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# Economic Impact of Sewage Water Use for Irrigation in Karnataka, India

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***ABSTRACT***

*Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened with increasing population growth and demand for high water quality for both domestic purposes and economic activities. A critical factor in the estimation of waste water generation is the population growth. Population of the Hubli-Dharwad twin cities is the second-largest in Karnataka, after Bangalore. The present study was based on primary data. The results indicated higher land use efficiency in the sewage water villages. Sewage water is a rich source of essential macro nutrients-nitrogen, phosphorus and potash and thereby contributed towards increased crop productivity and incomes of farmers. The farmers consider the resource as boon which provide water for irrigation throughout the year and serves as source of income and employment. Among the various problems faced by sewage water irrigation, the weed infestation was given utmost priority by the farmers as the sewage water carries countless number and variety of weed seeds.*

***Key words:*** *Sewage water generation, fresh water, Cropping pattern and Yield.*

## INTRODUCTION

Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened with increasing population growth and demand for high water quality for both domestic purposes and economic activities. The food requirement of the growing population will be about 450 million tonnes in 2050 as against the present highest food grain production of around 266.57 million tonnes. Two-thirds of this is obtained from irrigated food grain production areas. Thus, irrigation water requirement of the country is likely to exert tremendous pressure on our water resources in the future. In the semi-arid climate, where the summer temperature exceeds 35°c and the monsoon rains are erratic and unreliable, the waste water is an extremely valuable resource for farmers of urban and peri-urban areas and many extract it from the nallas and underground sewer pipes to irrigate their crops. This is considerably cheaper than digging a borehole.

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This practice is more accessible to farmers with lesser investment. The waste water also provides an irrigation source during the dry season, which enables farmers to sell their produce for three to five times the kharif (monsoon) season prices[5], while its high nutrient load increases crop yields and also reduces the need for costly fertilizer input. This farming practice alleviates poverty for many urban and peri-urban farmers. It simultaneously places producers, consumers' products and the environment at risk. The farmers are in close contact with the untreated waste water, containing pathogens and the high levels of anaemia found amongst them can be attributed to water-borne parasitic diseases and worm infestation. The waste water also contains potentially injurious bio-medical waste (including disposable needles and syringes), which after tilling operations becomes half buried in the soils creating hazardous conditions for farmers during work in the fields. Unregulated and continuous irrigation with waste water leads to environmental problems such as salinisation, phytotoxicity (plant poisoning) and soil structure deterioration (soil clogging), which in India is commonly referred to as 'sewage sickness'.Keeping afore said facts in view, the present study aims at analyzing the impact of waste water use for irrigation in Dharwad district with an objective to compare the impact of utilization of sewage water and fresh water for irrigation on cropping pattern, yield and income.

## MATERIALS AND METHODS

The Hubli-Dharwad Municipal Corporation is the second largest corporation in Karnataka state which is partially provided with underground drainage system. About 60 million litres of sewage is being generated every day in these twin cities. The untreated sewage water is being utilized by the farmers in nearby villages along the sewage discharge canals for the past 30-35 years. This might have affected crop yields, soil health and underground water quality.

Keeping in view the objective of the study to collect a primary data, multistage random sampling procedure was adopted for the selection of the district, taluks, villages and farmers. In the first stage, Dharwad district was selected as it serves as an agricultural representative of Karnataka state. In the second stage, Hubli taluk was selected where Hubli city's sewage waste water generated is being extensively used for irrigation purpose by farmers. In the third stage, three villages based on the sewage water used for irrigation and one village based on fresh water used for irrigation from Hubli taluk were selected for the study. These villages will purposively have selected which are located along the sewage discharge channel from a very close distance to Hubli city under Hubli-Dharwad Municipal Corporation where a large volume of sewage water flows through and used for irrigation in these villages. The village Parsapur in Hubli taluk located adjacent to the above villages where fresh water is used for irrigation was selected as a control village for the purpose of comparison. The data collected from these villages served as the primary sources of data. In the fourth stage, a sample of 30 farmers who are using sewage water for irrigation in each of these villages were selected randomly for the purpose of study. Thus, a total sample of 90 farmers where sewage water is used for irrigation were selected. Another 45 sample farmers were selected randomly from control village Parsapur for the purpose of comparison who used fresh ground water for irrigation. Thus, a total of 135 farmers were selected for collection of the required information for the study. The data was collected using pre-tested and well-structured schedule. The farmers were personally interviewed. The data collected were presented in tabular form to facilitate easy comparisons. The results were summarized with the aid of statistical tools like Tabular analysis (averages, percentages *etc.*), Statistical test of significance and Garrett's ranking technique to draw valid and meaningful conclusions.

