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Farmer's Perception of River Water Contamination in India: A Case Study of Rohini River in Maharajganj, India

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ABSTRACT

Background: River water is an indispensable natural resource supporting economic and social development. River has largely been exploited for supplying water for human consumption, livestock drinking, irrigation and other purposes. Despite these benefits, in developing countries, rivers are subjected to various anthropogenic and natural sources of pollution. Hence, the present study aimed to capture farmers' perception of river water contamination and its impact on farm productivity and human health.

Methods: A comprehensive field survey was carried out in the villages of Maharajganj district of Eastern Uttar Pradesh, India from 1 September to 30 September 2021. One control village (polluted) and one uncontrolled (non-polluted) village were selected using a multistage sampling technique. In totality, 1 state, 1 district, 1 Tehsil, 1 Development Block, 2 villages and 100 samples were selected.

Result: The results from the study show that farmers are well aware of river water contamination. Hence, the present study recommends the following policy measures. First, a necessity for proper policy, training, and more information on health precautions as well as on food safety in using contaminated river water. Second, when formulating relevant measures, differentiated should be taken for different groups of farmers. Lastly farmers with high dependence on cultivated land may need the most attention.

Key words: Crop productivity, Farmers' perception, Health, River water contamination.

INTRODUCTION

Water is the most essential natural resource and is utilized in a wide range of contexts and at varying intensities around the planet (McDonald and Kay, 1998). It is one of nature's most vital gifts for keeping everything from microbes to people alive. Rapid industrialization in emerging nations aided economic growth, but it also had a significant negative impact on agricultural operations, human health and the environment as a whole due to water pollution (Reddy and Behera, 2005). The contaminated water adversely affected agricultural productivity and restricted to yield of crops. In this connection, Prabhu (2009) finds that organic pollution in Akaki water body and irrigation with contaminated river water containing variables amount of heavy metals leads to increases in the concentration of metals in soil and vegetables and impacts negatively. High concentrations of metal will degrade soil fertility and also make poisonous vegetables (Kim *et al*., 2015). Arsenic is the king of poisons, high concentration of arsenic in drinking water and the food chain has caused severe health problems (Mukharjee and Bhattacharya, 2001).

River water is an indispensable natural resource supporting economic and social development. River and streams have largely been exploited for supplying water for human consumption, livestock drinking, aquaculture, irrigation, industries, transportation, recreation and other purposes (Barakat *et al*., 2016). Despite these benefits, in developing countries, rivers and streams are subjected to various anthropogenic and natural sources of pollution. These include expansion of urban, industrial growth, agrochemicals run-off, municipal and domestic wastes (Oketola *et al.,* 2013). As a result, organic, nutrients, trace metals and potentially hazardous substances are introduced in river system, causing deterioration of river water quality.

Further, river water pollution has negative effects on human health, economic stability and agricultural productivity (Singh, 2020a). In addition, pollution's negative impacts on water quality have a domino effect, harming aquatic life while upsetting the natural order of things and decreasing the bioavailability of drinkable water. Consuming polluted water on a frequent basis may have serious consequences for human health, including reduced blood flow, nausea, vomiting, diarrhoea, skin sores, cholera and harm to the central nervous system (Afroz, 2014).

The cross-country and cross-sector spill-over of environmental pollution through of waterborne effluents continues to be an important topic of research in environmental economics (Costantini *et al.,* 2013).

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Environmental pollution, as it is unambiguously accepted in the subject in general is a public 'bad' requiring interventions to ameliorate the negative externality associated with it. The loss of agricultural production and lower land fertility owing to pollution transmission are therefore central to various adjustments that an economy may have to endure. Effect of trans-boundary pollution generated by an upstream country on the welfare of a downstream country through trade linkage offers the mainstay of the present study.

The literature on the use of contaminated river water shows that farmers are well aware of the risks associated with it (Haghi *et al*., 2020; Chen *et al*., 2022). A study conducted by Haghi *et al.* (2020) in Iran revealed that more than 60 per cent of farmers perceived high or very high risk from treated wastewater use in crop production resulting in low crop yield with high input cost. The study also claimed that there is no specific source of information available on the subject for farmers. Further, extension services provided by the government were the most common source of information, followed by relatives and fellow farmers, which are relatively less aware of river water pollution. A responsible person like the local farmer help desk which is the only reliable source of information hardly engaged with farmers to deal with wastewater issues.

