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Research Article

URBAN WASTEWATER IRRIGATED AGRICULTURE AROUND HUBLI-DHARWAD, KARNATAKA, INDIA

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Abstract- India will become a water stressed nation by 2020 as the average availability of water is reducing rapidly with the increasing population. Within the twin city of Hubli-Dharwad approximately 110 million l of wastewater is generated every day. The present study was done to decipher the Urban Wastewater Irrigated Agriculture around Hubli-Dharwad, Karnataka, India using the primary data obtained by semi-structured interviews, participatory rural appraisal (PRA) technique and on-farm transect walks. Along the main Hubli wastewater nallas three distinct cropping systems are apparent: vegetable production; field crops with vegetables; and agroforestry. The perceptions of the farmers that they get more yields under sewage water irrigation compared to fresh water. Unregulated and continuous irrigation with wastewater also leads to soil clogging (sewage sickness), salinization and phytotoxicity. The treatment of sewage water to remove hazardous elements dissolved in it locally through socially acceptable, economically viable and cost-effective methods to sustain agricultural production, livelihoods systems and quality environment in the peri-urban areas is needed.

Keywords- Sewage water, Cropping pattern, Gender implication, Irrigation method.

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Introduction

India will become a water stressed nation by 2020 as the average availability of water is reducing rapidly with the increasing population. Hence use of non-conventional sources of water is inevitable to meet the future challenges of scarce water resource in terms of sustainability, food security, income security and environmental safety. The rapid expansion of cities and domestic water supply, quantity of grey/wastewater is increasing in the same proportion. About 70-80 per cent of total water supplied for domestic use gets generated as wastewater.

Within the twin city of Hubli-Dharwad approximately 110 million l of wastewater is generated every day: this flows, untreated, from sewers and wastewater nallas (open drains) into the natural watercourses that flow into the city's hinterland. In the semi-arid climate, where the summer temperatures exceed 35 degrees centigrade and the monsoon rains are erratic and unreliable, the wastewater is an extremely valuable resource for urban and peri-urban farmers and many extract it from the nallas and underground sewer pipes to irrigate their crops.

This untreated wastewater irrigation increases farmer income but in the contrary places consumers and environment at risk. The farmers are in direct contact with this wastewater during irrigation practice which contains pathogen and high amount of anaemia resulted in water-borne parasitic diseases and worm infestation. Also the bio-medical wastes (including disposable needles and syringes) are found in wastewater, which makes hazardous condition to farmers who work in wastewater irrigated field.

Hubli-Dharwad

Hubli-Dharwad, in southwest India, is the second largest urban agglomeration in Karnataka after Bangalore, the state capital. In Hubli, the main wastewater nalla flows to Bidnal, which is also now incorporated as a suburb. From Bidnal the nalla generally flows south passing on the village peripheries of Gabbur, Budarsingi and Katnur. In both Dharwad and Hubli smaller pockets of wastewater irrigation can also be observed in other areas of the city, however, the main areas of wastewater-irrigated agriculture are to be found along the two main nallas.

Methodology

A farming systems survey was conducted in March 2014 using semi-structured interviews, participatory rural appraisal (PRA) technique and on-farm transect walks. The survey was consisted of an orientation and familiarisation interview of the farming systems located along the main Hubli wastewater nallas. Villages namely, Gabbur, Katnur and Mavanur in Hubli taluk of Dharwad district identified as sample villages based on the extent of use of sewage water for irrigation. These villages were purposively selected as they are located on the sewage channel from a very close distance to Hubli city where a large volume of sewage water flows through and used for irrigation in these villages. The village Parasapur in Hubli taluk located adjacent to the above villages where fresh water is used for irrigation will be chosen as a control village for the purpose of comparison. This provided an opportunity to make contact with the farmers thereby identifying some of their main concerns, issues and constraints, in addition, the geographical extent to which wastewater is used for irrigation was also gauged.

During the survey group discussion was made with random sample farmers and some were interviewed. Cropping calendars and transect walks with the farmers in their field also supported the results from interview of sample farmers. Tabular analysis and graphical representation was used to analyse cropping pattern and yield. To achieve meaningful presentation of results, the data were compared and contrasted with the averages, frequencies and percentages.

Results and Discussion

Wastewater irrigated agriculture

Main Cropping Pattern

Along the main Hubli wastewater nallas three distinct cropping systems are apparent: vegetable production; field crops with vegetables; and agroforestry. The cropping pattern variation is resulted from various factors such as labour availability, farm size, market access, village conformity and soil types, with the major reason was the availability of wastewater itself. In the city and suburbs, where the wastewater supply is guaranteed, intensive vegetable production occurs. In locations where the supply is erratic and unreliable field crops and agroforestry predominate.

