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# IMPACTS OF INDUSTRIAL EFFLUENT ON CROP PRODUCTION IN MOKESH BEEL AREAS OF GAZIPUR DISTRICT

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## ABSTRACT

Industrial discharge is the prominent impediment of maintaining a congenial aquatic and terrestrial habitat. The present study was undertaken to evaluate the status of crop cultivation before and after industrial development in Mokesh beel area, where composite effluent of different industries are discharged intensively. Face-to-face interview was conducted among local relevant respondents to achieve the aforesaid objectives. Water quality of Mokesh beel was severely deteriorated and its usages were restricted mostly after industrial development. Remarkably decreased cultivation of rice, all vegetables, mango and jackfruit after industrial development were cited by maximum percent of respondents. Increased percentage of respondents (39 and 20%) mentioned that deformed fruit size and abnormal taste were maximized after industrial development than before, respectively. Besides decreased yield of rice and jackfruit was reported by majority of the respondents (75 and 84%, respectively). Maximum deterioration was reported of rice (27%) and jack fruit (25%) cultivation after industrial development. Industrial development in Mokesh beel area remarkably decreased crop production practices.

**Keywords:** Crop deterioration, industrial effluent, respondent, water quality, yield

## Introduction

The economy of Bangladesh depends mostly on agricultural enterprises but recently different industrial growth plays significant roles on it. In recent years about 80% of total foreign currency is being earned through exporting of textiles goods and at the same time it creates huge number of employment opportunities (Chowdhury 2015). Therefore, the textile industries development has reached significant level in Bangladesh within last 15 to 20 years. The highest number of textile industries present in Gazipur district, near capital city of Dhaka. Mostly these are dyeing, knitting, spinning, finishing and textile accessories (Haque *et al.* 2022). Besides, there are ample number of pharmaceuticals, tannery, chemicals, footwear and other industries existing in Gazipur district also. Perhaps the Kaliakair upazila (an administrative unit of the district) of Gazipur district, Bangladesh has achieved the top ranked of industrial development than the others. Increased industrial development usually generates vast amount of industrial effluent. Hossain *et al.* (2018) reported that only colored industrial effluent was discharged 217 $m^3$ in 2016 and it is projected that the textile dyeing industries of Bangladesh will discharge 203,000 million liters of effluent in each year since 2021 and onward (Haque *et al.* 2021a). Careless and indiscriminate disposal of effluents are being carried directly to the surface water reservoirs, agricultural fields, irrigation channels, canals and rivers etc (Sultana *et al.* 2009, Jaganathan *et al.* 2014), which might have negative impact in agronomic practices.

Industrial effluents comprise different chemicals of both organic and inorganic pollutants which are toxic, carcinogenic and highly prone of causing damage to the central nervous system of human, aquatic and terrestrial lives (Arefin and Mallik 2017, Wang *et al.* 2020, Fouda *et al.* 2021, Sultana *et al.* 2009, Haque *et al.* 2021a,b, Markandeya *et al.* 2022). The textile effluent is recognized as the top ranked pollutants among all industrial sectors considering both volume and composition (Roy *et al.* 2010, Hossain *et al.* 2018, Haque *et al.* 2021a). Indiscriminate disposal of industrial effluents induces serious negative impacts on surface water, damage aquatic ecosystem, soil health and losses crop yield. It may cause significant alteration of qualities and habitat environment which might give rise to dwindling biodiversity of different

flora and fauna and enhance food toxicities by destroying whole ecosystems and ecosystem services (Tüfekci *et al.* 2007, Dudgeon 2019). Generally, the industrial effluents contain different heavy metals, among them cadmium, chromium, mercury, lead and nickel are remarkable, have no useful biological function but impose toxic effects to plants and animals even in low concentration (He *et al.* 2005, Tchounwou *et al.* 2012). The biotic components of aquatic ecosystem might be affected by carcinogenic, mutagenic and genotoxic effects of these metals leading to damage biodiversity and ecosystem services (Kheirallah *et al.* 2019, Haque *et al.* 2021a). Indiscriminate disposal of effluents may have great chance to intake of these toxic metals by human and animal body through different food chains. Therefore, due to health hazards the industrial effluents are not encouraged for irrigation. Because it may pose detrimental effect for both the crops and crop consumers (Ogedengbe and Akinbile 2011). Besides, discharge/application of industrial effluent to crop field might alter the physical, chemical and biological properties of soil which impair the production of crop yield.