Likewise, Chen *et al.* (2022) have conducted a study on farmers' perception of heavy metal-polluted cultivated land. The results show that farmers are aware of land pollution due to heavy metal but the cost of land treatment is beyond their capacity, hence, they are not in a position to deal with the existing crisis. Further, Zhou *et al.* (2022) have conducted a study in Hubei Province, China on the impact of heavy metal pollution in farm productivity and also captures farmer's perception on the use of polluted mining water in agriculture. The results demonstrate that knowledge and information have significant positive effects on perceptions. They divided farmers into two groups namely farmers' adaptation perception and risk perception. A low level of adaptation perception, for which technology is the most important limiting factor followed by money, limits the adaptation behaviors of farmers. In additions, farmers' characteristics have significant effects on adaptation behaviors. Farmers tend to engage in adaptation behavior according to the actual situation of their family such as income and obligations. Withanachchi *et al.* (2018) have conducted a study in Mashavera River Basin, Georgia to capture farmers' perception of the water quality and their perceived risks to the economy. They found that aesthetic attributes (*i.e*., color changes observed in the river) and the sources of the water contamination (*i.e*., mining sites) were the main predictor variables for a perceived risk to water quality, health and livelihoods. The people who work in agriculture as the main income source had more concern about their ability to sell their agricultural products as a result of water contamination in river, compared with people for whom agriculture is a secondary source of income. The results also show that the health risk is perceived more strongly in areas with more heavily contaminated water compared to less polluted areas. Yonggua *et al.* (2001) have estimated the impact of industrial pollution on agriculture, human health and industrial in Chongqingm, which is one of the heavily polluted mega cities in China. It was estimated that the total costs of industrial pollution were 1.2 per cent of Chongqing's gross domestic product (GDP). Of this, 56 percent is in agriculture sector, while the damages to human capital and industrial sector are 20 per cent and 18 per cent, respectively. Further, Hanif *et al.* (2020) have conducted a study to evaluate the Kapotaksha river water pollution status and its impacts on human health. The findings of this study highlight that the polluted water due to various types of diseases such as scabies, asthma, dysentery and respiratory disease. Most of the people (49 per cent) are affected by scabies, 4 per cent are affected by diarrhea, 5 per cent are affected by dysentery, 25 per cent of people are suffering from respiratory diseases and 4 per cent suffering from asthma and the polluted water pollutes soil by using the water in agriculture purpose answered by 20 per cent respondents. If someone does not use contaminated water can not affect soil answered by 80 per cent of respondents. In totality, they find that river water becomes more polluted and harmful for human health and environment because contaminated water hampered by the local colony, local trader, lack of proper management of sewage system, mis-use on the river bank area for the dumping various soil waste on the river bank, chemical fertilizers, industries *etc*.

Above mentioned studies highlights the nexus between river water contamination and livelihoods of farmers using contamination water for irrigation and drinking purposes. Hence, the present study aims to capture farmers' perceptions of river water contamination in the Maharajganj district of Eastern Uttar Pradesh, India. The study also recorded farmers' responses on the impact of contaminated river water on agriculture production and human health. How contaminated water is creating chaos among the farming communities living bank of Rohini River which is polluted by heavy metals.

MATERIALS AND METHODS

The present study was conducted in the two villages of Maharajganj district of Eastern Uttar Pradesh, India. The district lies between 27.15° North latitudes and 83.56° East longitudes. The study was carried out in the catchment area of Rohini River lies in the middle of Nautanwa and Nichlaul *Tehsils* (administrative unit) of Maharajganj district from 1 September to 30 September 2021. Further, a multistage sampling technique was adopted to elicit the socioeconomic and demographic characteristics of sample farmers. Farmers' perception of river water contamination and its impact on farm production and health was also captured using a pre-tested structured schedule. In the first step, Maharajganj district was purposively selected because the Rohini River is passing from it and affecting the livelihoods of farming communities. In the second step, one *Tehsil*

