04
2017

IWMI-TATA
Water Policy Program

Water Policy Research
HIGHLIGHT

Drought Proofing Strategies by Farmers in Southern India

Droughts are a common occurrence in semi-arid areas and their frequency and intensity is expected to increase with climate change. Based on a study of 120 farmers from four districts in Karnataka and Tamil Nadu, this Highlight surveys the range of measures farmers adopt in response to droughts. The authors find that despite significant negative externalities, farmers assign higher priority to drilling new wells rather than investing in water conservation structures or demand management strategies. The authors estimate that adoption of drip irrigation and purchase of tanker water for providing life-saving irrigation yield the highest financial returns and suggest considering reuse of municipal waste water as a drought mitigation strategy.

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Drought Proofing Strategies by farmers in Southern India*†

Research highlight based paper with the same title (Palanisami and Kumar 2017).

1. Introduction

Drought has been a common phenomenon and its occurrence is not a shocking one. For a period 1871 to 2002, India experienced 22 droughts of which 5 were severe. Drought is a normal feature of climate, and it will keep occurring at intervals. Meteorologically, ± 19% deviation from the long-term mean is considered as normal whereas deficiency in the range of 20-59% is considered as moderate drought and more than 60% is severe drought (Samra 2004).

To manage droughts, the Central and State governments have implemented several measures like construction of larger reservoirs, water harvesting, institutional arrangements for drought monitoring (like Indian Meteorological Department), early warning, relief measures and so on. There are essentially two drought proofing measures on a long-term basis: [1] harness water through further spread of irrigation, groundwater and watershed development; and [2] evolve and spread drought resistant and short duration high yielding varieties (Ahluwalia 1991). In recent years, augmenting groundwater through artificial recharge and watershed development programs have also assumed importance (Palanisami and Kumar 2006).

Keeping recurring droughts one side and farmers' responses on the other, this Highlight aims to examine drought proofing measures adopted by farmers in response to recent drought of 2015-16 and the effectiveness of these measures. Such an exercise can help the planning process for tackling future droughts in different parts of the country.

2. Data and Methods

Our study relied on field survey conducted during May-August 2017 in two districts (Coimbatore and Tirupur) of Tamil Nadu and two districts (Tumkur and Bijapur) of Karnataka. The data pertained to the agricultural year 2015-16 and the survey covered 30 well irrigated farmers in each district. Water availability at farm was calculated by collecting water in bucket with timer and the same was calculated for one hour which again multiplied by number of hours water was pumped in a day. Some of the details available from recent studies in selected locations in Karnataka were also utilized (Palanisami and Doraisamy 2016; Water Technology Centre 2015; Palanisami *et al.* 2015).

3. Major Findings

3.1 Drought proofing measures adopted at farm level

Out of the 120 farmers surveyed, 67% reported that they invested in drilling additional bore wells followed by adoption of drip irrigation to conserve water; 20% followed the traditional flood irrigation method but reducing the quantum of water they normally used to irrigate; about 10% farmers fallowed the fields as the wells dried up; and rest of the farmers adopted organic farming along with drip and mulching. Some farmers were forced to cut down 15 to 20% of the existing (old) coconut trees in order to adjust water use among the productive trees. Regarding the cropping pattern, of the total sample, 60% cultivate perennial and annual crops (such as arecanut, coconut, grapes, sugarcane, banana etc.) while the rest grow mostly vegetables, onion and maize.

3.1.1 Supply management

Majority of the farmers expressed that their water level dropped significantly resulting in less number of pumping hours. From the normal pumping of 7 hours/day, it dropped to 2 hours/day and then reduced further to 1 hour/day.

Well investment

Most of the farmers in our sample invested in additional bore wells with depths ranging from 700 to 1000 feet. The rate of well failure ranged between 70 and 90%. Even then, farmers felt that some additional supplies will be useful to save the standing crops. As a consequence, the market for well drilling machines increased significantly. The annualized cost of well investment ranged from ₹18,500 to ₹52,500 per farm (Table 1).