## RESULTS AND DISCUSSION

In consistence with the objectives of the study, the necessary data collected from different sources were analyzed and interpreted. The

results of such analysis are presented and discussed in this chapter under the following headings.

Cropping pattern, yield and income in the study area

Advantages and problems in sewage water irrigation

**Cropping pattern, yield and income in the study area**

**Cropping pattern**

The farmers in the study area cultivated crops in all the three seasons' *viz.*, kharif, rabi and summer. Among the three seasons, kharif was the major season with a large cultivated area followed by rabi (Table-1). It is evident from the cropping pattern during kharif, maize-a cereal crop, commercial crops like-soybean, cotton was being cultivated in both waters. During rabi season maize and rabi sorghum were the major crops. Leafy vegetables and tomato occupied 25 to 27 per cent area under sewage and fresh water villages during summer season. The annual gross cropped area in fresh water irrigated village was highest at 19.40 acres compared to 12.98 acres in case of sewage water irrigated villages. It could be observed that there was a prominence of kharif crops (30% and 43%) over rabi crops (20% and 29%) in respective water categories in that order. Interestingly, it could be observed from the cropping pattern that perennial horticultural crops occupied considerable (about 25%) area in sewage water villages with the advantage of growing seasonal crops as inter crops. There was also a considerable area under fruit crops namely guava and sapota in sewage water villages. A higher cropping intensity of 257 per cent in sewage water villages was observed as compared to intensity of 230 per cent in fresh water village. This higher intensity was largely influenced by allocation of area under plantation crops. This shift towards diversified crops (seasonal and perennial) in sewage water villages as against fresh water showed farmer's inclination towards more remunerative crops. It could be concluded that there was a shift in the cropping pattern resulting into an increased cropping intensity an indicator of higher land use efficiency in the sewage water villages. Hazare[4] reported similar finding in his study that there was a shift from less remunerative crops to more remunerative crops. The technology adoption in terms of varieties cultivated showed a strong inclination towards the high yield varieties and hybrids in respect of all the crops both by sewage and fresh water irrigated farmers. Thus, farmers' tendency to adopt high yielding varieties for higher productivities under both conditions of irrigation could be seen.

**Crop yield performance under sewage and fresh water irrigation**

The crop productivity is a critical parameter for measuring performance of farm business. Soybean, maize, cotton and sorghum are the major seasonal crops grown with sewage water and fresh water. Crop yield levels was higher in the sewage water over fresh water irrigated crops (Table-2 and Fig-1).

The productivity level of maize was more in sewage water irrigated farms (23.60 qtls/acre) compared to fresh water irrigated farms (16.51 qtls/acre) showing an incremental yield of 30.04 per cent. The similar results were found in case of soybean, cotton and sorghum with an increase by 21.28 per cent, 13.38 per cent and 25.08 per cent yield, respectively. The sewage water with high levels of beneficial nutrients such as nitrogen, phosphorus and potash facilitated higher crop yields. The findings of the study are in line with the results obtained by Ahmed *et al*[1]., in Pakistan where the spinach yield was increased by twenty-three per cent with one per cent use of sewage water. Similar findings were observed by Kiziloglu *et al*[6]., in Turkey where the increase in cauliflower and red cabbage yield with the application of untreated waste water by 29.05 and 28.57 per cent, respectively as compared to fresh water.

**Annual household income of farmers**

The households derived their income from various farm and non-farm sources. Thus, average per family income derived from various sources including agriculture is presented in Table-3. They included income obtained from agricultural and horticultural enterprises, livestock, labour income, income from service, business and pension. The farm

