Chapter 4
Micro-irrigation in Karnataka: Potential and Constraints for Adoption

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4.1 Background

Groundwater irrigation plays an important role in the development of India's agricultural sector. The Green Revolution technology introduced during the 1960s in the form of improved seeds and fertilisers spread faster in the areas where the irrigation water resources were available adequately. It has been estimated that irrigation contributed significantly to total factor productivity growth in Indian agriculture (Fan et al. 1999; Chand et al. 2011; Kannan 2011). In fact, massive investment in irrigation infrastructure helped to achieve India's long term food security. There was considerable increase in the net irrigated area from 24.7 million hectare in 1960–61 to 63.6 million hectare in 2010–11. The surface and groundwater constituted important sources of irrigation even though their relative share has changed over time. While the share of surface irrigation declined from 70.4 to 38.6 % of net irrigated area between 1960–61 and 2010–11, the share of groundwater has almost doubled from 29.6 to 61.4 % (Government of India 2013). The expansion of well irrigation can be attributed to increased adoption of tube wells resulting from easy access to deep drilling technology, electric pump sets and rural electrification in Indian states (Gandhi and Namboodiri 2009; Kumar 2007).

The southern peninsular India including the state of Karnataka is characterised by the hard rock areas, which have widespread weathered zones flexible for water extraction through dug, dug cum bore, shallow bore and deep bore wells (Rao 1993; Nagaraj and Chandrakanth 1997). However, beyond certain depths of groundwater level, diesel pump sets will not be useful and only electric pumps can be used for the extraction of water. The dug wells were the predominant groundwater irrigation structures till 1980s, but thereafter the number of bore wells had

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increased tremendously due to fall in groundwater level as a consequence of its increased demand for irrigation. The increased demand for irrigation water has actually resulted from the intensive cultivation of high water requiring crops like paddy and sugarcane in Karnataka. The state government had provided subsidies for drilling wells and laying power lines to connect irrigation wells with electricity. The electricity tariff rates were also reduced to utilize the tube well technology. With virtually free access to captive groundwater in the hard rock areas and subsidized farm power, farmers did not have any incentive to conserve it for future use and hence they started competitive drilling of bore wells leading to decline in water table (World Bank 2010).

Based on the stage of ground water development, which is estimated as the ratio of net draft to net availability, the ground water scenario of the assessment (hydrological) units is classified as safe (<70 %), semi-critical (70–90 %), critical (90–100 %) and over-exploited (>100 %). According to CGWB (2011), Karnataka has Net Annual Groundwater Availability of 14.81 billion cubic metre (BCM) and the Annual Ground Water Draft of 10.01 BCM. So, the stage of groundwater development is estimated at 68 %, at the aggregate level. Out of the 270 hydrological units assessed, 71 was categorized as over-exploited, 11 as critical, 34 as semi critical and 154 are safe. There is widespread overexploitation of groundwater particularly in the southern districts of Karnataka leading to increased disturbance in the balance between recharge and extraction rates.

Since June 1992, the government of Karnataka has been following a differentiated tariff regime for electricity supplied for agricultural purposes. In fact, electricity supply to the agricultural sector was metered till 1991 and thereafter it has been provided free of charge up to 10 HP irrigation pump sets. For using more than 10 HP pump sets, farmers have to pay Rs. 30/HP/month as fixed charge and additionally pay Rs. 1.40 paisa/kWh as per the usage. Nevertheless, the free electricity supply has led to over draft of groundwater leading to depletion and wastage of energy. Such policy has benefited only the capitalist farmers, while resource poor peasants are left in a disadvantageous position (World Bank 2010, 56; Sarkar 2011). Further, energy subsidies in the farm sector pose serious environmental, social and economic problems, by causing groundwater over-exploitation (World Bank 2010).

