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ASSESSING THE ECONOMIC IMPACT OF TANNERIES' POLLUTANTS IN PAKISTAN

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ABSTRACT

The leather industry, which is dubbed "Noxious" around the world, is an essential element of Kasur's industrial heritage. Hundreds of individuals in Kasur are directly or indirectly involved in the tanning of leather. The study's goal is to determine the effects of the environmental deterioration caused by tanneries on the economic lives of Kasur residents. Crop output declines due to the detrimental impacts of waste emissions on the surrounding soil, posing economic hazards. The three most polluted areas of Kasur have been identified, and data from the study area is collected through In-depth Interviews from 30 potential respondents in those areas. The convenience sampling technique has been applied, while the Mix-method approach (qualitative and quantitative) is used for the analysis. It is found that toxic pollutants of tanneries have profound adverse effects on the animals' health such as cattle, poultry, fisheries, and adverse effects have been found on the production of meat and milk. The study suggests that the dangers of chemicals have a negative impact on those who live near chemical plants, both physically and economically. It proposes relocating industries away from residential areas.

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INTRODUCTION

Tanning is one of the world's oldest industries. To meet the local demand for leather, footwear, drums, and musical instruments, raw hides and skins are transformed into leather. Moreover, the industry is considered one of the most polluting industries because it generates a significant amount of solid and liquid waste. In the processing of one metric ton of raw hide, 600 kg of solid waste, and 40,000 m3 of wastewater are produced (Mottalib et al., 2014). This industrial waste, finally, discharged into rivers, canals, and open lands without any treatment.

Direct discharge of the huge amount of leather effluents into the nearby area and open land, where these effluents affect the soil, surface, and groundwater adversely and leave them uninhabitable for a feasible human life (Anbalagan et al., 1997). Around 8000-9000 cubic meters of heavily polluted wastewater have been extracted from a cluster of tanneries daily. The quality of soil has been badly affected due to the effluents and wastewater of tanneries which is discharged into the Rohi Nala for irrigation in downstream areas. Infertility and waterlogging caused by industrial effluents have also reduced yield in these areas. Furthermore, tannery effluents contaminate crops and reduce yields of wheat, rice, paddy, flower, and berseem. So, the fertility of the soil is under threat due to contaminated irrigation water (Gupta et al., 2007).

Contaminated water also damages the fisheries and aquatic life because untreated polluted water of tanneries, ultimately, leaches into the nearby fishing ponds, rivers, and seas. Effluents of the leather industry are haphazard and a hurdle for the growth of fish. In addition, many people are unwilling to purchase fish meat, produced in contaminated water of tanneries. So, the pollution of tanneries negatively impacts fisheries and aquatic life (Kibria et al., 2016).

Similarly, the commercial economy is also affecting due to the reduction of mangroves and shrimp production. The leaf litters of mangroves are the main source of nutrients and provide a habitat for many interdependent communities of

invertebrates, fish, reptiles, and birds. Around 90% of species living in the lakes, rivers, and seas use the mangroves for shelter for one stage of their life (Ghirardini et al., 2001). Moreover, the Chromium-d block element used in the tanning industry is recycled which is, later, used for feed production. It is revealed that insoluble particles of chromium in poultry chicken affect the health of those who consume such meat. Overgrazing of cattle across dumping sites and drinking water from a stagnant pool of tannery effluents decreases milk production. So, the health of the people living in other areas or cities may also indirectly affect these commodities. The people's economic lives are also affected due to the diminishing yield of crops, milk, etc., and reduces the sales of vegetables and editable crops because people are not willing to purchase them from the nearby areas of tanneries. Furthermore, the economy of fisheries is also affected due to the dripping of the species of fish in nearby fish forms or rivers (Losi et al., 1994; Sundar et al., 2010).

This study is conducted in District Kasur, Punjab's one of the important districts, that has observed a remarkable growth in agriculture, industrial, and especially in the leather sector. In contrast, the growth also led to the amplification of many environmental threats. The study aims to investigate the negative effects of environmental degradation on the economic life of people living in Kasur. Moreover, the study also tries to build a relationship between the economic life of people and tanneries' pollutants.

