug wells ventured into borewells. This shows that small farmers would rather assume risk by venturing to borewells than by investing on inbores (Table 3).

The small farmers who lost their dug wells had a waiting period of around seven years before venturing on to borewells. A majority of farmers were not eligible for receiving loans due to the policy of the banks in not funding the 'dark' and 'grey' groundwater use areas.[11] In the sample considered, 20 per cent of the borewells belonged to small farmers and 80 per cent belonged to large farmers. From among the small farmers who possessed dug wells, about 49 per cent had bore wells. From among the large farmers who possessed dug wells, about 95 per cent of them had bore wells. The fact that borewell irrigation farmers have farm size around 10.5 acres indicates that the borewell resource is not easily accessible for small farmers who constitutes a sizeable proportion in the total population of farmers. In this way, borewell irrigation seemed to widen the skewness in assets and income distribution and this has far reaching implications. Another reason for virtual dominance of large farmers is perhaps their capacity to absorb the shock due to high failure rate of borewells and the associated investment ranging from Rs 50,000 to Rs 60,000. The higher holding size of large farmers itself acts as a shock and stress absorbing mechanism.

The gross area under borewell irrigation is almost twice higher for large farmers compared with small farmers, with the result that the annuity for large farmers is twice that of small farmers. The IRR also exhibits similar trends. The net present value is three times higher for large farmers compared with small farmers. The productivity of the borewell for large farmers is 1.5 times that of the small farmers. Small farmers had one well per farm and one successful well for every two small farmers. The large farmers had three wells per farm and seven successful wells for every five large farmers. The small farmers devoted relatively larger area under food crops compared to large farmers. In both the cases, more than 50 per cent of the area was under high water intensive-commercial crops. The borewell productivity of the borewell reduced from 1,700 gallons per hour to 1,000 gallons per hour in small farms. The borewell productivity reduced from 2,200 gallons per hour to 1,500 gallons per hour in large farms. This is a pointer towards over-exploitation of the fragile groundwater resource. Nevertheless, both the small and large farmers would ultimately have to bear the brunt of virtual well failure, as interwell spacing would reduce over the years from the existing spacing of 312 feet for small farmers and 264 feet for large farmers.

COPING MECHANISMS

Farmers are often put in great difficulty if they have to move out of their irrigation infrastructure facility which they already experienced. For instance, if a farmer reaped benefits from an irrigation well and the well failed later, the farmer would not hesitate to invest once again in irrigation well infrastructure since he had had the experience of reaping the benefits earlier. In addition, the demonstration effect of successful wells motivates the farmers to a great extent. The coping mechanism refers to the efforts of the farmers to at least maintain the prc-failure level of incomes (Table 4). Compared to large farmers, small farmers could not undertake any expensive coping mechanism like drilling another well, deepening existing well or using drip irrigation. About 49 per cent of the large farmers drilled yet another well and 20 per cent each of them deepened existing well or used drip irrigation.

About 32 per cent of the small farmers who were earlier well owners were reduced to the status of buying irrigation water. Remaining 68 per cent of small farmers were forced to follow dry land farming and earn wage incomes from labour hiring (Table 5).

Rearing silk worms by buying mulberry leaves provides the great proportion of income to small farmers, followed by income from dry land agriculture and income from custom hiring of their bullock cart. Large farmers whose wells failed, rely heavily on wage income from offering bullock cart hire followed by income from dry land agriculture, dairy income, petty business income and other sources.

INTERGENERATIONAL EQUITY ISSUES

Considering the profile of well life, the productive life of the dug well was the highest (15 years), followed by dug-cum-bore well which worked for around seven to eight years and then the bore well which worked for around eight years. The sample of farmers considered for this study is restricted to one generation in order to observe the paradigm of well investments during one's lifetime, in which all the three types of wells dug, dug-cum-bore and bore wells passed. Considering the epics, dug wells had had a much longer history than what is observed in this study. Not that dug wells yielded water all the years. It may likely be that dug wells did suffer from seasonal overdraft, but they are not reported to have suffered from secular or long-term overdraft as observed in the study, which result in permanent well failure to yield groundwater. Since dug wells served for larger number of years, the intergenerational equity issue here is that those who had

