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RESEARCH PAPER

Growth and instability of area under drip method of irrigation in south Gujarat- A district-wise analysis

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Abstract : The competition among the various sectors of the economy particularly agriculture for the scarce water is becoming intense as the demand for available water resources is fast exceeding the economic supply. Many farmers still adopt conventional methods of irrigation which not only results in severe wastage of water but reduces crop production and also cause ecological hazards like water logging and soil salinity. The mounting water scarcity in Gujarat state validates the adoption of water efficient technologies like drip irrigation. The present study for undertaken to examine the current status and growth performance of area under drip method of irrigation for various districts of South Gujarat using compound growth rates. Instability analysis was carried out using the formula given by Cuddy and Della to know the variation in area under drip irrigation in over the years. The findings of the study suggested that during the period 2005-06 to 2019-20, the area under drip method of irrigation in case of loanee respondents declined significantly over the years.This could be probably attributed to the excessive documentation and other procedural formalities which were discouraging for the less educated and illiterate farmers. It also led to increase in the transaction cost. On the contrary, the growth in non- loanee area was found to be positive and significant in majority of the districts of South Gujarat. Moreover, the variability in loanee and non–loanee area was recorded to be high *i.e.* that the area under drip in all the districts of South Gujarat region demonstrated to be unstable during the period of study.

Key Words : Growth, Instability, Area under drip method, Irrigation

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INTRODUCTION

Of all the natural resources, water is considered to be the most vital resource for sustainable development of agriculture. The availability of water depends on various hydro-meteorological factors and therefore, the efficient use of available water for irrigation is not only crucial but a major challenge. Water is needed to ensure food security, develop animal husbandry, maintain organic life, carry out industrial production and to conserve biodiversity and the environment. The rapid growth of population, pressing need for food security and erratic rainfall pattern has led to higher demand for irrigation water in India. India is a primarily an agrarian economy and the rapid depletion of water is a major cause of concern. Many farmers still adopt conventional methods

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of irrigation which not only reduce crop production and soil fertility but also cause ecological hazards like water logging and soil salinity. The application of irrigation water by conventional methods causes upto 30 per cent loss of water through deep percolation depending on the soil type (Anonymous, 2014). Furthermore, the water table has gone very deep affecting the agricultural production due to erratic and scanty rainfall year after year. Failure of monsoons coupled with large scale exploitation of ground water resources far exceeding the rate of recharge has resulted in declining water tables. To overcome the problems of conventional irrigation methods and the challenges posed by ground water scarcity modern irrigation management practices such drip irrigation need to be given prime importance. Evidences show that water-use efficiency increases upto 100 per cent in a properly designed and managed drip irrigation system (INCID, 1994 and Sivanappan, 1994). Drip method helps in achieving saving in irrigation water, increased water-use efficiency, decreased tillage requirement, higher quality products, increased crop yields and higher fertilizer-use efficiency (Namara *et al.,* 2005). Hence, the present study was undertaken to analyze the growth and instability of area under drip method of irrigation (DMI) in various districts of South Gujarat region.

MATERIAL AND METHODS

For computing compound annual growth rate of area under drip irrigation in South Gujarat region, the exponential function of the following form will be used:

$$Y = ab^t u_t \quad \text{..... (1)}$$

where, Y = Area under drip in hectares in t^{th} period

a = Intercept

b = Regression co-efficient

t = Time variable

u_t = Error term.

The eq. (1) is transformed into log linear form and written as:

$$\text{Log } Y = \log a + t \log b + \log u_t \quad \text{.....(2)}$$

Eq. (2) is estimated by using Ordinary Least Squares (OLS) technique.

Then, per cent compound annual growth rate (G) will be calculated using the relationship.

$$G = [(\text{antilog of log } b) - 1] \times 100 \quad \text{.....(3)}$$

The significance of growth rate will be judged based on the student's t- test at 5 per cent and 1 per cent level of significance.