namely Nautanwa (administrative unit) was selected out of four *Tehsils*. In the third step, one Developmental Block purposively selected out of 12 Development Blocks In the fourth step, two villages (micro administrative unit) was selected. The selection criteria for villages were as follows. The first village namely Rajabari was selected as it is near the bank of Rohini River (exposed to river water contamination), while the second village namely Taraini was selected as it is far from the bank of Rohini River (more than 10 kilometers). In the fifth step samples from each village. farmers were selected using a systematic sampling technique. In totality, 1 state, 1 district, 1 *Tehsil*, 1 Development Block, 2 villages and 100 samples were selected to capture farmers' responses on river water pollution and its impact on agriculture and human health. The present study was carried out at Babasaheb Bhimrao Ambedkar University, Lucknow.

Lastly, farmer's perceptions on contaminated water are ranked by making used of Garrett's ranking technique. The technique was used to rank the preference mentioned by the respondents on different factors and aspects of the cultivation process (Garret and Woodworth (1969). Hence, responses ranked using following formula:

$$\text{Pe rcent position} = \frac{100\ (R_{ij}-0.5)}{N_j}$$

Where,

R_{ij}= Rank given for the i^{th} variable by j^{th} respondents.

N_j= Number of variables ranked by j^{th} respondents.

RESULTS AND DISCUSSION

Sources of River Water Contamination

Table 1 depicts sources of water contamination in the Rohini River. The statistics show that more than 90 per cent of sample farmers perceived that continuous industrial activities in the upstream area are responsible for river water contamination, while 86 per cent of farmers are dumping domestic waste into the river without proper treatment. With inadequate environmental laws, reverse boring is a common phenomenon in the area. More than 2/3 of sample farmers reported that industries situated far from the riverside are pumping their industrial waste in the river. Lastly, the majority of farmers (100 per cent) responded that they are mixing industrial waste in the water bodies. Our findings are in the line of Gupta *et al.* (2010). They have identified 54 points where domestic, agricultural and industrial wastes were dumped into the river. Only 15 (28 per cent) of these were authorized for dumping liquid waste, while for the remaining 39 (72 per cent) were not authorized by environmental authority.

Symptoms of river water contamination

Fig 1 depicts farmers' perception of water quality change in the sample villages. The results from Fig 2 show that the colour of the water has been changed due to water contamination. The intensity of water contamination is relatively high in Rajabari village compared to Taraini village. Where, more than 70 per cent of farmers belonging to the Rajabari perceived that colour of the water has changed, while only 12.50 per cent of farmers perceived that colour of the water is changed in Taraini. Further, about 69.50 per cent of farmers belonging to the Rajabari perceived that bad smell is always come from the water, while only 10 per cent of farmers belonging to the Taraini perceived smelly water. Furthermore, about 56.75 per cent of farmers belonging to the Rajabari perceived that the intensity of mud has increased during the past five years, while about 20.25 per cent of farmers belonging to the Taraini perceived muddy water. In totality, the intensity of water contamination in terms of change in colour, smell and particles is relatively higher in the contaminated village (*i.e.*, Rajabari) than that in Taraini. Our findings are in the line of findings of Withanachchi *et al.* (2018). They conducted study in Georgia to capture farmers' perception of the water quality and their perceived risks to the economy. They found the Mashavera River is contained with heavy metals. Farmers confirmed that color of water has been changed which is evidence of presence of heavy metals in the river water and affecting health and livelihoods of the farmers.

Farmers' perception of Contaminated Water use in Agriculture

Table 2 depicts farmers' perception of the impact of contaminated water on agriculture and health. The results show that the majority of farmers reported that contaminated water has an adverse impact. About 90 per cent of farmers reported that they are using contaminated water for domestic and agricultural purposes and the use of contaminated water has increased health expenditure. Further, 75 per cent of farmers perceived that contaminated water is damaging the crops and responsible for lower farm output. Our findings

Table 1: Sources of river water contamination.