The study explores the impact of tanneries pollutants through economic risk, and economic risk is an unclear term with multiple definitions. In the context of this research study, it is the risk that an endeavour will be economically unsustainable, for many reasons ranging from a change in economic fashions to deceptive/fake activities which devastate the outcome of economic activity. Economic risk can make foreign investors reluctant to invest in business activities. There are many types of economic risks depending upon the nature of the business or economic activity. The economic risks are divided into two groups in the study. The first is associated with agriculture and the second is concerned with animals, birds, and aquatic life. The risks, in this case, are those which are caused by pollutants of the tanning industry.

Insight from the Literature Review

Research shows that many heavy metals pollute the rivers resulting from industrial effluents. These heavy metals such as mercury, cadmium, chromium, etc. pollute the water resources. The economic cost of these elements in industrial waste is severe in the Asia-pacific region in the context of quality of life (Ilyas et al., 2019). The hazardous pollutant of tannery plants signifies a severe risk for soil, vegetation, and groundwater when it is carelessly dumped on the ground (Santos et al., 2011). The tannery waste is found to be concentrated toxic metals, which ultimately negatively affect the soil and the growth of plants (Khalil et al., 2011; Mohajer et al., 2009).

In a developing country like Pakistan, the problem of water pollution is getting attention. Since the leather industry is the main economic sector of Pakistan's economy, tanneries produce many toxic wastes. This toxic waste includes trivalent and hexavalent chromium, which is hazardous to human health (Lambin et al., 1994). The retardation of germination of plants, seeds, and loss of soil productivity is also considered the causes of these chemical effluents and pollutants of tanneries. The economy of the common man affects due to diminishing the yield of crops. Moreover, people are not willing to purchase the vegetables grown in the nearby areas of tanneries. Furthermore, the economy of fisheries also affects due to the dripping of the species of fish in nearby fish forms or rivers (Gupta & Sinha, 2007).

The contaminated soil due to tannery pollutants exerted adverse effects on the growth, yield, and nutrition of grass, rice plants, and the negative effect of this water on rice crops. The contents of nitrogen, phosphate, and sodium decrease in rice pollutants, grown in contaminated soil. In the grass, the contents of sulphur and sodium are decreased and showed no influence on nitrogen phosphate and sulphur status of the soil (Islam et al., 2006). The contaminated water of tannery is harmful to the crops that drip the yield of wheat, rice, paddy, and berseem. Furthermore, the flower yield also decreases due to tanneries' polluted water. Consequently, contaminated irrigation affects the fertility of the soil (Gupta et al., 2007).

Human beings are revealed to many harmful metals due to the different anthropogenic and professional actions such as industrial processes, modern agricultural practices, and waste disposal. These industrial activities have increased the concentration of metallic pollutants in the environment, which cause toxicity to living organisms. However, the waste of leather industry, which is considered as one of the heaviest metal polluting industries in India, contains high amounts of dangerous waste and their content in effluents; sludge and the plant rising in the surrounding area of the industry were found at a tragic concentration (Barman et al., 2000).

Agricultural activities and surrounding groundwater are negatively affected by organic compounds considerably possessed by tanneries effluents and its inappropriate control causes serious threats to the environment (Dixit et al., 2015). Tannery effluents spoil the composition and fertility of the soil but at the same time cause surplus loading of two important toxic metals', sodium, and chromium. An increased level of Na in the soil can be toxic for plants. Moreover, it may cause solidity in neighbouring soils. Besides, the excess amount of chromium can also become toxic to plants and reach human beings through the food chain. The tannery effluent infected lands, near Depalpur Road, Kasur, Pakistan, have been rendered infertile due to long-term effluent logging from the leather industry (Bareen & Tahira, 2011).