income accounted the largest share in the total income in both categories of farmers and it was highest in case of farmers of sewage water villages at ₹2,14,357 per farm with a share of 70.85 per cent followed by ₹1,20,975/farm having a share of 50.60 per cent in fresh water villages. Thus, it showed an increase in income by 43.57 per cent among sewage water villages over fresh water control village. This was due to higher yields and plantation crops in sewage water villages. The livestock income of households in sewage water villages was less by 45.92 per cent over control village due to highest number of livestock animals in fresh water village. Income from labour employment through wage earnings in agriculture and allied activities accounted about 4 per cent to the total both in sewage and fresh water villages, respectively and registered an increase in income by 29.50 per cent compared to fresh water village. This was due to more labours were required in sewage water villages as high weed infestation in sewage water irrigated crops. Thus, the average household annual income among sewage water villages was ₹3,02,554.14/farm as against ₹2,39,083.96/farm in fresh water control village with 20.97 per cent higher household among farmers of sewage water villages. The t-test applied to analyse the differences in mean incomes between sewage and fresh water farm households revealed higher income levels of sewage water village farmers over fresh water village farmers from agriculture, livestock, service, pension and total income, which showed a significant difference at 1 per cent probability level. However, there was no significant difference in respect of labour income and income from business between the two categories of farmers.Thus, it could be concluded that the annual average income from farming was more among the farmers of sewage water villages compared to fresh water village owing to sustained availability of nutrient rich irrigation water round the year coupled with substantial income contributed from plantations and vegetable crops on considerable area in these villages. Thereby, the families in the sewage water villages were economically considered to be better-off than their counterparts in control fresh water village. Similar inference was drawn in the study conducted by Samina and Mehmood[8] in Pakistan who reported that the impact of waste water irrigation on household income was considerable as waste water farmers earned approximately US$300/annum more than farmers using freshwater and similar findings were also observed in the study conducted by Bhamoriya[2].

**Advantages and problems in sewage water irrigation**

**Advantages of sewage water irrigation**

The use of sewage water for irrigation has been a traditional practice in the hinterlands of urban areas or in the urban and peri-urban areas. The farmers consider the resource as boon which provide water for irrigation throughout the year and serves as source of income and employment. The advantages of sewage water irrigation are presented in Table-4. In spite of the problems posed by sewage water use in agriculture and quantitatively captured the farmers consider sewage water availability as boon. On the positive impact of its use in agriculture, 92 per cent farmers revealed that the sewage water is nutrient rich and promotes better crop performance. The opined that the use of sewage water for irrigation has reduced the dependence on fertilizer application to crops and accordingly they applied less fertilizer and reported to have realised higher per acre crop yields in case of sewage water irrigated crops as against fresh water crop yields. The reduced application of fertilizer has resulted in saving considerably amount on fertilisers and thereby resulting in to higher profits.The water forms a critical input in agriculture and transform towards achieving higher productivity and returns. The productive capacity of land enhanced due to water availability has its impact on the rental value of land and land value appreciation. The increased land values intern also is an indicator of status symbols among the village community. The results indicated the appreciation in both rental and market value of land. The rental value of land which has access to sewage water round the year was ₹ 4200/acre/season as against ₹3500/acre/season

in the control village with ground/fresh water irrigation. Similarly, there was also an appreciation in the land value accessed to sewage water at ₹14,90,000/acre against the value in control village at ₹13,60,000acre. Study by Rusan *et al*[7]., observed increase in crop yield due to finite concentrations of essential macro-nutrients such as nitrogen (N) and phosphorus (P) contained in waste water.

**Problems faced by farmers in sewage water irrigation**

The ranks indicated farmers' preference on problems in sewage water irrigation. The results of the analysis are given in Table-5. In the ranking method weed infestation was given utmost priority by the farmers and ranked first with mean score of 81.99 as the sewage water carries countless number and variety of weed seeds along with it and thereby when water gets pumped into the farm the weed seeds also get imported along with it. As majority of farmers shared that they witnessed many weed species that they never seen before. The weed and pest infestation have risen phenomenally since last 10-15 years thereby increased the cost of plant protection measures and weeding operation.The second and third ranks was given to pest and disease attack (70.53) and soil hardening and cracks (64.15), respectively as the supply of nutrients in high doses would render the leaves, stems and other parts of crops more succulent and more pest and diseases attack to crops. Also the sewage waste water flowing through the canal might carry numerous eggs of pests that enter the fields of the farmers when this water gets pumped into the farms lands and thus affect the quality of produce. Water borne diseases (58.03), incidence of snails (54.69), debris accumulation (53.86) and lower keeping quality of produce (43.92) occupied next four positions as the sewage water canal serve as perennial breeding ground and depositing large cache of snails onto the farmers' fields during the season which damage the standing crops. The farmers also implied that despite several (chemical control and physical-hand picking, burning, etc) management measures the problem persisted making it endemic in these villages and unable to get rid of the problem. The above findings were in line with findings of Samina and Mehmood[8] in Pakistan. Whereas, the turbidity of ground water and mosquito problem ranked eighth and ninth positions with score of 41.71 and 33.14, respectively. Last rank was given to skin problems (32.58) due to direct contact of farmers with sewage water during irrigation. The above results were in line with findings of Bradford *et al*[3].