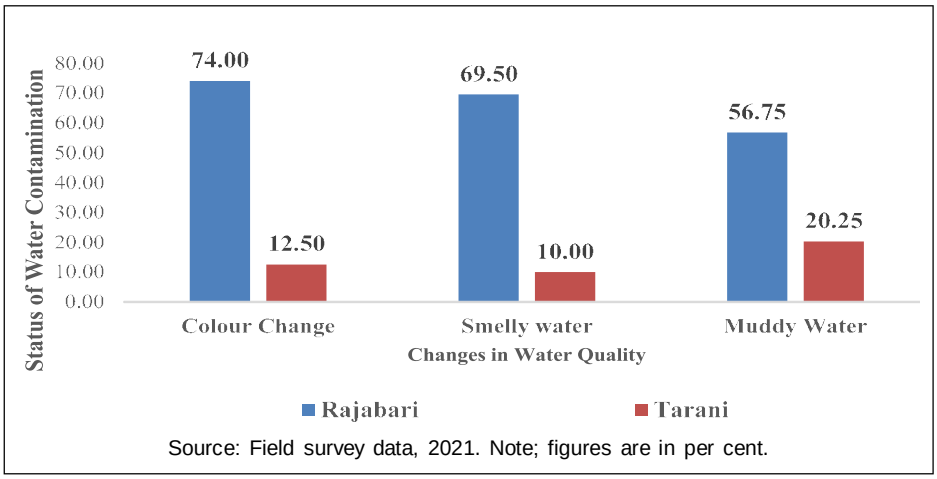
Indicators	Farmers' responses	Ranking
Dumping and mixing industrial waste in water bodies	100	I
Increased industrialization	95	II
Pumping industrial waste in farm land	92	III
Mixing of domestic waste in the water bodies	86	IV
Pumping of industrial water into under-ground through bore well	76	V
Partial treated water mixed in water bodies	75	VI

Source: Field Survey Data, 2021. Note; figures are in per cent.

are in the line of Chen *et al.* (2022). Their findings show that farmers are well-aware of adverse impact of contaminated water use in agriculture. Further, they reported that the cost of treatment of contaminated water is beyond their capacity.

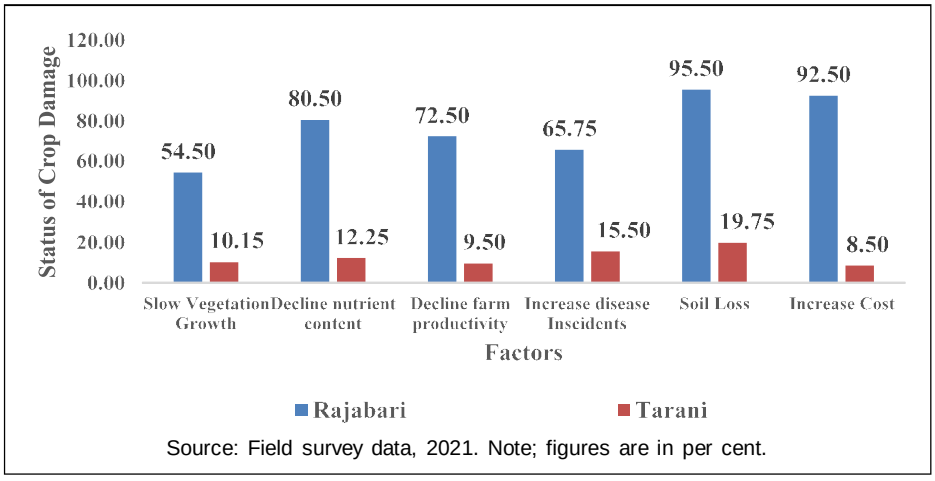
Impact of contaminated Water use in Agriculture

The use of contaminated water is creating negative externalities in farming. Fig 2 shows that water contamination exists in both villages, but the intensity is relatively higher in Rajabari (situated near the bank of Rohini River) compare with Tarani village. More than half of the farmers belonging to the Rajabari village responded that slow vegetation growth is one of the most visible impacts, while the corresponding figures in the Tarani village are only 10.15 per cent. Likewise, more than 80 per cent of farmers belonging to the Rajabari village reported that nutrient content has declined, while in Tarani village figures are much lower (*i.e.*, 12.25 per cent). More than 70 per cent of farmers reported in Rajabari village that farm productivity has declined, while less than 10 per cent of farmers responded. Control of pests and disease are also vital for sustainable agriculture production. The results from Fig 3 reported that more than 60 per cent of farmers belonging to the Rajabari village have perceived that the incidence of pests and diseases has increased, while corresponding figures in Tarani village are only 15.50 per cent. Further, more than 90 per cent of farmers belonging



Source: Field survey data, 2021. Note; figures are in per cent.