Table 3: Details of Borewell Farms

Particulars	Small Farmers (Less than 5 Acres)	Large Farmers (More than 5 Acres)
Proportion of farmers who drilled borewells from among dugwell owners in the sample	49	95
Percentage of farmers owning successful borewells	47	50
Size of holding (acres)	3.8	10.7
Net area under borewell irrigation (acres)	2	4.3
Gross area under borewell irrigation (acres)	4.5	10.32
Percentage of gross cropped area under		
Food crops	40	27
Vegetables	31	28
Mulberry	29	45
Number of wells per farm	1	3
Number of successful wells	1 out of 2 farmers	7 out of 5 farmers
Initial yield (gallons per hour)	1700	2200
Current yield (gallons per hour)	1000	1500
Life of the well (years)	8	8
Investment at historical prices (Rs)	50,000	60,155
Investment at current prices (Rs)	75,000	80,000
Horsepower of the pump	5	6
Interwell space (feet)	312	264
Annuity (Rs)	4,807	9,613
Internal Rate of Return	25	49
Net present value (Rs)	23,000	74,000
Pay back period (years)	4	2.7

Table 4: Coping Mechanism in the Event of Well Failure

Proportion of Farmers Coping with Well Failure	Small Farmers	Large Farmers
Drilled another well	–	49
Deepened existing well	–	20
Used drip irrigation	–	20
Bought irrigation water	32	5
Invested on improved storage structures	–	30

Table 5: Sources of Income Per Annum for Small and Large Farmers after Well Failure

(In rupees)

Category	Wage Income from Offering Labour	Wage Income from Offering Bullock Cart Hire	Petty Business Income	Buying Mulberry to Rear Silk Worms	Dairy Income	Dry Land Agriculture Income
Small farmers	1,800	2,500	–	4,000	1,000	3,000
Large farmers	–	12,500	5,600	5,000	6,000	10,000

dug wells earlier reaped the fruits of groundwater on a sustainable basis as their water withdrawal was in consonance with the recharge capacities and their cropping pattern was in consonance with the well productivity. The dug well provided equity for small and large farmers, as around 40 per cent of the farmers were owning dug wells. The dug wells were more whole as they provided drinking water water for washing clothes, a swimming pool for learners and fishery in addition to irrigation water. These benefits have now been totally denied to the present generation as the euphoria of well drilling continued unabated, as farmers were myopic to glorify successes and grossly discount failures. In addition, the irrigation tanks which were the major source of surface irrigation as well as groundwater recharge in dug wells were well maintained and helped in groundwater recharge. Institutional factors were largely responsible for the maintenance of irrigation tanks. These institutions degraded after the irrigation tanks were formally taken over by the government and the 'sense of belongingness' petered out. At present dug wells have just become 'museum' pieces for elders to exhibit them as a mark of their agriculture heritage.

Considering the location of dug wells constructed earlier, a good majority of the earlier wells were located in the proximity of irrigation tanks which itself provided a strong base for the sustenance of wells and their management. But the wells constructed later on during the 1970s did not follow the same pattern of location in the tank command. After the 1980s theborewell location virtually was spread all over without due consideration to the water bodies. This is also one of the reasons for the high degree of bore well failure.

The fast rig technology enabled farmers to drill deeper borcwells ranging from 200 to 500 feet in many areas. Interestingly, the rig technology did not accompany the technology of locating well point, even though geological surveyors were not that few in number. Farmers' increasing faith in local water diviners or water witches also indicates the mismatch of technologies of fast rigs with local divining. Around 33 per cent of the borewells failed in the initial stage itself. This has serious equity implications on small farmers' ability to sustain their interest in well irrigation (Table 4) as none of them were able to invest in additional wells, while 49 per cent of the large farmers were able to invest on additional well and 30 per cent of the large farmers were able to invest on storage structures to store and use irrigation water.[12]

The inter-generational equity thus is falling over the years moving with the technology of well drilling, water extraction and cropping pattern. This has resulted in increasing depth of well drilling, and reduced access to groundwater irrespective of their size of holding, thus increasing the scarcity of groundwater. This trend is most likely to exacerbate for future generations as the apathy towards tank desiltation has continued. The race to exploit groundwater resource will continue exponentially by haves, and have-nots will obviously bear the brunt of this negative externality. In addition, the knowledge base of the farmers is also weakening with regard to groundwater literacy. The real cost of extraction of groundwater will accordingly increase over time and this has serious equity implications for small farmers. Even considering water markets as partial answers to ease out inequity, the increasing real groundwater prices would mask whatever equity is achieved by water markets. These amply prove the acceptance of the hypotheses mentioned earlier.

