



Socioeconomic and Environmental Impacts of Tobacco Farming in Khyber Pakhtunkhwa, Pakistan

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Abstract: Tobacco production and curing cause a threat to the environment through injudicious use of pesticides, imbalanced use of chemical fertilizers, and excessive consumption of local firewood. Keeping all this in retrospect, this study has been designed to assess the impact of tobacco farming on family workers, and witness on spot involvement of children and nursing/ expecting mothers in tobacco-related health-hazardous tasks. General objective of the study is to document both the positive and negative environmental and socioeconomic externalities of tobacco production in the study area. It is based both on primary data and secondary statistics. Primary data has been collected from sixty farmers for the tobacco season 2021; including forty contract and twenty non-contract sample farmers. Farmers conceive that tobacco farming has a bad impact on human health (93 %), and causes degenerative deforestation and resource depletion (68 % each). Use of Green Tobacco Sickness gloves and Personal Precautionary Equipment was reported by eighty and sixty-two percent of the farmers, respectively. Impact of the disease on the workers' health was reported by thirty-five percent of contracted farmers, and 90 percent of non-contracted ones. Thus, the impact of the disease on human health was severe on non-contracted farms, mainly due to little or no use of Personal Precautionary Equipment. Cost of Personal Precautionary Equipment per season at the contracted farms was much higher (US\$ 18.0) than at non-contracted ones (US\$ 2.0). While the treatment cost of Green Tobacco Sickness or other agrochemical-related diseases of contracted farming households was 2.5 times lower than non-contracted ones. As per the results of the double log Ordinary Least Squares regression model about medical treatment cost, the coefficient of age of household head and use of Personal Precautionary Equipment have negative expected signs and are statistically significant. Laboratory tests of soil and water samples have revealed hazardous levels of Sodium Chloride and Dissolved Oxygen in canal water, which indicate imbalanced use of fertilizers by the growers and leaching of excessive nutrients below the root zone. Tobacco companies' contracted growers were found to have less occupational health hazards. Thus, raising awareness among tobacco growers about the importance of adopting precautionary measures and use of Personal Precautionary Equipment can reduce the negative effects of tobacco farming.

Keywords: Deforestation, Resource degradation, GTS, PPE, Tobacco, Pakistan

1. INTRODUCTION

Tobacco (*Nicotiana Tabacum*) is an important cash crop in the Khyber Pakhtunkhwa and Punjab provinces of Pakistan. Khyber Pakhtunkhwa and Punjab contribute nearly 65 and 32 percent in total tobacco cropped area, and about 79 and 20 percent in total tobacco produce, respectively. Its role in the economy can be judged by the fact that it is a major source of government revenue in the form of excise taxes. Pakistan earns considerable

foreign exchange by exporting tobacco and its products. The country exported raw tobacco and its products of worth US\$ 77.34 million in the fiscal year 2021 [1]. In Khyber Pakhtunkhwa province tobacco growing districts by production in decreasing order are Swabi, Mardan, Charsadda, Mansehra, Buner, Malakand, and Nowshera. Swabi district contributes about 30 % in area and 38 % to the provincial production of tobacco due to suitable agronomic and environmental conditions. Total number of tobacco growers and barns in

the district are 5500 and 6500, respectively. Area under tobacco cultivation in the district is 13179 hectares with a total production of 34.08 million kg, and productivity of 2586 kg per hectare. Tobacco is the main cash crop and source of livelihood for the farmers in the Swabi district of Khyber Pakhtunkhwa province of Pakistan [2].