**Table 1: Cropping pattern of the sample farmers during 2014-15**

| Season | Crop | Variety | Sewage water villages (n=90) | Fresh water village (n=45) |
|---|---|---|---|---|
| **I. Kharif** | | | | |
| 1. | Soybean | JS 335 | 0.96 (7.40) | 2.54 (13.09) |
| 2. | Maize | CP 818 | 1.66 (12.79) | 3.19 (16.44) |
| 3. | Cotton | Kanaka | 1.28 (9.86) | 2.69 (13.87) |
| **A** | **Sub-total** | - | **3.90** (30.05) | **8.42** (43.40) |
| **II. Rabi** | | | | |
| 1. | *Rabi* sorghum | M 35 1 | 1.43 (11.02) | 3.97 (20.46) |
| 2. | Maize | CP 818 | 1.18 (9.09) | 1.76 (9.07) |
| **B** | **Sub-total** | - | **2.61** (20.11) | **5.73** (29.54) |
| **III. Summer** | | | | |
| 1. | Leafy Vegetables | Local | 2.26 (17.41) | - |
| 2. | Tomato | Hybrid | 0.97 (7.47) | 5.25 (27.06) |
| **C** | **Sub-total** | - | **3.23** (24.88) | **5.25** (27.06) |
| **IV. Plantation Crops** | | | | |
| 1. | Guava | Lucknow/ Sardar | 1.94 (14.95) | - |
| 2. | Sapota | Cricket Ball | 1.3 (10.02) | - |
| **D** | **Sub-total** | - | **3.24** (24.96) | - |
| **V.** | **Gross Cropped Area** | - | **12.98** (100.00) | **19.40** (100.00) |
| **VI.** | **Net Cropped Area** | - | **5.05** | **8.42** |
| **VII.** | **Cropping Intensity (%)** | - | **257.62** | **230.40** |

Note: Figures in the parentheses indicate percentage to the gross cropped area

**Table 2: Productivity levels of major crops in the study area**

| Sl. No. | Crops | Sewage water villages (n=90) | Fresh water village (n=45) | t-Value | Percentage difference in productivity |
|---|---|---|---|---|---|
| 1 | Maize | 23.60 | 16.51 | 122.14*** | 30.04 |
| 2 | Soybean | 11.70 | 9.21 | 31.91*** | 21.28 |
| 3 | Cotton | 10.46 | 9.06 | 29.78*** | 13.38 |
| 4 | Sorghum | 12.36 | 9.26 | 43.35*** | 25.08 |