Instability analysis:

Instability analysis was used to know the variation in area under drip irrigation in over the years. The co-efficient of variation was computed by using the following formula:

$$CV = \frac{\text{Standard deviation } (\sigma)}{\text{Mean } (X)} \times 100 \quad \text{....(4)}$$

A linear trend line was fitted to the original data on area covered under drip irrigation system in south Gujarat for a period of fifteen years from 2005-06 to 2019-20. The trend co-efficients were tested for their significance. When the trend of series found to be significant; the variation around the trend rather than the variation around mean was used as an index of instability. The formula given by Cuddy and Della was used to compute the degree of variation around the trend. That is the co-efficient of variation was multiplied by the square root of the difference between the unity and co-efficient of multiple determinations (R^2) in the cases where R^2 was significant to obtain the instability index (II).

$$\text{Instability index} = \frac{\text{Standard deviation } (\sigma)}{\text{Mean } (\bar{X})} \times 100 \times \sqrt{(1 - r^2)}$$

RESULTS AND DISCUSSION

The current status and growth performance of area under drip method of irrigation was analyzed for various districts of South Gujarat using Compound Growth Rates (CGR). The growth rates and instability indices were worked out for loanee area, non-loanee area and total area under drip method of irrigation as depicted in Table 1 and Fig. 1, 2 and 3. The period of analysis was from 2005-06 to 2019-20.

It could be observed from Table 1 that the growth rate of loanee area under drip method of irrigation for Bharuch district was -39.01 per cent which was negative and highly significant which may probably be due to the lack of arrangements for institutional credit at the grass root level. In case of non-loanee area, the growth rate was found to be 4.98 per cent *i.e.* positive but non-significant. The growth in total area under drip method of irrigation in Bharuch district was negative and non-significant to the tune of -2.21 per cent. Furthermore, the instability indices indicated that area under loanee,

Table 1: Growth rate and instability of area under drip method of irrigation in South Gujarat (2005-06 to 2019-20)

District	CGR (%)			instability index (%)		
	Loanee	Non-loanee	Total	Loanee	Non-loanee	Total
Bharuch	-39.01** (-7.41)	4.98 (1.86)	-2.21 (-1.19)	60.47	40.33	30.44
Dangs	-	49.68** (4.59)	49.68** (4.59)	-	117.83	117.83
Narmada	-35.10** (-6.61)	17.93** (3.72)	11.08** (2.98)	56.15	42.74	39.51
Navsari	-47.02** (-9.02)	3.45 (1.86)	1.54 (0.86)	59.21	25.18	25.34
Surat	-42.50** (-10.19)	4.63* (2.44)	1.25 (0.74)	46.90	25.63	24.54
Tapi	-33.06** (-4.81)	16.48** (3.90)	3.41 (1.08)	63.15	50.54	44.79
Valsad	-45.61** (-13.30)	-1.66 (-1.11)	-3.67** (-2.88)	41.76	20.44	16.94
South Gujarat	-34.96** (-9.99)	6.90** (2.97)	1.70 (0.93)	40.31	30.09	24.95
Gujarat	-17.54** (-5.72)	20.29** (5.32)	12.85** (4.87)	32.59	33.64	29.44

Source: GGRC, Gujarat. N.B.: Loanee area in the Dangs district was nil. Figures in parentheses indicate t values
* and ** indicate significance of values at P=0.05 and 0.01, respectively

non-loanee and total area under drip showed a high variability of 60.47, 40.33 and 30.44 per cent, respectively.

With regard to the Dangs district, the growth in total area under drip method of irrigation in Dangs district was the highest and it was solely due to the growth in non–loanee area which accounted for 49.68 per cent *i.e.* positive and highly significant growth. The highest positive growth could be attributed to the provision of nearly 100 per cent subsidy with Dangs being predominantly a tribal district. The instability in area was found to be very high *i.e.* 117.83 per cent per annum for both non-loanee and total area under drip, respectively.