Therefore, the present study was undertaken to evaluate the crop cultivation status before and after of industrial development in Mokesh beel area which is severely polluted due to indiscriminate discharged of industrial effluent.

## Materials and Methods

The study was conducted in Mokesh beel, [the 'beel' denotes the natural water reservoir, approximate area 1000 acres of land and 15 km far in north-east direction from Upazila head quarter of Kaliakair, Gazipur district of Bangladesh] is being intensively polluted by discharging of composite industrial effluent generally in the months of January and February each year. The necessary data were collected from studied area through face-to-face interview by pre tested questionnaire.

**Questionnaire preparation and respondent selection for interview**: Before preparation of questionnaire a survey was done for preliminary assessment to achieve the targeted objectives. Next a questionnaire was prepared in local language based on initial survey for collecting relevant information from the studied area. Randomly 80 respondents of both male and female were selected from respective area, who was minimum 25 years of old and had minimum primary education.

**Survey and data collection:** Prepared questionnaire was used to collect the necessary information. Face-to-face interview was conducted for collecting necessary information considering useful necessary questions. The information on water, crop biodiversity and cultivation status were collected on two different aspects such as before and after establishment of industries.

## Results and Discussion

Due to indiscriminate disposal of industrial effluents from several industries (mostly textiles) to Mokesh beel, it has lost its previous aesthetic beauty. In Table 5, it was cited clearly that 100% of the respondents mentioned that the beel's water was used for cooking, bathing, irrigation, several domestic activities, boating and recreational purposes etc before establishment of industries. Interchangeably, due to severe pollution of Mokesh beel's water, none of the above activities (except irrigation) was carried out now were expressed by 100% respondents (Table 1). The obtained results conveyed that the water of the Mokesh beel lost its color, taste and aesthetic scenery. Odor was too much pungent and color was grey to black based on opinion of 100% respondents. Excessive pollutants loading and significant discharges of industrial effluents to surface water (rivers/canals) decreased the water quality as well as lost the aesthetic values (Rahman *et al.* 2012). Almost similar fact i.e. river water pollution by discharges of industrial effluent was described by Hafizur *et al.* (2017).

Among the cereals crop, mostly rice and wheat were grown by farmers in Mokesh beel area. Maize was cultivated there but not in higher scale. Barley and millets were not well-known crop there. Based on the present survey, 90% respondents expressed their opinion that rice was intensively cultivated in Mokesh beel area before establishment of the industries but at present i.e. after establishment of industries only around 54% respondents shared the same opinion (Table 6). On the other hand, earlier wheat was intensively cultivated there shared by 91% respondents but at present none responded the same as before. Perhaps wheat crop could not sustain at industrial wastewater irrigated environment but rice

**Table 1. Respondent's response to water quality and usages status of Mokesh beel wastewater discharged with industrial effluent [Based on responses of (N) =80 respondents]**

| | Contents | Before establishment of industries | | After establishment of industries | |
|---|---|---|---|---|---|
| | | Comments | RP (%) | Comments | RP (%) |
| Water quality | Appearance | Excellent | 100 | Dirty and ugly | 100 |
| | Taste | Good | 100 | Bad and people could not use it. | 100 |
| | Odor | None any pungent odor | 100 | Pungent odor. Smell seems to chemicals from water. | 100 |
| | Color | Fresh water color | 100 | Grey to black color. Dying & washing are the main reasons. | 100 |
| Usages of water | Cooking | Yes | 100 | No | 100 |
| | Bathing | Yes | 100 | No. Skin diseases can occur if they used this water. | 100 |
| | Irrigation | Yes | 100 | Yes | 70 |
| | Domestic activity | Yes | 100 | No | 100 |
| | Animal's bathing | Yes | 100 | No | 100 |
| | Boating | Yes | 100 | Boating occurred but it was very rare. | 62.5 |
| | | | | Boating could not happen. | 37.5 |