Since agriculture is the major consumer of water, demand side management of water assumes great importance not only in the water scarce regions, but also in relatively water abundant regions to avoid possible impending water crisis. Demand side management can be effected through adoption of suitable agronomic practices like bund cultivation, shift in cropping pattern, direct seeding and alternate wet-dry irrigation, and also through adoption of micro-irrigation technologies. The demand management interventions have the potential to save considerable amount of water by reducing net consumptive requirement of water used for irrigation. Among these interventions, micro-irrigation technologies comprising drip irrigation and sprinkler irrigation methods are considered to be superior to conventional method of irrigation as they help to save water, reduce weeds, energy use, enhance crop productivity and improve the water use efficiency considerably (Narayanamoorthy 2003, 2008; Palanisami et al. 2011). In terms of

techno-economic feasibility, drip irrigation suits better to well irrigation than gravity irrigation (Chandrakanth et al. 2012). Notwithstanding, sprinkler irrigation method has also been used for crops like ground nut and cabbage in Karnataka. In this chapter, we review the status of adoption micro-irrigation in Karnataka and analyses its potential and constraints.

4.2 Changes in Cropping Pattern and Irrigated Area

Food grain crops dominate the cropping pattern accounting for about two-third of total gross cropped area (GCA) in Karnataka (Table 4.1). Among food grains, coarse cereals such as jowar, maize, ragi and bajra occupy a prominent place in the cropping pattern. But, proportion of area under food grains has declined from 71.9 % in triennium ending 1962–63 to 61.7 % in triennium ending 2010–11.

Table 4.1 Changes in cropping pattern in Karnataka (% of GCA)

Crop	TE 1962–63	TE 1972–73	TE 1982–83	TE 1992–93	TE 2000–01	TE 2010–11
Rice	9.9	10.7	10.3	10.3	11.9	11.9
Jowar	28.0	21.8	19.2	18.0	15.4	10.4
Bajra	4.8	4.6	5.4	3.3	2.6	2.3
Maize	0.1	0.7	1.4	2.3	4.9	9.4
Ragi	9.6	9.8	9.8	8.8	8.1	6.3
Wheat	2.9	2.9	3.0	1.7	2.2	2.1
Small Millets	4.2	4.1	3.2	1.1	0.6	0.2
Cereals	59.7	55.4	52.4	45.5	46.6	42.5
Arhar	2.7	2.5	3.3	3.9	4.3	5.5
Gram	2.5	1.4	1.3	1.7	2.8	6.9
Pulses	11.9	11.0	13.2	13.8	15.8	19.2
Foodgrains	71.9	68.3	66.6	59.4	62.4	61.7
Groundnut	8.4	9.2	7.6	10.5	9.3	6.6
Sunflower	–	–	1.0	8.6	4.9	5.8
Total Oilseeds	9.7	11.0	12.2	22.7	17.3	15.2
Cotton	9.3	10.2	9.0	5.0	4.7	3.7
Sugarcane	0.7	1.0	1.6	2.2	3.1	2.7
Coconut	–	–	1.6	2.0	2.8	3.8
Arecanut	–	0.4	0.5	0.5	0.9	1.5
Fruits and vegetables	–	–	–	2.1	5.4	6.1
Others[a]	8.4	9.1	8.5	6.0	3.5	5.3
GCA	100.0	100.0	100.0	100.0	100.0	100.0

Note [a]Include tobacco, coffee and other plantation crops
Source Government of Karnataka (various issues)

The decline in area under food grains is offset by increase in area under oilseeds and other crops (which include coconut, arecanut, chillies and coffee). The share of area under fruits and vegetables in GCA has considerably increased to 6.1 % in 2010–11 from 2.1 % in 1992–93.