In case of Narmada district, the growth rate of area under drip method of irrigation for loanee respondents

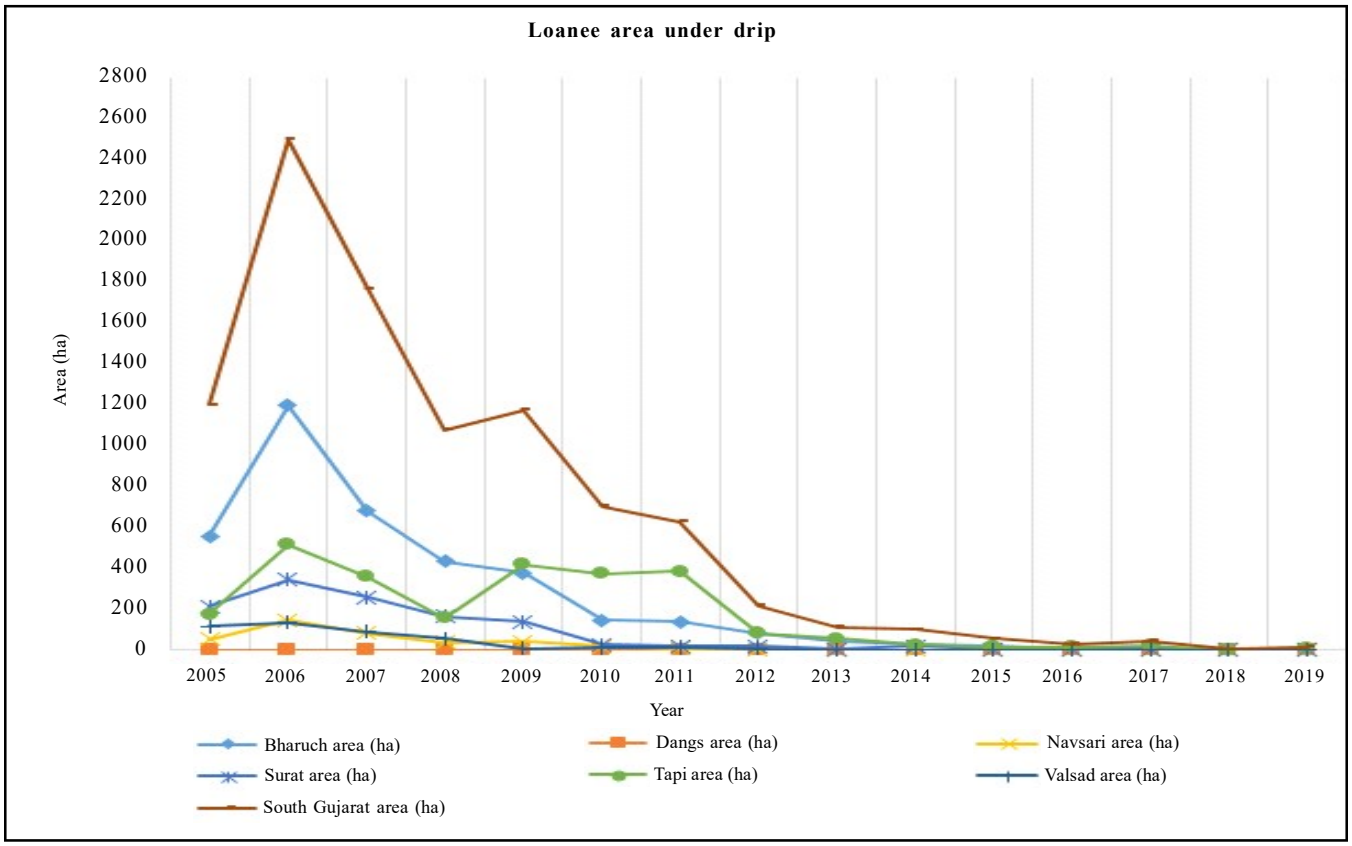

Fig. 1 : Compound growth rates and instability index for loanee area under drip method of irrigation (2005-06 to 2019-20)