Agricultural crops like Maize, Sorghum, Soybean, Paddy, cotton and ground nut etc are cultivated. Horticultural crops like tomato, brinjal, radish and some leafy vegetables like palak, etc are cultivated. More than 85% of area cultivated is under agricultural crops and 15% of area is under vegetable crops. Nearly, 80% of the farm income is from horticulture crops in the village. The farmers grow Guava, Sapota, Custard Apple, Mango, Coconut, etc. The spectrum is depicted below.

Table-1 *cropping pattern of the sample villages*

Particulars		Katnur	Mavanur	Gabbur	Parsapur
		Area (%)	Area (%)	Area (%)	Area (%)
Khariff	Soybean	10	20	15	40
	Groundnut	05	03	05	15
	Maize	60	40	50	10
	Paddy	05	01	-	-
	Sugarcane	10	06	-	-
	Bt cotton	-	20	30	20
	Vegetables	10	10	-	-
Rabi	Maize	60	50	10	15
	Wheat	10	15	05	-
	Groundnut	10	10	-	25
	Rabi sorghum	10	05	40	45
	Chickpea	-	-	10	-
	Sugarcane	-	05	-	-
	Sunflower	-	05	-	-
	Vegetables	10	10	35	5
	Flowers	-	-	-	10
Plantation crops	Sapota	30	45	-	30
	Guava	30	30	-	-
	Mango	15	10	-	15
	Coconut	15	5	-	-
	Custard apple	-	5	-	-
	Banana	-	5	-	-

Crop Yield

The crop productivity ultimately is the critical parameter for measuring prosperity of farmers. [Table-2] provides results on the crop yield performance under sewage and fresh water production. Crops like soybean, maize, cotton, rabi sorghum, Guava, Sapota, methi and tomato were the crops grown in experimental villages, the farmers in the control village also cultivated these crops except Guava, Sapota and Methi. The perceptions of the farmers that they get more yields under sewage water irrigation compared to fresh water. This was reflected by higher crop yield levels in the sewage water over fresh water irrigated crops.

Table-2 *Crop yield under sewage water irrigation (q/acre)*

Particulars	Katnur		Mavanur		Gabbur		Parsapur	
	khariff	Rabi	Khariff	Rabi	khariff	Rabi	khariff	Rabi
Soybean	7.50	-	6.50	-	7.00	-	4.50	-
Ground nut	9.00	9	8	8.00	8.00	-	6.50	6.50
Maize	27.50	24	22.50	23.50	24.00	21.50	19.00	17.5
Paddy	9.00	-	11.00	-	-	-	-	-
Sugarcane (t/acre)	40.00	-	32.50	43.00	-	-	-	-
Vegetables	-	-	-	-	-	-	-	-
Bt. Cotton	-	-	9.00	-	9.00	-	7.00	-
Sunflower	-	-	-	5	-	-	-	-
Wheat	-	7.5	-	7.50	-	7.00	-	-
Chickpea	-	-	-	-	-	5.50	-	-
Rabi sorghum	-	8.5	-	9.5	-	8.50	-	6.50

As per the table, crops in general have higher yields in sewage water villages compared to control villages as indicated by the farmers. While, an increase in yield was by 30-40 per cent in case of soybean in sewage water villages over the control village. According to farmers, the sewage waste water carried high levels of beneficial nutrients such as nitrogen, phosphorus and potash and considers that is nutritious for the plant growth. The highest yield increases were found in maize and tomato (around 30%). The findings of the study are in line with the results obtained by Ahmed *et al*. (2006) [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*. (2008)[3] in Turkey.

Key issues

Impact of sewage water irrigation on health:

The use of sewage water in agriculture also bring about certain disadvantages as it carries along with it various unwanted, harmful substances and produce repercussions in more than one way to the crops, humans and the animals health in addition to the environment. It is unbearable to stand near the sewage water canal as it emits intense/foul smell. However, an attempt was made to capture the perceptions of the households in the sewage water irrigated villages on the health related problems they are facing**.** According to farmers of these villages, the waste water carries many harmful oils, greece and mixture of chemicals that might have been discharged from hospitals or industries of Hubli city. The farmers also acknowledged that the intensity of harmful substance that waste water carried along with it also has increased in the recent 8-10 years with increased human activities-industrious and domestic. Obviously the water contains huge population of harmful microbes. This has increased the incidence of skin diseases (19%) among the farmers and the serious risk of suffering from skin ailments in the years to come likely to increase. Moreover, the inflowing sewage water also carries disposed hospital wastes (as metals, needles, syringes, nails, glass pieces, sharp edged solid wastes, etc) that harm the farmers working with sewage water physically and may produce long-term implications. The foremost concern for these farmers is the cost of any medical treatment that is required if infection does occur. The farmers also on physical contact with hazardous elements present in sewage water, the nails of both hands get spoiled [Fig-1]. The sewage water forms a solid stratum for mosquitoes to grow and multiply. The mosquito menace is so much encouraged particularly in the sewage water used villages where members of few households informed of mosquito nets being provided for their cattle also. The villagers shared that they have been noticing the mosquito population growing exponentially especially in the last few years since the pollutants that contaminated sewage water multiplied due to human activities. They strive hard to protect themselves, and their children from the mosquito peril. These findings are in conformity with the findings of Srinivasan and Ratna (2009) [5].

Fig 1- Farmer diverting sewage water to field

Effect of sewage water use on soil properties

It is vital to know the impact on the soil properties after so many years of usage of sewage water for irrigation. Agricultural researches have proved that persistent application of high doses of fertilisers does have a bearing on the soil health. Also the oils, chemicals, metals, greece, and other acidic materials also are being carried by the sewage water through various domestic and industrial effluents of populated Hubli town. The water also downloads quintals of debris onto the agricultural fields [Fig-2]. All these are bound to have adverse and deleterious effect on-the soils physical and chemical properties albeit to various extent that depends upon the initial or baseline health of the soil. Most of the farmers have observed this phenomenon, though many opted not to speak out explicitly. This may have changed soil structure and its properties that will affect the productivity of the soil adversely in the long run. The microbial population that is beneficial to the soil also gets destroyed due to the deposition of chemicals, oils and acids contained in the sewage water [Fig-3]. Similar results were also observed in the study carried out by Ramanathan *et al*. (1997) [4].

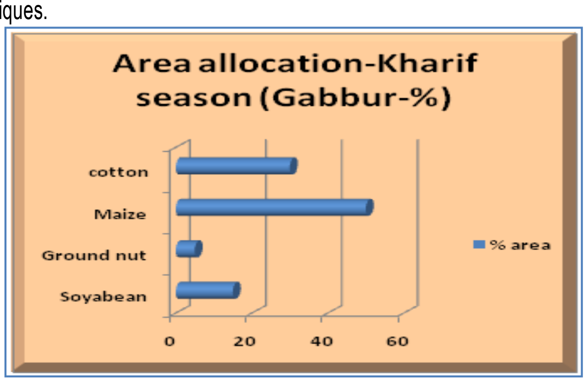
Fig 2- Debris collected in the sewage water canal

Fig 3- Sewage water impact on soil surface after irrigation

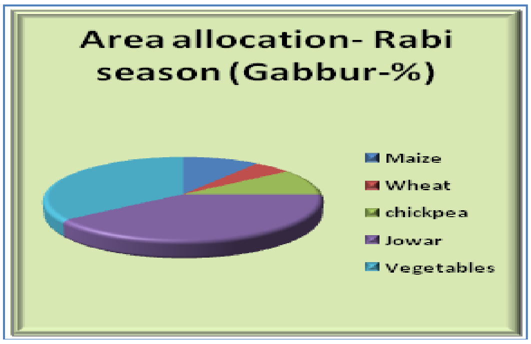
Pest and disease management

It was explicitly evident that the use of sewage water for irrigation contributed to the increased incidence of crop pests. Since, the farmers today are exposed to various information pertaining to the pest management (including the Integrated Pest Management measures), one can expect a good number of farmers having adopted improved pest management practices. The farmers in the sewage water villages as well as in the fresh water village practiced some of the IPM measures to manage pests.

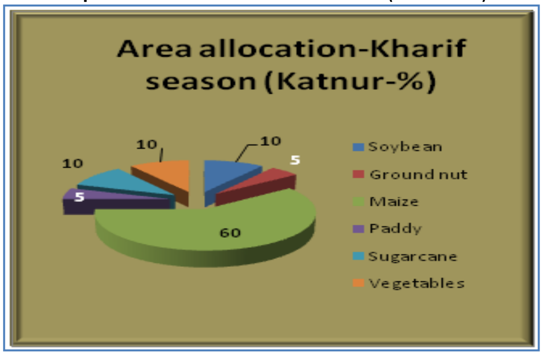
Mechanical shaking, hand picking and use of neem extract are being followed. Among the IPM measures, use of plant origin pesticides seemed to be the most popular IPM measure followed both in sewage water villages and in fresh water village. However, majority of the farmers resorted to non-IPM measures using insecticides and fungicides for the control of pests. This was mainly because of greater awareness among the farmers on chemical measures over IPM techniques.