Fig 1: Farmers' perception of water quality change.



Source: Field survey data, 2021. Note; figures are in per cent.

Fig 2: Farmers' perception of the impact of contaminated water use in agriculture.

Table 2: Farmers' perception of contaminated water use in agriculture.

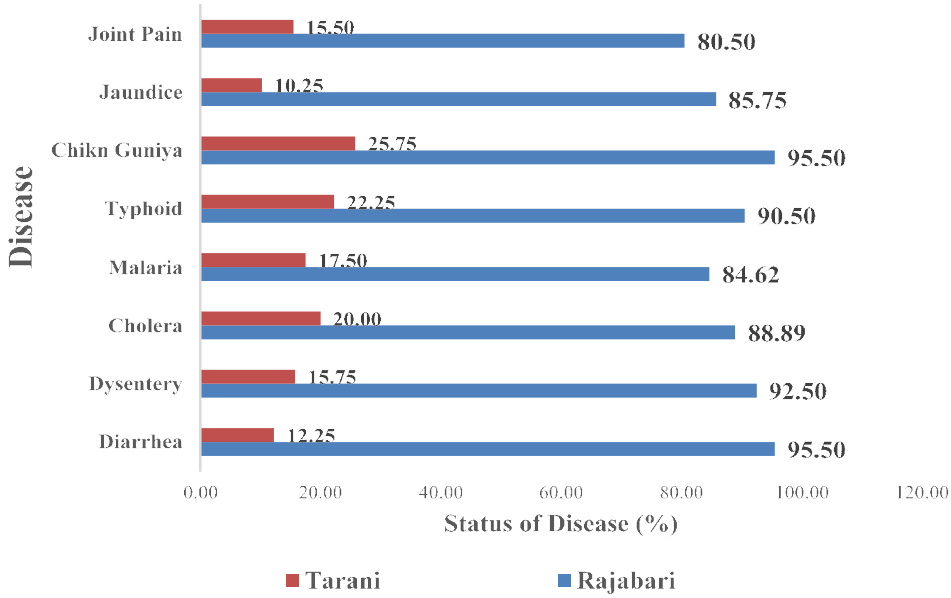
Indicators	Farmers' responses	Ranking
Contaminated water has increased health expenditure	95	I
Perceived that drinking water is contaminated	90	II
Agriculture water is contaminated	86	III
Contaminated water is damage to the crop	75	IV

Source: Field survey data, 2021. Note; figures are in per cent.

to the Rajabari village reported that due to the use of contaminated water, the fertility of the soil has declined, while only 19.75 per cent of farmers belonging to the Tarani village claimed. Lastly, more than 90 per cent of farmers in the control village (Rajabari) claimed that contaminated water has increased the cost of cultivation, while only 8.50 per cent of farmers belonging to the Tarani village claimed. Similar results are also reported by Haghi *et al.* (2020). They reported that more than 60 per cent of farmers perceived high or very high risk from treated wastewater using in crop production resulting in low crop yield with high input cost.