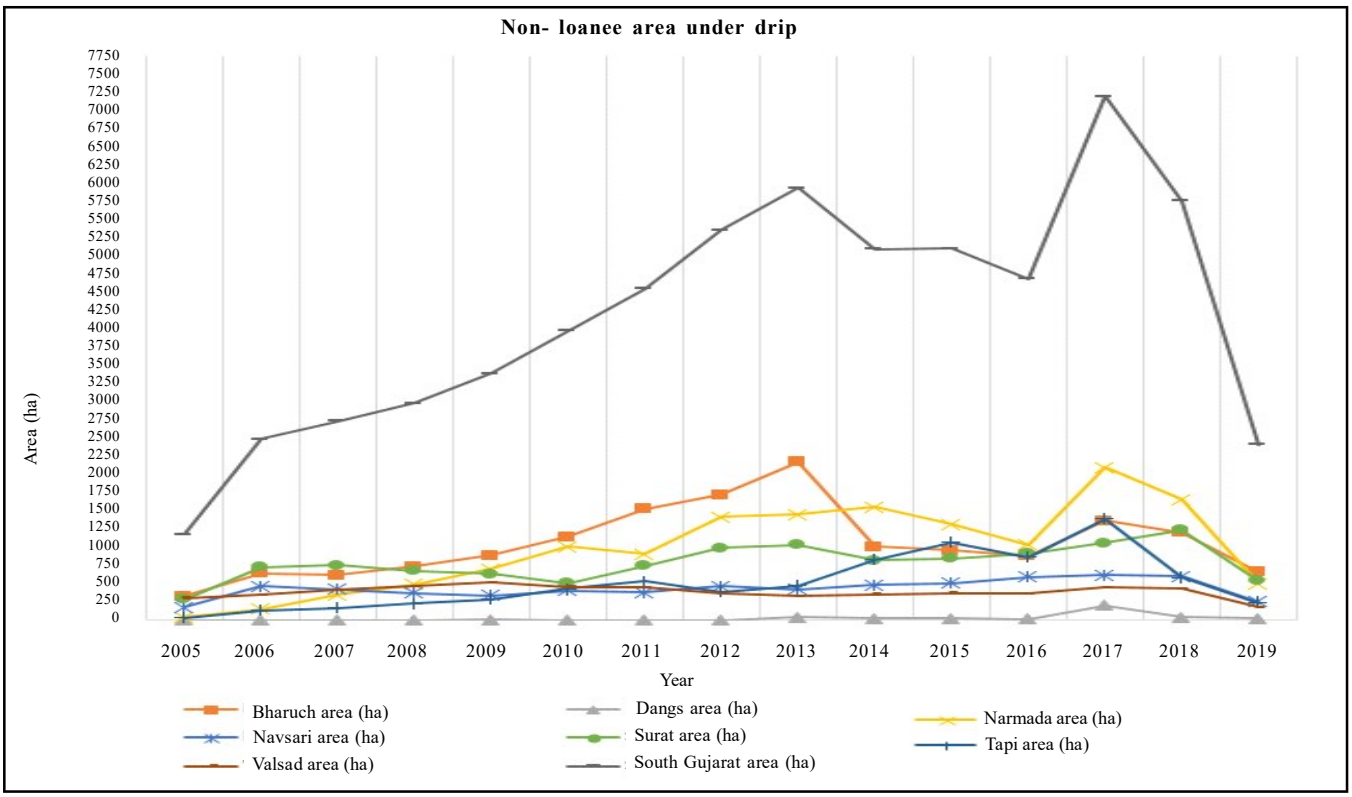

Fig. 2 : Compound growth rates and instability index for non- loanee area under drip method of irrigation (2005-06 to 2019-20)