For several decades, river pollution and freshwater depletion due to the development of tanneries in Bangladesh are causing serious problems. So, the development of the tannery industry in Bangladesh pulled the economy of Bangladesh into crushing pollution and depletion of the ecosystem. Finally, the environmental problems get worse. Yet export earnings from the tanning industry increase rapidly but tanneries effluents, which are directly discharged into the Furigana River, are responsible for the high Biological Oxygen Demand (BOD) and low Dissolved Oxygen (DO). This threat diminishes the quality of Furigana water severely. It is observed that a relation of trade lies between the export trend of the leather sector and Dissolved Oxygen values in furigana water and such relation is a crucial problem for any developing country to continue the economic growth. Lack of severe sewerage, infrastructure facilities, and inadequate wastewater management system are the main problems. On the other hand, lack of capital, education, and effective pollution control measures is greatly responsible for this tragic and grave situation (Biswas & Hamada, 2012).

A rapid industrialization process in developing countries has ended up in heavy losses to economic welfare in terms of human health and eco-system through water and air pollution (Reddy & Behera, 2006). The industrial sludge that is released into the sewage, finally, reaches into the soil with several heavy metals when it is used as a Bio-resource Technology to directly irrigate the agricultural land in most of the towns of India (Kansal, 1994). Pollutants of tannery plants cause various livestock diseases and decline the production of livestock. In addition to this, inadequate disposal of tannery wastes affects the fisheries sector as well by decreasing its production gradually (Tinni et al., 2014).

Cadmium is a potentially dangerous pollutant in the environment. Cadmium toxicity in fish has been reported to depend on water quality criteria (Calamari et al., 1980). The fishing industry is also, somehow, depending upon the shrimp supply but the loss of commercially imported shrimp in Pakistan is having a bad effect on the fishing industry (UNIDO, 1991).

Exceedingly contaminated and non-degradable metals that existed in the toxicity of tannery sewage have been discovered in the aquatic and global ecosystem (Aich et al., 2015; Chandra et al., 2009; Matsumoto et al., 2006). And these toxic metals, mainly, chromium have been testified to change the structure of bacterial activities in the ground which results in decreasing their action and delay their bioremediation potential (Cheung et al., 2007; Mishra & Bharagava, 2016). Piercing smell and dark brown colour of tanneries wastewater might be due to the presence of sulfides and azodyes respectively used for processing of skins, and these chemicals reduce the speed of photosynthesis by resisting the sunlight entering into the plant's cells, which finally disturb the aquatic life (Mahmood et al., 2013; Saxena et al., 2016).

When fishes discharged into the water mixed with effluents, they died within 2 hours after discharge. Conversely, in the presence of the bacteria, the fishes survived for 20 days. Moreover, by adding glucose to the treated effluents, fishes survived for 29 days. Interestingly, the chemical oxygen demand (COD) and concentration of chromium decreased in the bacteria-treated effluents (Mohanta et al., 2010). Excess use of chromium in leather industries has resulted in chromium contaminated soil and groundwater at production sites, which pose a serious threat to human health and fish, and other aquatic biodiversity (Turick et al., 1996).

METHODOLOGY

Risk to agriculture commodities and farm animals are the variables that have been identified by authors for analysing the economic risks. For that purpose, a convenience sampling technique is used to collect the information from the tanneries located in different areas of Kasur including, Niaz-Nagar, Din Garh, Roi Nala, and across the Lahore-Kasur Road. A total of 30 respondents were interviewed and each respondent was asked 10 questions. The questions were asked in Urdu, Punjabi and then translated into English. Different researchers have diverse opinions about the adequacy of sample size in qualitative and quantitative studies, but (Malterud et al., 2016; Boddy, 2016; Dworkin, 2012; Sandelowski, 1995) show that the sample size of 30-50 is enough when In-depth interview technique is carried out.

The interview guide is divided into two main parts to know the perceptions about the economic risks.

- Perception about Agricultural risks
- Perception about Animal risks

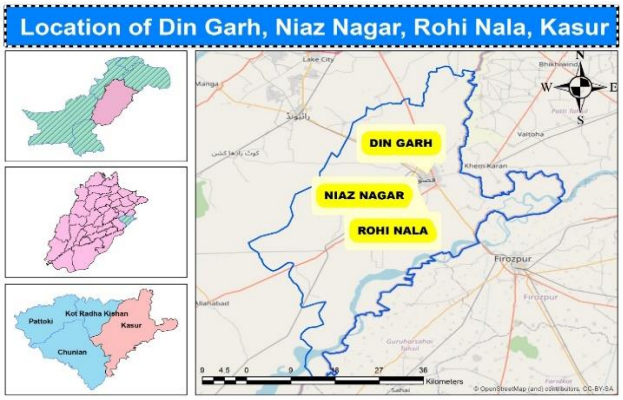

Figure 1. Location of Study Site
Source: DIVA-GIS

DATA AND DISCUSSION

Analysis of Economic Perspective

The Economic Risk is analysed in the context of the following perspective.