In 2010–11, jowar and rice accounted for a significant proportion of the total cropped area followed by sunflower and maize. Despite occupying relatively high share, area under jowar had declined drastically since early sixties. Similar pattern could be noticed with respect to other coarse cereals such as bajra, ragi and small millets. However, crops like maize, pigeon pea and gram have gained in their relative area during the study period. Maize occupied only 0.1 % of GCA in 1962–63, which had increased steadily to reach 1.4 % in 1982–83 and then to 9.4 % in 2010–11. Similarly, per cent area under pigeon pea in total cropped area had increased from 2.5 % in 1972–73 to 5.5 % in 2010–11. Share of area under gram decelerated during seventies and early eighties, but started picking up since nineties because of better price.

Groundnut is one of the traditional crops grown in Karnataka. It is cultivated both under irrigated and rainfed conditions. The per cent area under this crop has declined sharply since 2000 due to persistent drought like conditions in most parts of the State. However, share of area under sunflower has registered a sharp increase from 1.0 % in 1982–83 to 5.8 % in 2010–11. Among cash crops, area under cotton has declined drastically over time. However, sugarcane area has increased considerably from 1960s to 2000s, but has showed declining trend since 2001–02. It emerges from the analysis that there was a marked shift in area from cereals to pulses, oilseeds and high value crops like vegetables and plantation crops.

Among the sources of irrigation, tanks were predominant source of supply of irrigation water during 1960s (Table 4.2). Overtime, canal and tube wells have

Table 4.2 Sources of irrigation

Particulars	TE 1962–63	TE 1972–73	TE 1982–83	TE 1992–93	TE 2000–01	TE 2009–10
Gross irrigation (lakh ha)	10.0	15.0	18.6	27.4	31.8	39.4
Percentage of GIA to GCA	9.3	14.0	16.9	22.6	26.0	31.0
Net irrig. area (lakh ha)	9.1	12.2	15.1	22.1	25.6	32.5
Sources of irrigation (% of net irrigated area)						
Canal	28.3	35.9	40.5	40.5	37.9	32.4
Tanks	39.5	30.1	21.0	12.0	9.9	6.3
Tube wells	–	0.3	0.5	9.6	19.1	39.6
Wells	16.1	25.5	26.7	24.1	18.7	13.0
Other sources	16.1	8.2	11.3	13.8	14.4	11.5

Source Government of Karnataka (various issues)

emerged as the major sources of irrigation. As percentage to net irrigated area, the share of canal irrigated area has increased from 28.3 % in 1962–63 to 40.5 % in 1982–83. Though canal water as source of irrigation remained almost constant during nineties, it showed decelerating trend during 2000s.

The area irrigated through tanks declined drastically from 3.6 lakh hectare in triennium ending 1962–63 to 3.2 lakh hectare in 1982–83 and then to 2.0 lakh hectare in 2009–10. In terms of percentage to net irrigated area, it was 39.5 % in 1962–63, 21.0 % in 1982–83 and 6.3 % in 2009–10. Although tanks are found to be one of the best strategies for conservation of rain water at low investment with short gestation period, poor maintenance, encroachment of tank bed and change in land use pattern led to decline in tank irrigation (Govindaiah 1994; Palanisami et al. 2010; Thippaiah 2006). Interestingly, area irrigated through tube wells increased remarkably from 0.3 % in 1972–73 to 39.6 % in 2010–11. In fact, drying up of tanks and vagaries of rainfall had forced the farmers to resort to bore wells. Open wells were another important source of irrigation till early 1990s constituting about 25 % of net irrigated area. Its share declined to 13 % in 2010–11. Wells are the third important source of irrigation after tube wells.

As discussed above, only less than one-third of total cropped area is irrigated in Karnataka. The coverage of irrigation to principal crops is also very limited. The per cent irrigated area under food grains crops rose marginally from 10.1 % in 1962–63 to 15.5 % in 1982–83 (Table 4.3). Surprisingly, the irrigation coverage remained more or less constant at around 20 % during 1990s and 2000s. Among individual crops, irrigated area under rice was little over 60 % during 1962–63 to 1992–93 and then rose to 74.2 % in 2006–07.