**Note:** RP=Respondent perception

plants do not face problem to sustain at that environment too much. In Bangladesh wheat is grown in winter (dry and cold) season, no rain at that time and the discharges effluents became more concentrate because of no raining in winter. Perhaps these situations may impair the wheat cultivation. Rice is mostly grown in rainy season, which does not face similar situation as wheat. But at industrial wastewater irrigated situation sterility of rice was enhanced reported by Hossain *et al.* (2015). In case of cash crop, jute and sugarcane were not cultivated in Mokesh beel area but bamboo was there. Bamboo was cultivated as intermediate scale before establishment of industries were responded by maximum respondents but later the scale of bamboo cultivation was dropped expressed by above 71% respondents (Table 2). In industrial area, the disposal of effluents not only pollutes the water and soil of the disposed area, but also the surrounding air and soil become polluted by volatile gases and acid rains, which are common facts in industrial areas. Obviously, these environments impose negative impacts on living beings including plants and animals. None respondents expressed their opinion on growing of pulse crop in Mokesh beel area before and after establishment of industries there. Toxic soil and water by industrial discharges enforce negative impacts on crop seed germination. Total germination of mustard seeds (*Brassica juncea* L.) failed while it was irrigated with textile effluent (Molla and Khan 2018). Heavy metals exerted the most adverse effects on seed germination of different crops (Mahmood *et al.* 2007). Excessive heavy metals were noticed in rice grown near the disposed area of polluted wastewater (Uddin *et al.* 2016). Decreased crop cultivation in industrial areas was reported by Hossain *et al.* (2010, 2015).

In case of vegetable production in Mokesh beel area, the obtained results implied that high scale production practice of maximum vegetables except red amaranth, radish, sweet potato, potato, cauliflower and carrot were mentioned by higher percent of respondents before establishment of industries. But that situation was drastically changed after establishment of industries. The highest percent of respondent's perception was diverted to low production of all vegetable crops except amaranth (Table 3). Moreover, the lowest respondent's perception was recorded against the high scale production of vegetable after establishment of industries. However, the present results implied that the majority vegetable crops (Carrot, Amaranth, Ash gourd, Sweet gourd, Cauliflower, Brinjal etc.) were grown in Mokesh beel area and its production was high at prior establishment of industries. Existing environment impedes in some extent the production of all vegetables and the obtained reports present that some were under threatened and endangered situation. Bangladesh is the country, where plenty of vegetables growing are being practiced including the areas are located near the source of

**Table 2. Respondent's perception (%) on crop cultivation intensity in Mokesh beel area polluted by industrial effluent discharges [Based on responses of (N) =80 respondents]**

| Crop | | Before establishment of industries | | | | | | | | After establishment of industries | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | None | | Low | | Medium | | High | | None | | Low | | Medium | | High | |
| | | No. | Percent | No. | Percent | No. | Percent | No. | Percent | No. | Percent | No. | Percent | No. | Percent | No. | Percent |
| Cereal | Rice | - | - | - | - | 8 | 10 | 72 | 90 | - | - | 14 | 17.50 | 23 | 28.75 | 43 | 53.75 |
| | Wheat | - | - | - | - | 7 | 8.75 | 73 | 91.25 | - | - | 75 | 93.75 | 5 | 6.25 | - | - |
| | Maize | - | - | 10 | 12.50 | 30 | 37.50 | 40 | 50.00 | - | - | 50 | 62.50 | 25 | 31.25 | 5 | 6.25 |
| | Barley | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Millets | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| Cash | Jute | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Sugarcane | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Bamboo | - | - | 20 | 25 | 45 | 56.25 | 15 | 18.75 | - | - | 57 | 71.25 | 18 | 22.50 | 5 | 6.25 |
| Pulse | Lentil | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Mung bean | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Black gram | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Chick pea | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Grass pea | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Pea | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |
| | Pigeon pea | 80 | 100 | - | - | - | - | - | - | 80 | 100 | - | - | - | - | - | - |

**Table 3. Respondent's perception (%) on production of vegetable in Mokesh beel area polluted by industrial effluent discharges [Based on responses of (N) =80 respondents]**