Cost of Irrigation water

Average area irrigated during the drought year was about one-third of the farm area. Even with drip, only marginal increase in area irrigated was observed and this might be due to the water scarcity where farmers experienced difficulties in allocating water among the standing perennial crops such as coconut, arecanut, sugarcane and banana. Farmers who used to grow only seasonal crops like vegetables had reduced the area to almost one-fourth of the farm area. Cost of irrigation water ranged from ₹2.1 to ₹9.2 /m^3 under

* This Highlight is based on research carried out under the IWMI-Tata Program (ITP) with additional support from the CGIAR Research Program on Water, Land and Ecosystems (WLE). It is not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or its funding partners.
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Picture 1: Investments in deepening wells

Picture 2: Drip method of irrigation

Table.1: Well investment, groundwater pumping and cost of irrigation water

Particulars	Tumkur	Bijapur	Coimbatore	Tirupur
Rainfall during 2015-16 (mm/year)[#]	382.0	377.0	257.6	254.3
Average farm size (acres)	4.2	4.6	5.6	6.3
Maximum depth of existing well (feet)	690	570	710	650
No. of new wells drilled/farm during the year	2	1	2	2
Average depth of new wells (feet)	800	750	1,000	1,000
Well failure rate (%)	70	65	90	90
Capital cost per well (₹)	65,000	60,000	80,000	85,000
Annualized cost (AC) of new well (₹/year)[@]	40,127	18,520	49,387	52,474
Minimum water pumped (m^3/year)	6,374	8,660	5,980	5,650
Maximum water pumped (m^3/year)	9,486	11,475	8,750	8,270
Average water pumped (m^3/year)	7,930	10,067.5	7,365	6, 960
Average area covered with flood irrigation (acres)	1.4	1.8	1.3	1.2
Average area covered with drip irrigation (acres)	2.2	2.8	2.0	1.9
Cost of water (₹/m^3) with minimum water pumped	6.30	2.14	8.26	9.29
Cost of water (₹/m^3) with maximum water pumped	4.23	1.61	5.64	6.35

Source: field survey.
[#] Average of the selected weather stations in the respective districts where rainfall variability is high.
[@] Annualized cost (AC) of well water was worked out using the formula:
AC = Capital Cost * CRF where CRF (Capital Recovery Factor) = $i(i+i)^n/(1+i)^n-1$ [i = bank interest rate (9%); n= expected life of well (4 years)].

minimum well water pumping situation compared to ₹1.6 to ₹6.2/m^3 under normal or maximum well pumping situation[1].

Water use

The water availability varies from bore well to bore well depending on the volume of water delivered during pumping with an average capacity of 7.5 to 10 HP submersible motors. Among the sample farmers with in different pumping categories (like 1 inch to 2.5 inches delivery pipes), the average water supply worked out to 6,010 litres per hour.

Buying water from urban centres

Farmers in Coimbatore and Tirupur districts made attempts to buy water from urban areas through tankers. The cost of water from tankers ranged between ₹1,500 and ₹2,000 for 12,000 litres (₹125 to ₹150/m^3). It required about 4 trips to provide one irrigation for one acre of coconut trees.

3.1.2 Demand management

Drip irrigation

About 80% of the farmers used drip systems and the capital cost of drip system ranged from ₹22,000 to ₹40,000 per acre depending on the crop and inter-crop spacing. 65% of the farmers have not availed any subsidies and invested in drip mainly due to acute water scarcity, 5% have applied recently for subsidy and are waiting while the remaining 30% have benefited from government subsidy which ranged from ₹10,000 to ₹15,000 per acre.

[1] Due to free farm power, the cost of irrigation here includes only the amortized cost of well investment.

Mulching and trenches for moisture conservation

In several cases, farmers applied plastic and organic mulches to minimizing evaporation losses. As such, field observations and discussions with farmers indicated that about 2-5% water saving is possible due to these practices. Trenches were made with a length of 24 feet, width of 3 feet and a depth of 2.5 feet. The cost of mulching ranged from ₹5,000 to ₹7,500 per acre. Other practices adopted by farmers include organic practices like use of cow dung based manures and panchakavya spraying to avoid pest attack and diseases[2].

Reduction in water use

Reduction in applied water was observed in all crops studied. This was mainly due to the adoption of drip irrigation. The reduction ranged from 26% in grapes to 38% in pomegranate and sugarcane. In the case of onion, maize and tomato, the reduction was 25%, 34% and 36% respectively.

Comparison of cost of water

Cost of water from different investment measures was worked out. The results show that the most cost effective measures were recharging bore wells and investing in percolation ponds. Demand management measures like adoption of drip irrigation has comparatively lower cost vis-à-vis options like tanker water purchase[3] (Table 2).

While investing in a new borewell promises reasonably cost effective water, it should be noted that each new well pumping water would lead to further exploitation of the aquifers. In areas where the level of groundwater development is classified as "critical" or "over-exploited", well drilling is not advised.