Table 4.3 Area under irrigation of principal crops (%)

Crop	TE 1962–63	TE 1972–73	TE 1982–83	TE 1992–93	TE 2000–01	TE 2006–07
Rice	59.5	65.1	61.7	63.2	71.3	74.2
Jowar	2.2	5.2	4.5	7.2	7.9	8.8
Maize	84.2	79.2	81.1	69.5	50.3	39.0
Ragi	5.4	10.3	8.4	8.1	5.6	5.0
Wheat	3.3	10.8	19.4	37.2	42.0	52.0
Cereals	12.0	18.3	19.3	24.4	29.7	32.2
Arhar	0.6	0.2	0.3	1.9	1.1	3.3
Gram	0.6	1.2	7.8	12.9	10.4	15.7
Pulses	0.7	0.5	1.6	3.7	3.6	5.6
Foodgrains	10.1	14.9	15.5	19.5	23.1	24.7
Groundnut	–	6.8	13.4	21.8	21.2	20.2
Sunflower	–	–	8.6	18.8	19.9	18.9
Cotton	1.9	5.0	8.4	25.5	16.1	14.7
Sugarcane	96.6	98.4	99.8	99.7	99.9	99.9

Source Government of Karnataka (various issues)

The area under irrigated maize was 84.2 % in 1962–63. It has declined to 69.5 % in 1992–93 and then to 39.0 % in 2006–07. Decline in area irrigated under maize might be due to availability of varieties which can be grown in rainfed conditions. However, area under irrigated wheat has increased considerably from 3.3 % in 1962–63 to 52.0 % in 2006–07. In case of ragi and jowar, less than of 10 % of their respective cropped area is irrigated. Pulses are generally cultivated under rainfed conditions. Similarly, cotton and oilseeds are predominantly grown under rainfed conditions. It emerges from the above analysis that development of irrigation facilities assumes utmost importance in the dry tracts of the state to improve agricultural growth and productivity. Concerted efforts should be made to bring more area under micro-irrigation through water harvesting, storage, and watershed development programmes.

4.3 Policy Initiatives on Micro-irrigation in Karnataka

Karnataka State Water Policy launched in 2002 recognized the fast depleting groundwater resource and hence the need for proper development and management of available resource. The rainfall pattern is erratic both in time and space. As a result there is uneven exploitation of groundwater in the state with a higher level in drier areas of North and South interior Karnataka as compared to malnad, coastal and canal command areas. The state water policy emphasised a proper management of water and land resources for achieving water use efficiency and land productivity. Promotion of appropriate cropping pattern, conjunctive use of water and adoption of drip and sprinkler irrigation hold the key in achieving the goal.

Agricultural Policy of Karnataka 2006 also highlighted the alarming status of groundwater in the state and predicament of farmers' investment in drilling bore wells. Agricultural Policy encourages the adoption of micro-irrigation technologies for saving water, increasing yield, adoption of new technological package and addressing labour shortages. It suggested that the scheme of subsidies for drip and sprinkler irrigations should be provided to all types of farmers and all regions in the state.

Government of Karnataka is one of the earliest states to introduce subsidy scheme to promote micro-irrigation for horticultural crops. The Department of Horticulture had taken lead in promoting drip irrigation system for horticultural crops since 1991–92. Even though micro-irrigation was initially adopted for wide spaced perennial crops, later it was recommended for close spaced annual crops due to availability of technology and demand from the farmers. Under the Centrally Sponsored Scheme of Micro-irrigation implemented from 2006–07 , subsidy has been provided for drip and sprinkler irrigation systems. In case of horticultural crops (except coffee, tea, rubber and oil palm), for drip irrigation system, financial assistance is available for a maximum area of 5 ha per beneficiary household with 80 % subsidy for the first 2 ha and 50 % for the remaining 3 ha. For sprinkler irrigation, subsidy is fixed at 80 % (Government of Karnataka 2013). For field

crops, drip and sprinkler are provided at 75 % subsidy to the general farmers and 90 % subsidy to Scheduled Caste/Tribes farmers.