| Crops | Before establishment of industries | | | | | | After establishment of industries | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | | Medium | | High | | Low | | Medium | | High | |
| | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent |
| Brinjal | 18 | 22.50 | 26 | 32.50 | 36 | 45.00 | 43 | 53.75 | 23 | 28.75 | 14 | 17.50 |
| Sweet gourd | 12 | 15.00 | 23 | 28.75 | 45 | 56.25 | 38 | 47.50 | 30 | 37.50 | 12 | 15.00 |
| Bean | 15 | 18.75 | 30 | 37.75 | 35 | 43.75 | 49 | 61.25 | 18 | 22.50 | 13 | 16.25 |
| Rib gourd | 10 | 12.50 | 21 | 26.25 | 49 | 61.25 | 52 | 65.00 | 23 | 28.75 | 5 | 6.25 |
| Ash gourd | 5 | 6.25 | 17 | 21.25 | 58 | 72.50 | 40 | 50.00 | 32 | 40.00 | 8 | 10.00 |
| Red amaranth | 17 | 21.25 | 36 | 45.00 | 27 | 33.75 | 37 | 46.25 | 33 | 41.25 | 10 | 12.50 |
| Amaranth | 15 | 18.75 | 26 | 32.50 | 39 | 48.75 | 32 | 40.00 | 39 | 48.75 | 9 | 11.25 |
| Snake gourd | 2 | 2.50 | 27 | 33.75 | 51 | 63.75 | 52 | 65.00 | 24 | 30.00 | 4 | 5.00 |
| Radish | 8 | 10.00 | 45 | 56.25 | 27 | 33.75 | 56 | 70.00 | 22 | 27.50 | 2 | 2.50 |
| Sweet potato | 30 | 37.50 | 50 | 62.50 | - | - | 65 | 81.25 | 15 | 18.75 | - | - |
| Cabbage | 14 | 17.50 | 32 | 40.00 | 34 | 42.50 | 45 | 56.25 | 22 | 27.50 | 13 | 16.25 |
| Cauliflower | 12 | 15.00 | 44 | 55.00 | 24 | 30.00 | 45 | 56.25 | 25 | 31.25 | 10 | 12.50 |
| Carrot | 20 | 25.00 | 55 | 68.75 | 5 | 6.25 | 44 | 55.00 | 36 | 45.00 | - | - |
| Pointed gourd | 55 | 68.75 | 25 | 31.25 | - | - | 66 | 82.50 | 14 | 17.50 | - | - |
| Potato | 37 | 46.25 | 40 | 50.00 | 3 | 3.75 | 56 | 70.00 | 24 | 30.00 | - | - |

heavy metals pollution like industrial areas (Ahmad and Goni 2010). Vegetables growing in industrial effluents discharged areas were high of heavy metals and it has high influence on carcinogenic risks of consumed people (Haque *et al.* 2021c).

All common fruits are grown in Mokesh beel area but mango, jack fruit, litchi, black berry and guava were the most common cultivated fruit crops there. Before establishment of industries production of mango and jack fruit received the highest respondent's perception (86 and 91%, respectively), which was dropped to 10 and 11% after establishment of industries (Table 4). It indicated that fruit production magnitude was decreased drastically after industrial development. The fruit production scale of black berry, litchi and guava was comparatively lower than the mango and jack fruit.

The fruit shape and texture of Mokesh beel area was influenced by industrial development. Before industrial development 83 and above percent respondents expressed their opinion in favor of normal shape and texture of all studied fruits in Mokesh beel area (Table 5). It indicated that before industrial development all fruits shape and texture was normal expressed by 83 and above percent of respondents and only 8-16% respondents shared their opinion that there were deformed fruits. The obtained report in Table 5, before industrial development deformed jack fruit was reported by 16.25% respondents only but after industrial development, higher number (38.75%) respondents expressed their opinion on deformed jack fruit. It suggested that deformed jack fruit number was increased after industrial development. Almost similar observations were recorded in all studied fruit crops.

Conversely, abnormal fruit taste was enhanced after industrial development also (Table 5). The majority percent of respondents shared their opinion about normal fruit taste before industrial development but the percent respondents were decreased in respect of normal fruit taste after industrial development. In general, the taste of all studied fruits was deteriorated in some extent by discharging of industrial wastes to the environment. During expression of opinion, the most of the respondents conveyed the message about pungent and bad smell of the fruits. It might be induced by the different chemicals present in effluents.

Fruit quality parameters of citrus were monitored after three consecutive years irrigation with wastewater to young citrus plants. The used wastewater was rich in sodium, chloride and boron, but both growth and fruit quality parameters were unaffected by the high levels of sodium, chloride and boron in wastewater (Reboll *et al.* 2000). In another study, increased concentrations of Zn and Cu in pepper fruit were noticed while it was grown with the addition of sewage sludges (Pascual *et al.* 2010). Textile dyeing wastewater was used to grow tomato in pot, however the researchers reported the dramatically reduced yield and physiochemical attributes of tomato. They didn't investigate heavy metals accumulation pattern in different plant parts of the tomato grown by applying as irrigation of textile dyeing wastewater but increasing trends of heavy metals in irrigated soil were monitored (Hassan *et al.* 2022). Awad *et al.* (1995) stated that sewage sludge application significantly increased the growth of apple seedlings but the Pb and Ni contents of fruits and leaves were slightly increased. Fruit yield and cumulative