3.2 Comparing different drought proofing measures

Given the investment in different drought proofing measures, it is important to examine their relative merits in terms of benefits, rate of return and constraints which can help for planning the up-scaling of these drought proofing measures (Table 3).

Simple rate of return for different drought proofing measures was calculated which ranged from 7% for field trenches to 20% for drip irrigation showing the financial feasibility of the investments during droughts (Figure 1).

Table 2: Cost of water under different drought proofing measures

Drought proofing measures	Cost (₹/m^3)
Recharge bore well	1.7
Percolation ponds (PP)	2.8
Drip irrigation	3.3 to 5.0
Additional (new) borewell	4.5 to 6.5
Farm pond	5.5 to 8.5
Farm trenches	20.8
Water purchase from urban areas	125 to 150

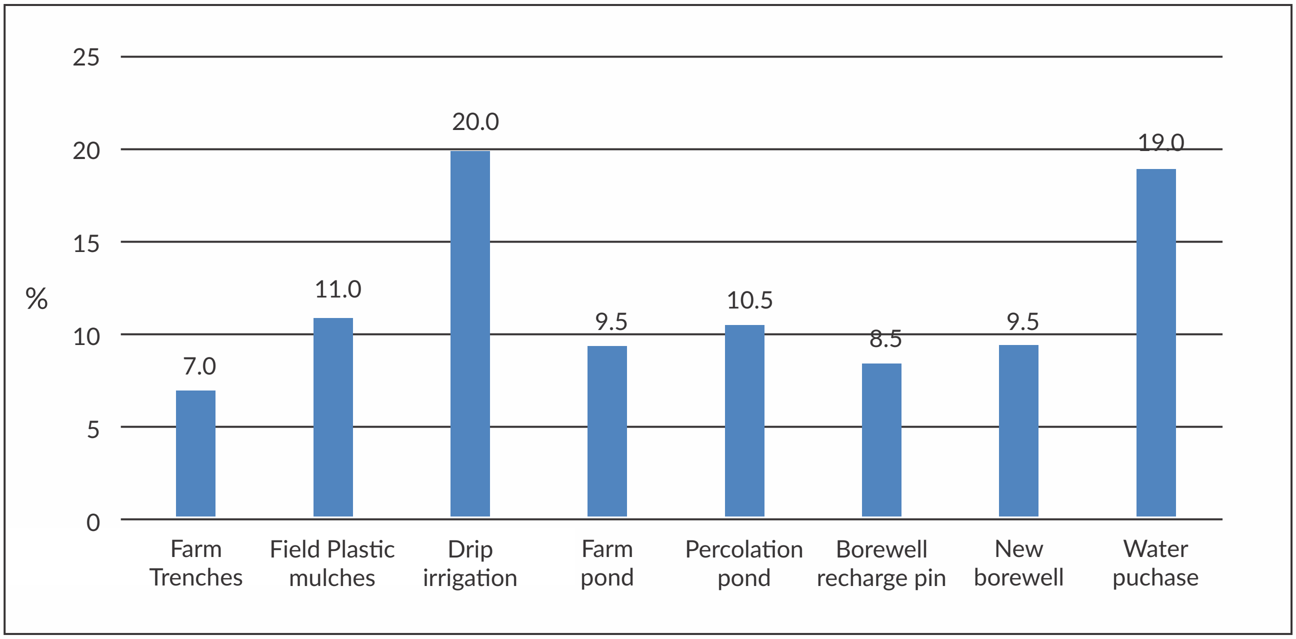

Figure 1: Comparison of rate of returns across drought proofing measures

[2] These are localized practices followed by the farmers who prepare the panchakavya mixtures using locally available materials. The general belief is that these mixtures help to keep the plants in good condition. The cost of these measures is varying from farm to farm depending upon the ingredients they use.

[3] Such a costly irrigation was done mainly for coconuts gardens to keep the matured trees in good condition, as in many cases coconut trees dried up for want of irrigation water. Since the tress in the survey farms were 30 to 40 years old, it is important to keep the tress alive so that they can pick up the yields in the coming seasons when there is assured rainfall and irrigation supplies.