Under the National Horticulture Mission, transfer of subsidy to farmers has been streamlined to avoid the problem of intermediaries and delay in release of subsidy. Under this arrangement, subsidy will be directly transferred to the beneficiary farmers' bank account after the necessary clearance for demonstration of equipment/machinery by the empanelled firms in the farmers' field and subsequent submission of preference for such equipment by the farmers. Due considerations have also been given in guidelines to make available subsidy to marginal and small farmers.

However, field evidences show that there are problems in accessing the subsidy on various inputs including micro-irrigation equipments by the farmers. The average amount of input subsidy received by farmers in the last five years preceding date of survey (2009–10) in Karnataka is presented in Table 4.4. Among the farm size groups, the large farmers received the highest amount of Rs. 20,456 per household followed by marginal, small and medium farmers.

Large farmers appropriate more benefits from the subsidy schemes due to their high economic status and familiarity with the government officials for whom generally the large farmers remain as contact farmers in the village. There are differences in the access to different subsidy items across the farm groups. Although the medium and large farmers appropriated high amount of subsidy on seeds and irrigation equipments, the marginal and small farmers also received subsidy on these items. The average amount of subsidy received on irrigation equipments varied between Rs. 817 per household among small farmers and Rs. 25,400 per household for large farmers. The subsidy on farm machinery like tractor and tractor mounted plough was availed by the large farmers only.

Table 4.4 Average amount of subsidy received by farm size groups in Karnataka (Rs./farm household)

Items	Marginal	Small	Medium	Large
Seeds/planting Materials	590.0	757.5	992.2	1697.5
Plant protection chemicals	–	180.0	900.0	950.0
Irrigation equipments	3000.0	816.7	8837.5	25,400.0
Farm machinery	–	–	–	86,666.7
Land improvements	1140.0	80.0	–	500.0
Construction of farm pond	–	–	–	–
Drilling of wells	45,000.0	60,000.0	–	–
Bio fertilizers	–	–	–	–
Micro nutrients	–	2000.0	–	–
Others[a]	–	–	6155.0	–
Overall	15,995.0	5182.0	3907.6	20,456.3

Note [a]Includes subsidy on cow
Source Kannan et al. (2012)

Table 4.5 Difficulties in receiving direct subsidies in Karnataka (percent farmers reported)

Problems	Marginal	Small	Medium	Large	Overall
Information about subsidy is not available	58.6	61.9	55.0	38.9	54.5
Procedural complexities (e.g. documentation, paper work)	65.5	45.0	66.7	50.0	58.0
Recommendation letter from elected representative	50.0	35.3	55.6	44.4	46.7
Government officials are not co-operative	50.0	52.4	61.1	50.0	53.0
Bribing government officials	10.5	30.0	13.3	20.0	18.8
Sub-standard quality of items supplied	30.0	26.3	20.0	21.4	25.0
Lack of money to meet the remaining cost	5.3	11.8	26.7	20.0	15.2
Favoured towards select farmers	61.5	47.6	42.1	56.3	52.4
Subsidy dispersal agency is located far away from the village	11.8	13.3	7.1	30.8	15.3

Source Kannan et al. (2012)

In addition, there are several constraints that farmers face in availing the benefit of direct input subsidies provided by the government. Among various constraints, lack of information about the subsidy schemes was major problem (Table 4.5). Nearly 33 % of the farmers expressed procedural complexities as another important constraint in getting direct agricultural subsidies. A high percentage of farmers also reported the problems related to getting recommendation letter from elected representative and non-cooperation of government officials. Favouritism towards select farmers and bribing of government officials also seem to be major problems in administering the direct input subsidies to farmers. Therefore, it implies that even after introducing governance reforms for proper administering subsidy programmes, problems of accessibility particularly for marginal and small farmers continue to exist.