**Table 4. Respondent's perception on fruit production in Mokesh beel area of Kaliakoir upazila in Gazipur district, Bangladesh**

| Crops | Before establishment of industries | | | | | | After establishment of industries | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | | Medium | | High | | Low | | Medium | | High | |
| | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent | Res. no | Percent |
| Mango | - | - | 11 | 13.75 | 69 | 86.25 | 55 | 68.75 | 17 | 21.25 | 8 | 10 |
| Jack fruit | - | - | 7 | 8.75 | 73 | 91.25 | 52 | 65.00 | 19 | 23.75 | 9 | 11.25 |
| Black berry | 8 | 10.00 | 28 | 35.00 | 44 | 55.00 | 45 | 56.25 | 24 | 30.00 | 11 | 13.75 |
| Litchi | 15 | 18.75 | 30 | 37.50 | 35 | 43.75 | 20 | 25.00 | 28 | 35.00 | 32 | 40.00 |
| Guava | 14 | 17.50 | 33 | 41.25 | 33 | 41.25 | 27 | 33.75 | 30 | 37.50 | 23 | 28.75 |

**Table 5. Respondent's perception (%) on fruit shape & texture, and taste in Mokesh beel area discharged with industrial effluent [Based on responses of (N) =80 respondents]**

| Crop | Fruit shape & texture | | | | Fruit taste | | | |
|---|---|---|---|---|---|---|---|---|
| | Before establishment of industries | | After establishment of industries | | Before establishment of industries | | After establishment of industries | |
| | Normal | Deformed | Normal | Deformed | Normal | Abnormal | Normal | Abnormal |
| Mango | 86.25 | 13.75 | 76.25 | 23.75 | 95.00 | 5.00 | 87.50 | 12.50 |
| Jack fruit | 83.75 | 16.25 | 61.26 | 38.75 | 96.25 | 3.75 | 82.50 | 17.50 |
| Litchi | 87.50 | 12.50 | 77.50 | 22.50 | 91.25 | 8.75 | 88.75 | 11.25 |
| Black berry | 91.25 | 8.75 | 73.75 | 26.25 | 96.26 | 3.75 | 80.00 | 20.00 |
| Guava | 88.75 | 11.25 | 81.25 | 18.75 | 95.00 | 5.00 | 86.25 | 13.75 |

**Table 6. Respondent's perception on yield reduction of major crops in Mokesh beel area discharged with industrial effluent [Based on responses of (N) =80 respondents]**

| Crops | Percent respondent perception | Percent decrease of yield | Remarks |
|---|---|---|---|
| Rice | 72.50 | 27 | Due to sterility |
| Jack fruit | 83.75 | 25 | Deformed and reduced fruit size |
| Litchi | 56.25 | 21 | Deformed and infested |
| Cucurbits | 62.50 | 18 | Reduced fruit setting |

yield efficiency of apple trees significantly increased with sewage sludge application (Bozkurt and Yarilgaç 2003). Application of wastewaters from domestic and industrial sources may have some positive effects on promotion of plant growth and fruit production but always it might not be true. Besides application of these wastewaters have great chance to enhance toxicity of consumable parts of the plants.

Decreasing yield of major crop was recorded in Mokesh beel area (Table 6). Majority respondents expressed their views that a remarkable percent of yield loss of rice, jack fruit, litchi and cucurbits was noticed in last few years i.e., after establishment of industries. In the present study 72.50% of respondents shared that the yield of rice was reduced about 27% in recent years. It was happened due to increase of sterility percent of spikelets in panicles, which was not noticed before (establishment of industries). Enhanced sterility percent of rice was recorded by Hossain *et al.* (2015) in their study on irrigation with industrial effluent to rice in pot cultivation. In Mokesh beel area jack fruit is the major fruit crop was affected in significant level after establishment of industries. The recorded report conveyed that 25% yield of jack fruit was deteriorated in recent years based on opinion of 83.75% of respondents (Table 6). A significant number of deformed and reduced sized fruits were remarked in maximum plants at present than the before. As like as rice and jack fruit incredible percent of yield loss was monitored at present in litchi and cucurbits also. No doubt the present situation is the output of changing of agro-ecosystems by disposal of different wastes from several industries. Decrease fertility, increase insect infestation and reduce yield of rice were reported from a study conducted in industrial areas (Afrad *et al.* 2020). Negative effect of industrial wastewater on crop yield was reported by Han-jie *et al.* (2022).

## Conclusions

Aquatic habitat of Mokesh beel was drastically deteriorated by indiscriminate discharge of industrial effluents. The situations decreased the cultivation and yield of cereals, vegetables and fruits as well as fruit quality in the studied area.

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