Table 3: Comparison of different drought-proofing measures

Measures	Current Performance	Constraints for Upscaling
Farm trenches	*Adoption: Very low.* *Benefit: Increase in yield 3 to 5%*	*The technology was not accepted by the farmers. They say it is disturbing the field plot layout hampering tractor movement for inter cultivation operations.*
Field plastic mulches	*Adoption: Low.* *Benefit: Increase in yield 5-8%*	*Initial cost high; should be replaced in each season due to poor quality of plastic*
Drip irrigation	*Adoption: Moderate.* *Benefit: Yield increase 12-15%*	*Initial cost high; poor knowledge on maintenance of the system*
Surface water harvesting structures – farm ponds	*Adoption: Moderate.* *Benefit: Improvement in water table depth by 3-4 feet; 1-2 supplemental irrigation provided for 1-2 acres.*	*Initial investment is high. Not direct use during droughts due to no rains. Silting is the major problem due to ploughing fields in each season.*
Percolation ponds	*Adoption: By group of farmers/community.* *Benefit: Helps recharge groundwater by 3-4 feet in wells located in a 0.5 km radius*	*No direct use during drought due to no rains. Silting is the major problem. More evaporation losses.*
Borewell recharge pits	*Adoption: Low to moderate.* *Benefit: Water table increased 2-4 feet post monsoon season; average area increase 1 to 1.5 acres with Irrigated Dry (ID) crops*	*Initial investment high; Location of the borewells and pits different*
New bore well	*Adoption: More extensively done.* *Benefit : Can cover 1-2 acres*	*Investment high and well failure is also very high*
Water purchase from tankers	*Adoption: Practiced in coconut farms due to failure of existing wells.* *Benefit: 2-3 life saving irrigation to existing trees*	*Water costly; even then, water not available in peri- urban and urban areas for transport through tankers*

Picture 3: Mulching in watermelon

4. Conclusion

Most of the supply management measures (percolation ponds, farm ponds, recharge wells etc.) are inter-linked and have impact during post rainy seasons. However, during droughts, vast majority of farmers' investments are made for drilling new boreholes for instant supplies. The cost of well drilling works out to be ₹180 crores in Coimbatore district and ₹100 crores in Tirupur districts thus showing capital formation in agriculture is increasing through investments in borewells. However, given the free farm power regime and tendency for over-pumping, this results in negative externalities in terms of high well failure rate (90%) and increasing cost of groundwater which will be prohibitive for agriculture production.

One area of interest will be how to use the treated domestic waste water directly for irrigation or through recharging groundwater aquifers. Given the quantum of domestic waste water generated in urban areas is as high as 67 million m^3 (Mm^3) in Coimbatore and 39 Mm^3 in Tirupur districts[4], it is possible to focus future investments in waste water treatment processes. ITP studies on the prevalence of waste water irrigation in Gujarat (Palrecha *et al*. 2012), Maharashtra (Palrecha *et al*. 2016), Karnataka (Gupta *et al*. 2016) and Tamil Nadu (Leaf Society 2016) found that more than 50,000 hectares are already being irrigated by farmers using untreated municipal waste water[5]. Regarding demand management measures, use of drip irrigation is common but a major challenge of inadequate water supplies from bore wells remains. As a result, sub-optimal level of irrigation water application was observed. Overall, most of the farmers growing perennial crops indicated that they will reduce the area by 20 to 30% by cutting the old trees and will start diversifying their farming activities.

Given the scope for expanding micro irrigation, continuing public support for the wider adoption and promotion of micro irrigation technologies is warranted. Financial institutions may be geared up to offer special loans for the installation of drip and sprinkler irrigation. Also special purpose vehicles like GGRC models can be introduced at state level for effective spread of MI.

Picture 4: Farm trench in coconut field

[4] Given the urban population of 2.6 million in Coimbatore and 1.5 million in Tirupur districts, using a minimum of 100 LPCD (litres per capita per day) and assuming that about 70% of freshwater supply becomes available as reusable municipal waste water.

[5] These studies covered the peri-urban areas of 7 cities in Gujarat (Ahmedabad, Vadodara, Rajkot, Gandhinagar, Bhuj, Bhavnagar and Surat); 3 locations in Maharashtra (Purandhar, Pune and Jalgaon); 3 locations in Karnataka (Dharwad, Hubli and Vijaypura); and 2 in Tamil Nadu (Trichirapali and Salem).

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About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

Water Policy Highlights are pre-publication discussion papers developed primarily as the basis for discussion during ITP's Annual Partners' Meet. The research underlying these Highlights was funded with support from International Water Management Institute (IWMI), Tata Trusts, CGIAR Research Program on Water, Land and Ecosystems (WLE) and CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). However, the Highlights are not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or any of its funding partners.

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