4.4 Status of Micro Irrigation in Karnataka

Agriculture is one of the largest users of water and its efficient use will have implications for adequate availability of water for industrial and household purposes. Groundwater is becoming scarce in different parts of the Karnataka state. An important means to overcome the irrigation water scarcity is through effectively managing the consumptive requirement for agriculture and improve efficiency in the application of water. Micro-irrigation has proven to improve the water use efficiency in irrigated region and provide solution to many problems in dry land region (Shashidhara et al. 2007). Despite its known benefits, the spread of

micro-irrigation still remains low. According to Palanisami et al. (2011), Karnataka has potential area of about 7.45 lakh hectare, but only 23.8 % (1.77 lakh hectare) has been brought under drip irrigation. In terms of potential area, Karnataka stands at the fifth place at the all India level and as percentage of area coverage to potential area it occupies the fourth place after Andhra Pradesh, Maharashtra and Tamil Nadu. For sprinkler irrigation, potential area has been estimated at 6.97 lakh hectare and actual area at 2.29 lakh hectare with the coverage of 32.8 % only. There exists huge scope to expand the area under micro-irrigation, which will be a boon to the vast stretch of dry tracts in Karnataka.

A few studies have estimated economic benefits of adoption of micro-irrigation as compared to conventional irrigation for different crops in Karnataka. According to Chandrakanth et al. (2012), net return per acre inch of water from mulberry, grapes and tomato was higher for drip irrigated farms than that for conventional irrigation farms by 62, 84 and 61 %, respectively in Karnataka. A high level of return per acre inch of water was a crucial factor influencing the adoption of drip irrigation by the farmers. Further, adoption was also found to be relatively high among farms with high probability of failure of wells. A study conducted in Dharward district showed that drip irrigation saved about 45 % of applied water in fruit crops as compared to the surface method of irrigation (Meti 2013).

Productivity of crops was higher with drip irrigation than conventional method of irrigation. In Karnataka, productivity of banana increased by 25 % with drip irrigation and also fetched a premium price of 5–10 % due to better quality of fruits (Chandrakanth 2009). Similarly, Shashidhara et al. (2007) found that drip irrigation helped to increase the yield in arecanut and banana by 5.9 and 3.5 %, respectively as compared to the traditional irrigation. Drip irrigation was also found to have saved water and labour cost to a large extent.

Even after realisation of perceptible benefits from micro-irrigation, its actual area has not expanded rapidly. Some of the constraints reported for low adoption include high initial capital cost, non-availability of quality spare parts, lack of technical knowledge in operation and maintenance, lack of appropriate design to suit topography, delay in release of subsidy and small land holding (Shashidhara et al. 2007; Narayanamoorthy 2008; Palanisami et al. 2011).

4.5 Conclusions

Irrigation plays an important role for improving agricultural productivity and maintaining food security in the country. Since water is becoming highly scarce due to increase in demand for consumptive use sector and dwindling supplies from the natural system, agricultural production would suffer. Water saving technologies like micro-irrigation system is found to be beneficial to farmers and improve the water use efficiency considerably. With the changes in cropping pattern and technology, farmers tend to adopt the drip irrigation method even for close spaced crops like vegetables. But, area irrigated through drip and sprinkler irrigation systems remains

low as compared to their potential area due to various constraints like initial capital cost, lack of technical knowledge for operation and maintenance, unsuitability to different topography and soil conditions. A proper mechanism to address the governance problems with respect to operation of subsidy schemes to make available the subsidy amount timely and also regular revision of subsidy rate to compensate the rise in the cost of equipment components need to be undertaken.

Regular interactions with stakeholders like farmers, micro-irrigation equipment companies, dealers and government officials should be held to get continuous feedback for designing and modification of equipment parts suitable to different soil conditions and farmer groups. Local educated youths should be trained through special programmes to provide repairing and maintenance service to the farmers. This will help to save time and resources that the farmers have to spend to locate the technical persons far away from the villages.

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