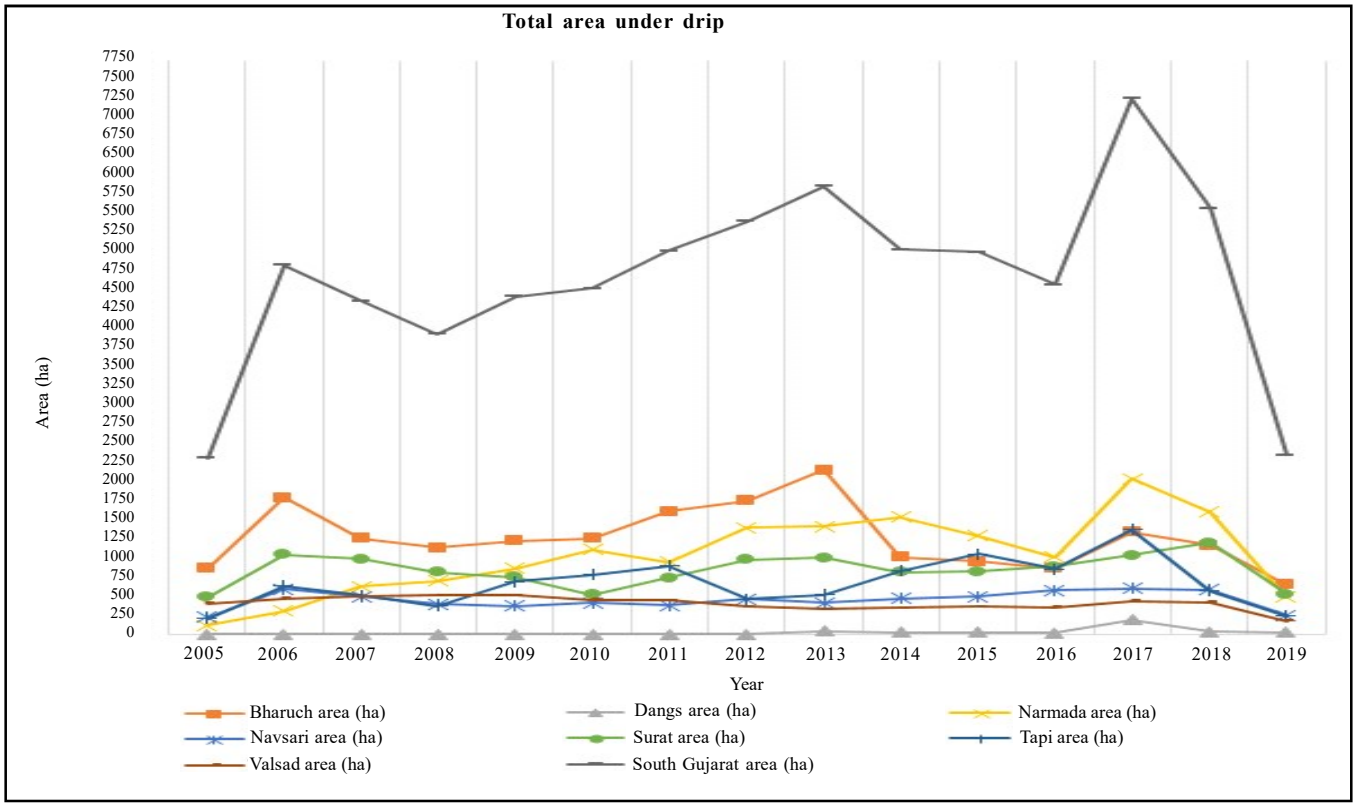

Fig. 3 : Compound growth rates and instability index for total area under drip method of irrigation (2005-06 to 2019-20)

was -35.10 per cent indicating negative and highly significant growth. The negative sign indicated that the loanee area in the district was found to be decreasing over the years probably due procedural difficulties in obtaining loans which was discouraging especially to the less educated and illiterate farmers. Conversely, the growth rate obtained for non–loanee area was found to be positive and highly significant *i.e.* 17.93 per cent per annum. The total area under drip method of irrigation registered a positive and highly significant growth of 11.08 per cent. The variability in loanee, non–loanee and total area under drip in the district was high *i.e.* 56.15, 42.74 and 39.51 per cent, respectively.