- Agriculture
- Animals (cattle, poultry, fisheries, etc.)

Table 1. Demographic Profile of the Respondents.

Socio-economic Background	Respondents	No. of family members working in tanneries
Urban	12	15
Rural	18	23
Total	30	38

Table 1 shows that a total of 30 potential respondents were selected based on convenience sampling in which 12 people reported to have urban background while 18 belong to the rural background.

Agriculture

The untreated effluents of the leather industry have embarrassed the farmers of Kasur and its nearby areas. The soil is unable to represent rich fertility. One of the respondents very pessimistically shares his ideas about his agricultural land as:

> I have 18 acres of agricultural land but only 12 acres are able for cultivation and the remaining 6 acres is fall prey to erosion due to mixing toxic effluents of tanneries in the groundwater of the surrounding area. I also want to become rich but producing cultivated land is much less than that of other non-affected areas' land. So, my dream of being rich would never reach to climax. Now, I do not believe just in my agricultural activities and do a job of a journalist to fulfill my dream.

He further added:

> We have complained many times to the D.C.O of Kasur, but he/she ignores us after making lame excuses. The most solid reason is that all the government and environmental officers have become corrupt, and the tanners bribe them on a timely basis. Financially, the tanners of Kasur are very strong people, so they are always given importance by the government officers and even the media. And as we know, the priority is always given to the power holders in our country so very scarcely the environmental pollution of Kasur tanneries may be controlled. But, if it might be possible somehow, the spread toxic effects of tannery effluents in agricultural soil would not get exonerate till the coming decades.
>
> (Respondent, 30)

According to Ullah et al (2009), the continued seepage of effluents into nearby areas results in a loss of soil fertility, contamination of groundwater aquifers, and unfavourable effects on cash crops such as wheat, corn, rice, and citrus fruits.

Another respondent stated that:

> We do not have the facility of the water-irrigation system as other areas have, so we cultivate in polluted water. This polluted water is not suitable for any type of life. For the irrigation of our crops, we must establish electric motors and tube wells which are also very costly. Because we must drill up to 800-1000 ft. When our tube wells are turned off due to load shedding, we use the polluted water of Rohi Nala (Kasur). We cannot bear to see our crops dry up due to a lack of water.
>
> (Respondent, 24)

Hence, it is investigated that the crops of surrounding farmers are damaging, and the yield of crops is also diminishing due to the penetrating and seepage of toxic effluents of tanneries in the agricultural land of surrounding areas.

Quantitative Analyses

As mentioned earlier, for the quantitative analyses of agriculture the most cultivating crops of district Kasur

are maize, rice, and wheat have been taken. Per-acre, the average cost and production of these affected areas are compared with per acre cost and production of another non-affected area.

Table 2. Average Production and Cost of Affected Area.

Sr. No	Crops	Average Cost (In Rs)	Average Production (In Mound)
1	Wheat	15000	35
2	Rice	22000	25
3	Maize	20000	30

Source: Based on Authors' Calculations.

In Table 2 the average cost and production of the three most cultivating crops of the affected area is mentioned. The average cost of the wheat crop is found to be 15,000 per acre in the affected area while the average production of wheat crop in affected areas is less than the non-affected areas and, finally, per acre cost of maize crop in affected areas is found to be 20000 per acre. Similarly, the average production of wheat, rice, and maize crops is 35, 25, and 30 Maund per acre, respectively.

On the other side, the average cost and production of the non-affected area are assessed and later it is compared with the average cost and production of the affected area of Kasur. The average cost and production per acre are given below in Table 3.

Table 3. Average Production and Cost of Non-affected Area.