The food security and equity was provided to a large extent by dug well irrigation. The failure of dug wells, shift to high water - high value crops and favourable policy instruments like soft loans to sink wells and zero marginal cost for electrical power to lift groundwater, disturbed the equity in well irrigation and paved the way for use of expensive technologies for rapid harness of groundwater. As a result the dug-cum-borewell/bore welIs sprang and contributed to inter- and intra-generalional inequity even though they increased the overall growth in agriculture. If equity is one of the concerns of the society, as small farmers find it difficult to make huge lumpy and risky investments in well irrigation, it is desirable to promote group investments among the willing riparian farmers to benefit from the fruits of groundwater irrigation, thereby distribute the risk of failure among many. In order to promote inter-generational equity, groundwater recharge efforts by desilting existing irrigation tanks, and various watershed development measures be adopted by promoting participatory action among farmers.

Notes

1 Seckler, David and R K Sampath (1985), *Production and Poverty in Indian Agriculture*, report submitted to Indian Mission of the US Agency for International Development, New Delhi.

2 Directorate of Economics and Statistics, (1994), *Agricultural Statistics at a Glance*, Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi, pp 81-82.

3 Saleth. R M and M Thangaraj (1993), 'Distribution Pattern of Lift Irrigation in India: An Analysis by Hydrogeological Regions', *Economic and Political Weekly*, Review of Agriculture, Vol 28, No 39, pp A102 - A110.

4 Radhakrishna, B P (1971), 'Problems Confronting the Occurrence of Groundwater in Hard Rocks' in *Groundwater Potential in Hard Rock Areas of India*, seminar volume, Geological Society of India, Bangalore, pp 27-44.

5 Overseas Development Institute, 'Who Gets a Last Resource?... of Small Scale Irrigation', Sussex, England, 1980, (quoted by Shashi Kolavalli and L K Atheeq, 'Access to Groundwater; A Hard Rock Perspective', paper presented at the seminar on Water Management: India's Groundwater Challenge, VIKSAT, Ahmedabad, December 14-16,1993.

6 David Pearce and Jeremy Warford, *World Without End*, Oxford University Press, Madras, 1993. p 49.

7 Karl-Goran Maler, *Sustainable Development*, Stockholm School of Economics, Stockholm, Sweden, 1989, quoted in David Pearce and Jeremy Warford, op cit, p 49.

8 The studies referred are: (i) S P Kulkarni, 'Comparative Economic Analysis of Bore well and Openwell Irrigation in North Karnataka Region', M Sc(Ag) thesis (unpublished), Department of Agricultural Economics, University of Agricultural Sciences, Hebbal, Bangalore, 1976; (ii) J V Venkataram, 'Evaluation Study of Karnataka Agricultural Credit Project', Department of Agricultural Economics, University of Agricultural Sciences, Hebbal. Bangalore, 1979; (iii) B Jayaraman, 'Comparative Economic Analysis of Investment in Borewell and Openwell: A Case Study in Bangalore District of Karnataka', M Se (Ag) thesis (unpublished), Department of Agricultural Economics, University of Agricultural Sciences, Hebbal, Bangalore, 1981; (tv) N Nagaraj, 'Groundwater Irrigation from Low-Yielding Borcwells in Hard Rock Areas of Karnataka-An Economic Analysis', Ph D thesis (unpublished). Department of Agricultural Economics, University of Agricultural Sciences, Hebbal, Bangalore, 1994.

9 The villages we visited are Aramakalahalli and Shettyhalli,Srinivasapur Taluk, Kolar district, Karnataka, India.

10 The small farmers who were borrowers of dug well loan from co-operative banks had an overdue of Rs 3,518, which formed 80 percent of the amount of annual instalment repayment (Rs 4,355). For details see J V Venkataram, op cit, p 71.

11 In order to regulate the agricultural credit for drilling irrigation wells, the stale department of mines and geology periodically examines the groundwater utilisation status in all the taluks of the state. A dark taluk is one where the groundwater utilisation is above 85 per cent of the recharge. In such taluks, the financing institutions are not permitted to approve requisitions for irrigation well loans from the farmers. A grey taluk is one where the groundwater utilisation is between 65 per cent and 85 per cent of the recharge. In such taluks, financing institutions may selectively approve requisition for irrigation loans from farmers. A white taluk is one where the groundwater utilisation is below 65 per cent. Here there is no restriction on financing for well irrigation by financial institutions.

12 The expenditure incurred by small and large farmers after dug well failure is provided in the following table:

Items of expenditure	Small Farmcrs (Less than 5 Acres)	Large Farmers (More than 5 Acres)
Drilling cost	17,000	20,130
Irrigation pump set + energisation	24,000	25,500
Pump house	3,000	3,500
Pipe line and distribution	1,700	5,300
Repairs to pump	2,600	2,460
Water storage (earthen)	1,7100	–
Improved storage (concrete)	–	9,000
Total	50,000	65,890
Proportion of farmers investing	49	95