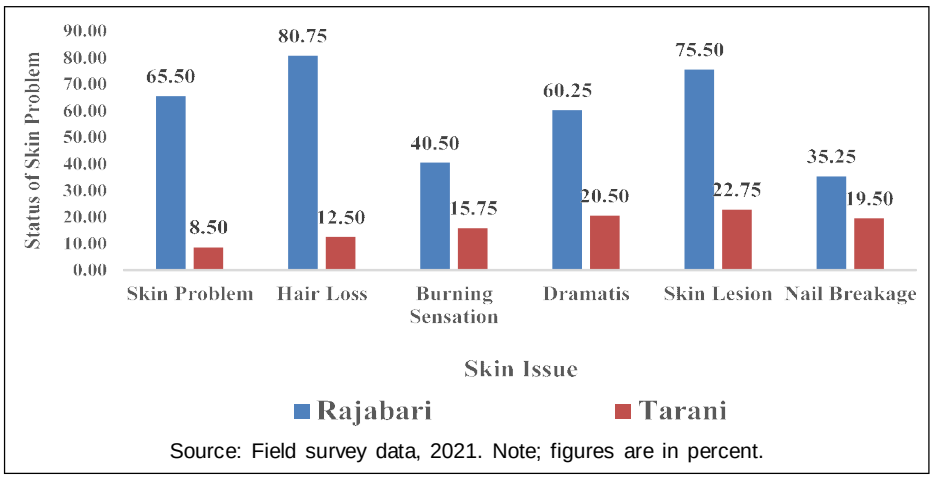
Impact of contaminated water on health

Fig 3 depicts the impact of contaminated water on farmers' health. Farmers have reported several health problems such as joint pain, jaundice, Chikn Guniya, typhoid, malaria and diarrhea due to drinking contaminated water. The results from Fig 4 show that more than 80 per cent of farmers belonging to the Rajabari village have reported that joint pain is a common health issue throughout the years and this is due to drinking untreated water, while only 15.50 per cent of farmers belonging to the Taraini village reported joint pain health issue. Further, 85.75 per cent of farmers belonging to the Rajabari village have reported that jaundice problem is common during the summer season, while only 10.25 per cent of farmers belonging to the Taraini village have reported. Likewise, results were also observed in the case of cholera, dysentery, typhoid and diarrhea. All of these health diseases have caused due to drinking unsafe water. Our findings are in the line of Woldetsadi *et al.* (2018). They



Source: Field survey data, 2021. Note; figures are in percent.

Fig 3: Impact of contaminated water on health.



Source: Field survey data, 2021. Note; figures are in percent.

Fig 4: Impact of contaminated water on skin diseases.

find that farmers are confirmed adverse effects of contaminated water use on health. Among the perceived health risks, skin problems were top-rated health risk while eye burn, sore feet and abdominal pains were rated highest across the four farming sites. To cope with this, farmers in Akaki-Addis, farmers' suitability perceptions of planting non-food produce and non-raw eaten crops were significantly higher than other farming sites.

Impact of contaminated water on skin diseases

Fig 4 shows the farmers' perception of skin infections due to contaminated water. It is observed that more than 65 per cent of farmers belonging to the Rajabari village have reported skin problems, while only 8.50 per cent of farmers belonging to the Taraini village have reported. Further, hair loss, skin lesions and nail breakage are common symptoms of adverse impact of contaminated drinking water. More than 80 per cent of farmers belonging to the Rajabari village have reported that hair loss has been relatively increasing from the normal level due to the use of contaminated water for bathing, while only 12.50 per cent of farmers belonging to the Taraini village reported the same. Moreover, about 35.25 per cent of farmers belonging to the Rajabari village have reported that nail breakage is now a common problem across the age- groups, while only 19.50 per cent of farmers have reported that nails have breakage. In totality, drinking contaminated water is severely affecting farmers' health and increasing health expenditure.

CONCLUSION AND POLICY RECOMMENDATIONS

The present study aims to capture farmers' perception of river water contamination and its impact on agriculture and human health. The findings demonstrate that farmers firmly believed that solid wastes needed to be removed from wastewater during its initial treatment before it could be used for irrigation. Most farmers recognize the potential fertility benefits of wastewater, but they don't know how to properly use it. All of these events highlighted the need of having well-defined policies, comprehensive training and updated information on health and food safety concerns related to the use of polluted river water. In addition, the government should provide funding for adequately reducing heavy metals from the water in order to enable farmers better adapt. Polluted communities need immediate action to convert farmland and compensate farmers. Finally, while developing appropriate responses, it is important to distinguish between various types of farmers. This may be especially true for poor farmers who rely heavily on their land for survival.

Conflict of interest: None.

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