Sr. No	Crops	Average Cost (In Rs)	Average Production (In Mound)
1	Wheat	12000	50
2	Rice	20000	50
3	Maize	18000	100

Source: Based on Authors' Calculations.

Table 3 the average cost and production of the non-affected area. When the cost of both areas' wheat crops is compared it is inferred that the average cost at the infected area is greater than that of the non-affected area. But the average production of the non-affected area is greater as compared to the average production of the affected area.

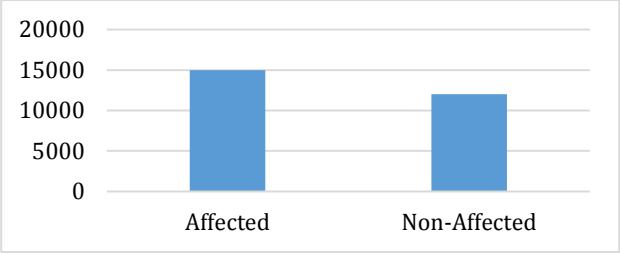

Figure 2. Average Cost (Rupees) of Wheat in Affected vs Non-affected Area.

Figure 2 drawn bar chart shows that the average cost of the wheat crop in affected area which is Rs. 15000 whereas, the average cost of the wheat crop of non-affected area is Rs. 12000 which is Rs. 3000 less than the affected area.

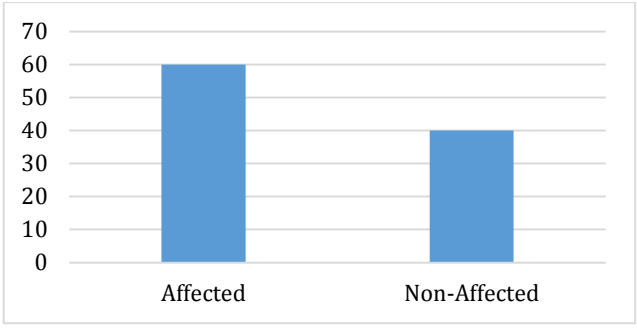

Figure 3. Average Production (Maund) of Wheat in Affected and Non-affected Area.

Figure 3 represents the average production of wheat crop of affected area versus non-affected area. The average production of wheat crop in the affected area is 20 Maund less than the non-affected area.

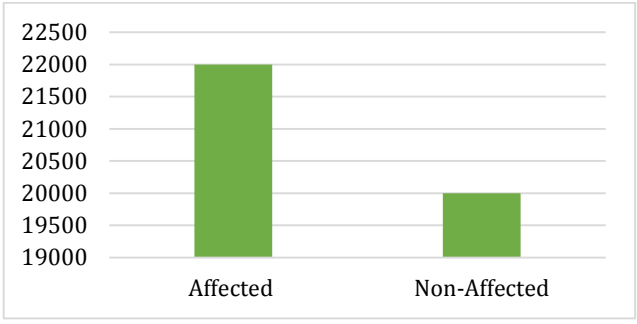

Figure 4. Average Cost (Rupees) of Rice in Affected vs Non-affected Area.

Figure 4 shows the average cost of rice crop in affected and non-affected areas. In the affected area, it is calculated Rs. 20,000 whereas in non-affected it is Rs. 22000 less and parallel to Rs. 20000.

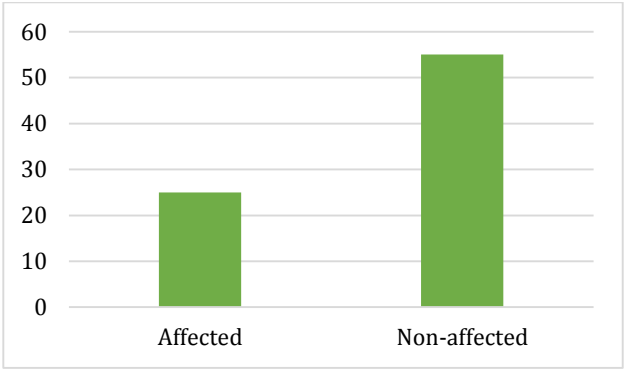

Figure 5. Average Production (Maund) of Rice Crop in Affected vs Non-affected Area.