*** - significant at 1 per cent probability level

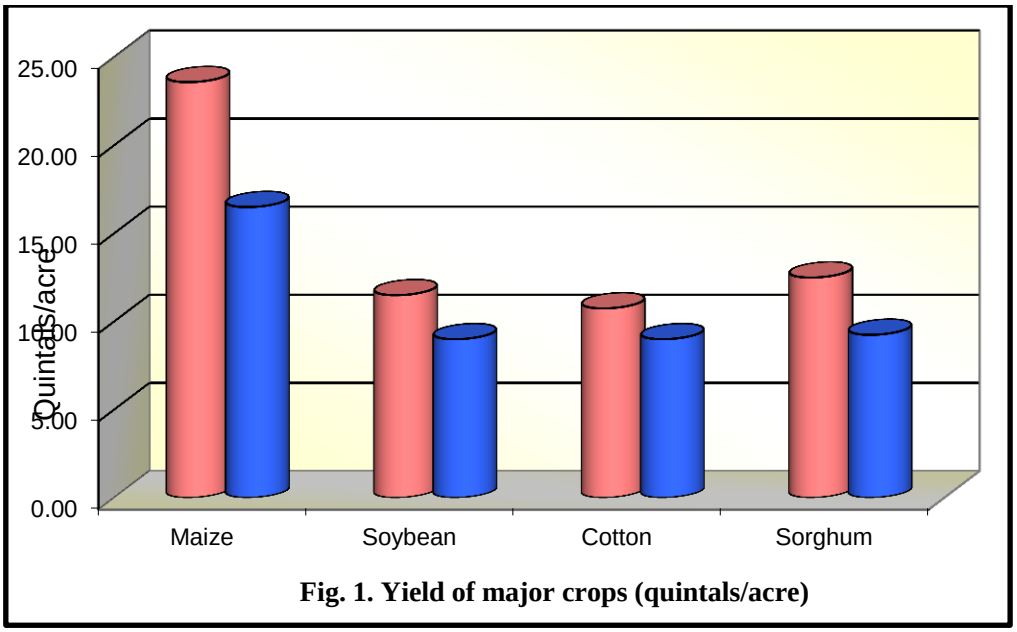


**Fig. 1. Yield of major crops (quintals/acre)**

**Table 3: Total annual income of sample farmers**

| Sl. No. | Source | Sewage water villages (n=90) | | Fresh water village (n=45) | | Percent difference in income level | t-value |
|---|---|---|---|---|---|---|---|
| | | Amount | Per cent | Amount | Per cent | | |
| 1 | Agriculture | 214357.14 | 70.85 | 120975.08 | 50.60 | 43.57 | 11.7552*** |
| 2 | Livestock | 48397 | 16.00 | 70620 | 29.54 | -45.92 | 7.7544*** |
| 3 | Labour | 14500 | 4.79 | 10222.22 | 4.28 | 29.50 | 1.3413 |
| 4 | Service | 19500 | 6.45 | 31000 | 12.97 | -58.97 | 3.2487*** |
| 5 | Pension | 3666.67 | 1.21 | 3066.66 | 1.28 | 16.36 | 6.7831*** |
| 6 | Business | 2133.33 | 0.71 | 3200 | 1.34 | -50.00 | 1.6975 |
| | **Total** | **302554.14** | - | **239083.96** | - | 20.97 | 11.2458*** |

*** - significant at 1 per cent probability level

**Table 4: Advantages of sewage water use in agriculture**

| Sl. No. | Particulars | Sewage water villages (n=90) | Fresh water village (n=45) |
|---|---|---|---|
| 1 | Less use of fertilizer | 83 (92.22) | - |
| 2 | Increase in productivity | 83 (92.22) | - |
| 3 | Land value (₹/acre) | 14,90,000 | 13,60,000 |
| 4 | Rental value of land (₹ /acre/annum) | 8400 | 7000 |

*Note: Figures in parentheses indicate percentage to total*

**Table 5: Problems faced by farmers in sewage water irrigation (n=90)**

| Sl. No | Particulars | Mean | Rank |
|---|---|---|---|
| 1 | Weed infestation | 81.99 | I |
| 2 | Pest and diseases | 70.53 | II |
| 3 | Soil hardening and cracks | 64.15 | III |
| 4 | Water borne diseases | 58.03 | IV |
| 5 | Incidence of snails | 54.69 | V |
| 6 | Debris accumulation | 53.86 | VI |
| 7 | Lower keeping quality of produce | 43.92 | VII |
| 8 | Skin problems | 41.71 | VIII |
| 9 | Turbidity in ground water | 33.14 | IX |
| 10 | Mosquito problem | 32.58 | X |

## CONCLUSION

Among the three seasons, kharif constituted a major season with a large per farm cropped area followed by rabi. It was evident from the cropping pattern that relatively a higher cropping intensity of 257 per cent in sewage water villages was observed as against 230 per cent in fresh water village. Thus indicated higher land use efficiency in the sewage water villages. Sewage water is a rich source of essential macro nutrients-nitrogen, phosphorus and potash and thereby contributed towards increased crop productivity and incomes of farmers. In general crop productivities in sewage water were significantly more than (10 to 30%) over fresh water yields. The annual average income from farming was more among the farmers of sewage water villages (₹ 3,02,554) compared to fresh water village (₹ 2,39,083) due to higher yields owing to sustained availability of nutrient rich irrigation water round the year. The farmers consider the resource as boon which provide water for irrigation throughout the year and serves as source of income and employment. Among the various problems faced by sewage water irrigation, the weed infestation was given utmost priority by the farmers and ranked first with mean score of 81.99 as the sewage water carries countless number and variety of weed seeds.

**Policy Implications**

Use of sewage water by farmers is extensively practiced in peri-urban areas resulting in an increased crop yields (10% to 30%) and returns over fresh water irrigation. Farmers found to adopt direct handling of this nutrient rich but highly contaminated water. In order to fix responsibility an additional tax could be imposed by the municipal corporations. The collected tax could be used to build water treatment plants for management and safeguard the overall health of the community.

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