Further, Navsari district registered the highest annual negative growth rate which was found to be highly significant so far as loanee's area under drip was concerned (47.02 %) implying declining trend of loanee area in the district. On the contrary, the growth rate for non–loanee area was observed to be 3.45 per cent, which was positive but non-significant. Similarly, the growth in total area under drip method of irrigation was reported to be 1.54 per cent which was also positive and non-significant. The variability in loanee area was found to be high *i.e.* 59.21 per cent whereas the variability in non–loanee and total area under drip in the district was moderate *i.e.* 25.18 and 25.34 per cent, respectively.

The growth rate of area under drip method for loanee respondents in Surat district was reported to be -42.50 per cent indicating negative and highly significant growth. The growth rate for non–loanee area was worked out to be positive and significant at 4.63 per cent. However, the total area under drip was found to grow marginally at 1.25 per cent per annum *i.e.* positive but non-significant growth. The instability indices indicated that the variability in loanee area was high *i.e.* 46.90 per cent while the variability in case of non–loanee and total area under drip was moderate *i.e.* 25.63 per cent and 24.54 per cent, respectively.

With regard to Tapi district, the growth rate of loanee area was negative and highly significant (-33.06 %). On the other hand, the growth rate for non–loanee area was positive and highly significant (16.48 %). The total area under drip method of irrigation registered a positive and non-significant growth of 3.41 per cent per annum. The instability indices in case of loanee, non–loanee and total area under drip in the district were high *i.e.* 63.15, 50.54 and 44.79 per cent, respectively.

For Valsad district, the growth rate of loanee area, non–loanee and total area under drip method of irrigation was negative indicating declining area under drip method during the study period. However, the growth in loanee area (-45.61 %) and total area under drip was highly significant (-3.67 %) while the growth in non-loanee area was non-significant (-1.66 %). The variability in loanee area was found to be high *i.e.* 41.76 per cent whereas the variability in non–loanee and total area under drip was moderate *i.e.* 20.44 per cent and 16.94 per cent, respectively.

Moreover, with respect to South Gujarat as a whole, during the period 2005-06 to 2019-20, the area under drip method of irrigation in case of loanee respondents declined significantly at the rate of 34.96 per cent per annum. Some of the probable reasons could be the lack of bank finance for Micro irrigation System (MIS) emerging as a hurdle in upscaling, excessive documentation and other procedural formalities which were discouraging and also increased the transaction cost of less educated and illiterate farmers and the implementation of GST which led to increase in the beneficiaries cost.

On the contrary, the growth in the area under drip method for non–loanee households was positive and highly significant to the tune of 6.90 per cent. The total area under drip in the region registered a positive and non-significant growth of 1.70 per cent per annum. This indicates that there is tremendous potential to bridge the gap between the created and utilized micro-irrigation potential.

Moreover, the variability in loanee and non–loanee area was recorded to be high *i.e.* 40.31 and 30.09 per cent, respectively while the variability in total area under drip was moderate *i.e.* 24.95 per cent. Overall, it could be observed that the area under drip in all the districts of South Gujarat region demonstrated to be unstable during the period of study.

Conclusion:

The growing water scarcity in Gujarat state validates the adoption of water efficient technologies like drip irrigation. Every drop of water needs to be used optimally. Drip irrigation decreases the water need per unit of land resulting in and gives a substantial saving of water. The findings obtained through the study on the current status and growth performance of area under drip method of irrigation with respect to South Gujarat as a whole, during

the period 2005-06 to 2019-20, indicated that the area under drip method of irrigation in case of loanee respondents declined significantly over the years. Some of the probable reasons could be the excessive documentation and other procedural formalities which were discouraging and also increased the transaction cost for the less educated and illiterate farmers and the implementation of GST which led to an increase in the beneficiaries cost. On the contrary, the growth in non-loanee area was found to be positive and significant in majority of the districts of South Gujarat. Moreover, the variability in loanee and non–loanee area was recorded to be high *i.e.* that the area under drip in all the districts of South Gujarat region demonstrated to be unstable during the period of study.

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