Figure 5 bar-chart shows the average production of rice crop in affected vs non-affected areas. In the affected area the rice production is found to be 25 Maund whereas in the non-affected area it is 55 Maund.

Similarly, per acre, cost, and production of maize crop in affected and non-affected areas are compared. It is concluded that affected areas are infertile for maize crops, but the non-affected areas are rich in nutrients for the production/yield of this crop.

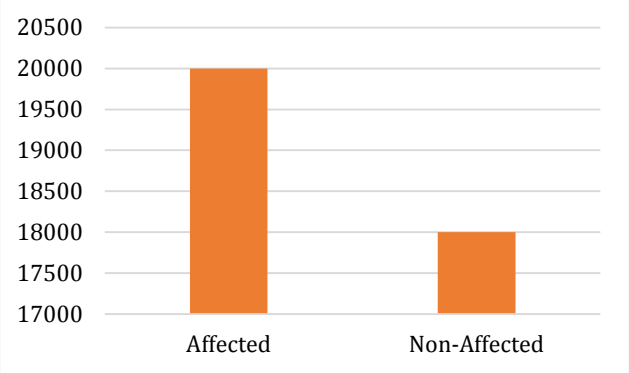

Figure 6. Average Cost (Rupees) of Maize in Affected vs Non- affected area

Figure 6 shows the average cost of maize in affected and non-affected area. In the affected area it is calculated Rs. 200,000 whereas in non-affected it is Rs. 2000 less and parallel to Rs. 180,000.

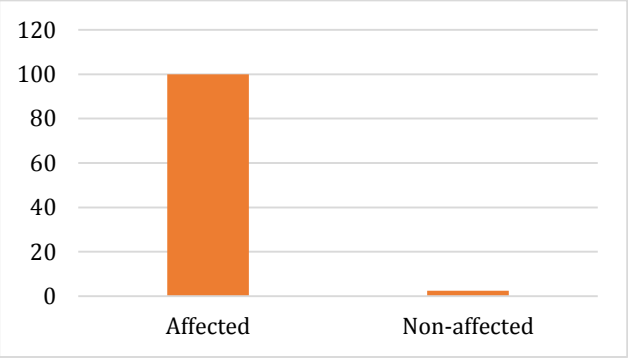

Figure 7. Average Production (Maund) of Maize in Affected vs Non-affected Area.

Figure 7 symbolizes that the average production of maize of affected area is 25 Maund whereas, the average production of maize crop of non-affected area is 20 Maund which is 80 Maund less than the affected area. All these crop's comparison shows the pollutants badly affect the fertility of the soil which cause the

Animals (Cattle, Poultry, Fisheries)

Gottrfired (1993) explains that the effects of water pollution are devastating to people, animals, birds, and fish. In this regard, a respondent, who was also a veterinary doctor, have mentioned that:

> The health of the cattle badly affects due to the toxic pollutants of tanneries. Diseases such as hepatitis, cancer, gastrointestinal disease mastitis, and skin diseases are spreading in domestic animals due to polluted air and water of tanneries. Owing to these pollutants, the growth of domestic animals is adversely affected which will affect milk and meat production. There may be a chance of contaminated milk which may affect human life.

He further explained about the fisheries and poultry:

> Most of the owners of poultry farms use control sheds because chickens cannot survive after drinking the pollutant (water respiratory diseases in the chicken are the result of the bad smell of emitting tanneries and that pollutant). Chickens breathe rapidly in such an atmosphere to survive. In addition to that, fish are also distressing due to the tannery effluents. Mostly polluted water of tannery goes through underground resources of water and nearby ponds, lakes, rivers, and seas. The polluted water of tanneries makes the water of these resources poisonous, and fish cannot survive in this water. Also, many species of fish have been made extinct from natural resources.
>
> (Respondent, 18)

Excess use of chromium in leather industries has resulted in chromium contaminated soil and groundwater at production sites which pose a serious threat to human health, fish, and aquatic biodiversity (Turick et al., 1996).

So, this research study finds that tanneries are adversely affecting many domestic and commercial animals which are the bread and butter of many local people.