Graph 1- Area allocation-Kharif season (Gabbur-%)



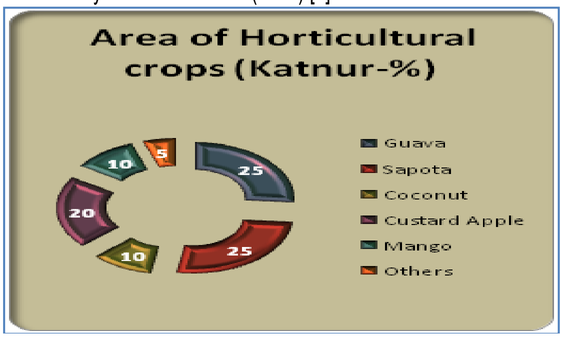
Graph 2- Area allocation-Rabi season (Gabbur-%)



Graph 3- Area allocation-Kharif season (Katnur-%)

Impact of pests and diseases on crops

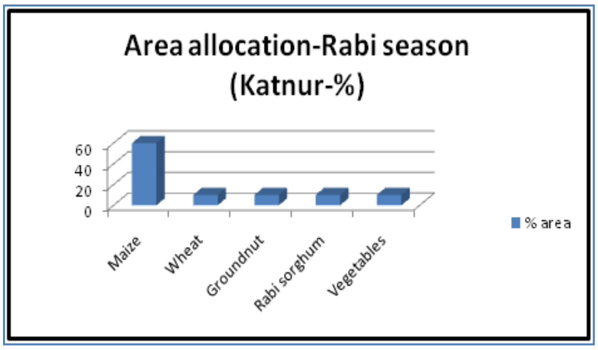
It is interesting to note the perceptions of the farmers on the extent of incidence of pests and diseases and subsequent damage caused to major crops. The respondents opined that cotton and soybean faced the brunt of pest and disease attack causing major damage to the crops. When asked about the incidence in the past 5 years, they informed that the incidence has been medium across crops. The damage was more during *kharif* season to the extent of 35.25 per cent and 50.75 per cent in cotton and soybean crops, respectively. The farmers used hand picking and mechanical shaking as IPM measures along with non-IPM methods using chemical based control measures. Similar results were also observed in the study carried out by Blumenthal *et al*. (2001) [2].



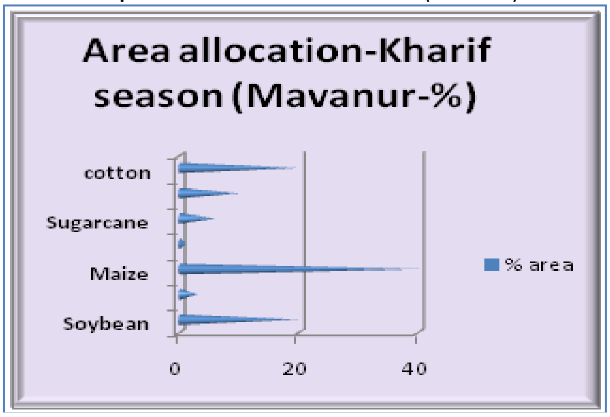
Graph 4- Area of Horticultural crops (Katnur-%)

Policy implication

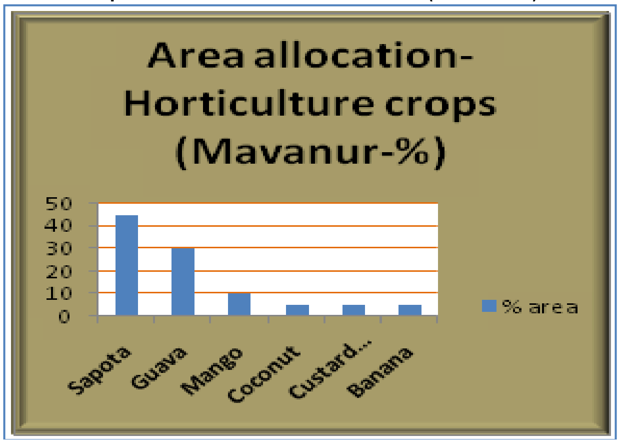
Need for treatment of sewage water to remove hazardous elements dissolved in it locally through socially acceptable, economically viable and cost-effective methods to sustain agricultural production, livelihoods systems and quality environment in the peri-urban areas. Wastewater treatment plants would certainly mitigate the public health and environmental risks that are associated with the wastewater use. Secondly, the actual moulding of wastewater irrigated agriculture has been hugely influenced by pesticide dealers; this has resulted in farmers becoming completely dependent on local pesticide dealers for their biased agricultural advice, which is inevitably linked to pesticide sales rather than that of good farming practices. The lack of institutional support in the form of extension services for urban and peri-urban farmers has only compounded the situation and strengthened the position of the pesticide dealer. Extension services are not provided to urban and peri-urban farmers because their farms are located within the official city boundary.



Graph 5- Area allocation-Rabi season (Katnur-%)

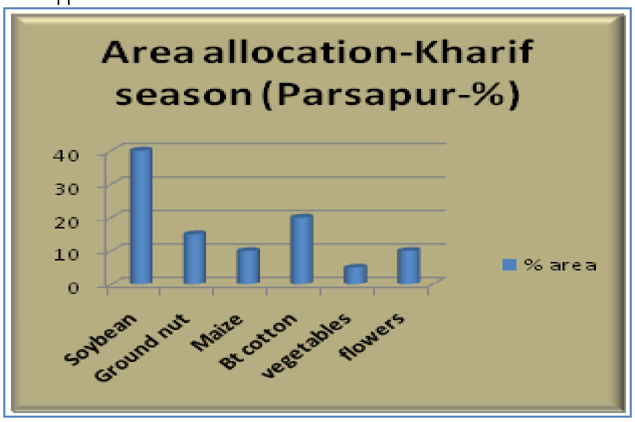


Graph 6- Area allocation-Kharif season (Mavanur-%)

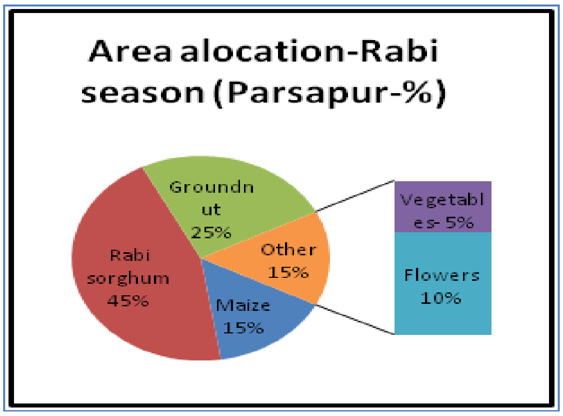


Graph 7- Area allocation-Horticulture Crops (Mavanur-%)

The outright banning of wastewater irrigation would be both unpractical and infeasible, in addition, for urban and peri-urban farmers the poverty implications of such a measure would be vast. Therefore, the attainment of a 'proper management' approach is vital if the public health and environmental risks are to be mitigated without threatening the livelihoods of marginalised farmers; the key to such an approach lies in education.



Graph 8- Area allocation-Kharif season (Parsapur-%)



Graph 9- Area allocation-Rabi season (Parsapur-%)

Fig 4a

Fig 4b- View of pumping of sewage water from the canal using drum filter

Conclusion

Rapid urbanization places immense pressure on the fragile and dwindling fresh water resources and over-burdened sanitation systems, leading to environmental degradation. Thus, at this point of time wastewater is a resource of increasing importance. However, use of such sewage water without proper management poses high risks to human health and cause environmental degradation. Availability of sewage water according to farmers is a boon as a water source for irrigation along the sewage canal and provides opportunity to expand irrigated area and thereby explore potential benefits from its use. Sewage water is a rich source of essential macro nutrients-nitrogen, phosphorus, potash and there by contributed towards increased crop productivity and incomes of farmers and thereby induced either reduced or no use of fertilizer for crops. Heavy weed infestation and of diverse varieties of weed seeds observed due to sewage water irrigation amounting to increased cost on weeding operation. Direct handling of hazardous, contaminated and untreated sewage water without any precautions by farmers. Use of sewage water for long has left resulted in several heath related problems such as diarrheal diseases, cholera, malaria and typhoid among the farmers. Thus to conclude "Safeguard and strengthen livelihoods and food security, mitigate health and environmental risks and conserve water resources by confronting the realities of wastewater use in agriculture through the adoption of appropriate policies and the commitment of financial resources for policy implementation" is of paramount importance.

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I author- Radhika V S: Data collection, Review, Analysis and Draft preparation
II author- Dr. G N Kulkarni: Interview questionnaire, Methodology finalized and Correction of
final draft

Abbreviations: IPM- Integrated Pest Management

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest: None declared

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