Another respondent, a senior veterinary officer at the District Veterinary Hospital, Kasur, stated that:

> The health of animals badly affects due to the tannery pollutants. Cattles of our region are suffering from liver, kidney, and stomach diseases. Owing to these diseases, an animal cannot grow, and its quantity of milk production also decreases. Physically, these animals seem very weak and unhealthy.

He further added:

> The untreated polluted water of tanneries reaches the fishing ponds of nearby areas; it is

> very hard for fishes to survive in such an atmosphere because the water of these resources makes poison due to the tannery chemicals. As a result, growth, and production adversely affect.
>
> (Respondent, 19)

Data shows that the leather industry is on one side economically supporting people by giving them employment. But on the other side, it is negatively affecting the economy of local people. A handsome amount of their salaries is spent to treat numerous diseases caused by the tanneries' pollution. Additionally, pollutants of tanneries damage the health of people, cattle, and crops hence jeopardizing the economy of common people.

The business of tanning is highly profitable, and the tanners of Kasur are earning millions even trillions. And this is the reason that they do not care about any trouble resulting from their tanneries. However, they are openly exploiting all the residents living around the tanneries because these residents are somehow vulnerable to tanneries' pollutants. For instance, the capability of yield production of their land is very low due to penetrating the toxic effluent into the agricultural soil Moreover, the hazardous chemicals of tanneries also affect the domestic cattle i.e., buffalo, cow, sheep, goat, poultry, and fish, etc. many diseases like respiratory disease, skin disease, hepatitis, and tumor have been investigated in domestic animals.

> Poultry farming is disallowed in surrounding areas of tanneries because contaminated air of tanneries is becoming the cause of C.R.D (Chronic Respiratory Disease) in chickens.
>
> (Respondent, 23)

As per the respondent:

> The bones of dead cattle or other animals are useless for the tannery and these bones are used for preparing the feed of chicken. So, we do not like to eat chicken.
>
> (Respondent, 03)

It is observed that some people are using the control shed in their poultry farms. In the control shed, they use better food and clean water. So, the people who have their poultry form in an open area are worried about the environmental problem and tannery influents. But the people who have the control shed in their poultry forms, are doing a good job and have the miner effect of tannery pollutants.

The study found that tanneries are generating a huge quantity of effluents on land or into water bodies. These effluents contain primary and secondary plant nutrients (N, P, K, S, Mg, Ca, etc.) as well as micronutrients and heavy metals. The addition of tannery effluents is reported to cause an increase in pH and sodicity of soil. Similarly, these effluents have an adverse impact on various crops, trees, and shrubs as well as water bodies. Resultantly, the average cost of crops is increased, and average production is decreased in the affected area. Furthermore, a sharp decline in fish and poultry production has been observed by the residents. Tanneries' pollutants have affected animal health badly as animals are suffering from liver, kidney, and stomach diseases. As a result, these animals seem very weak and unhealthy, and their milk production decreases.

CONCLUSION AND RECOMMENDATIONS

The process of conversion of raw skins and hides into final leather is the traditional business of the people of District Kasur. Despite being the oldest and essential economic sector of Pakistan's economy, this sector is becoming a severe problem for humans and animals, agriculture, and aquatic life. The chemicals sodium chloride, sulphate, chromium, ammonium chloride, etc. are used in the tanning process and during tanning operations and different wastes are generated along with toxic chemicals. When the chemicals like chromium and Cadmium are discharged into the environment, they cause various complications not only to workers as well as plants and animals. The contaminated water of the tannery is harmful to the soil which ultimately has profound negative impacts on the plant growth and food chain. Furthermore, the farmer gets less amount of average production in the affected area as compared to non-affected. The social and economic risks associated with tannery pollutants can be decreased if tanneries would be shifted out of residential areas. Similarly, eco-friendly chemicals must be used in the tanning phase, which is already being used in European countries such as colloidal silica. Finally, there is an immediate need to apply the effluents measuring units.

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Author Contributions

All authors contributed equally to the designing, data collection, assimilation, and writing of this manuscript,

and the final version was read and approved by all authors.

Conflict of Interest

The authors declare no conflict of interest.

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