As already stated, it contributes to the national economy through excise taxes and foreign exchange earnings. According to Pakistan Tobacco Board (PTB), almost 350 thousand people are involved in the tobacco industry in Pakistan, creating an income of Rs. 300 billion per annum. Similarly, tobacco production is a livelihood source for 1.2 million people. There are 75000 tobacco growers in the country, out of these more than 45000 growers (60 %) are in Khyber Pakhtunkhwa, which implies the importance of the tobacco crop in the study area [3]. Farooq *et al* [4] reported that there are 53 tobacco companies registered with PTB. While the cigarette market in Pakistan is highly skewed as only two multinational companies control 98 % of the market. In the country, PTB and United Kingdom-based multinational companies viz. Pakistan Tobacco Company (PTC) and Phillip Morris Pakistan Limited (PMPKL) are actively involved in the research and development of tobacco. These multinational companies distribute certified high-yielding seeds of the crop to their contracted growers. They disseminate knowledge to the farmers about recommended production package of the crop, including fertilizer application, keeping crop protection agents' (CPAs) in lockups, use of personal protective equipment (PPE) including masks, protective clothes, goggles, Green Tobacco Sickness (GTS) gloves, shoes, etc. Moreover, through the corporate social responsibility (CSR) program, these companies work for the social welfare of the farming community with the involvement of community support organizations. These companies operate mobile first aid providing medical units, and arrange summer schools for children through contractual farming to eliminate child labour from hazardous tasks of tobacco production viz, harvesting, post-harvest handling and processing viz. leaf picking, stick tying and barn loading, etc. Women are provided alternate sources of income to discourage their involvement in tobacco-related activities by arranging vocational training centers for them. Thus, women folk is

protected from health hazards and empowered to become skillful and productive members of society [3].

It is a fact that tobacco cultivation causes an irrevocable cost to the environment, as tobacco curing requires about one ton of firewood per barn for one week. Sami *et al.* [5] estimated that 14,156 kg of firewood per hectare is used for tobacco curing in the Swabi district, and firewood cost shared 38 percent of the total cost of production. Similarly, Nasrullah *et al.* [6] reported that firewood cost was Rs. 39,957 per hectare, with a share of 25 percent of the total cost of tobacco production in year 2019. Thus, it results in huge pressure on forest resources along with soil erosion & degradation, water pollution, changes in climate and cropping seasons, etc. Furthermore, tobacco cultivation causes losses to farming households in form of sickness/health costs and missing farming days due to the non-adoption of PPEs. Though, contractual farming of tobacco completely has banned child labour, and involvement in hazardous tasks of tobacco leaf handling activities of nursing women as well expecting mothers. However, at non-contractual farms due to unawareness, they are at the risk of GTS disease caused by the entrance of nicotine into the human body through skin pores from the wet tobacco leaves specifically in teenagers after rains [7].

Different chemicals are used on tobacco crops from sowing to harvesting, among them some most commonly used pesticides are *Imidacloprid*, *Chlorpyrifos*, *Dichloropropen*, *Aldicarb*, and *Methyl Bromide* causing chronic infections and soil degradation. According to Khan *et al.* [8], the majority of farmers suffer mild to moderate poisoning as a result of pesticide usage. According to Food and Agriculture Organization, the tobacco-producing regions in the developing countries are wood deficient and are below the proficiency level, specifically in Asia and Africa, resulting in deforestation and biodegradation [9]. It is worth mentioning here that in the 1990s tobacco curing caused 19 % of deforestation in Pakistan as reported by British American Tobacco (BAT), which is a visible footprint for climate change [10]. Moreover, multinational companies are providing PPEs to the contract growers for agrochemical use, harvesting, leaf picking and grading. They provide

extension services and training facilities for use of PPEs, as well as the adoption of protective measures against GTS disease. This is supported by proper promotion of less toxic chemicals having low residues, and the disposal of empty bottles of agrochemicals to protect the environment besides the health of farming households. The companies claim to provide safety training with a special focus on the use of PPEs to around 89 % of the contracted tobacco growers [11]. The use of PPE was quite low in the country about a decade ago, as Khan *et al.* [8] reported that during pesticide spraying only 30 % of tobacco growers were using shoes, 14 % were using masks and 9 % used protective gloves in year 2010. In order to promote the use of PPEs, PMPKL and PTC created mass awareness among the growers. PMPKL also recruited both farm workers to monitor the use of PPEs and all tobacco-related activities performed by male and female workers.

According to Ali *et al.* [12], Pakistan's tobacco yield is 3017 kg per hectare, which is significantly higher than the average yield in developed countries i.e. 1900 kg per hectare. Nasrullah *et al.* [6] estimated that the net revenue of tobacco production in district Mardan was Rs. 405,636 per hectare in the year 2014. Similarly, Aman and Khan [13] reported net revenue of Rs 401,982 per hectare of tobacco crop in the Swabi district in year 2019. They also identified that the problems faced by tobacco growers are low quality of seed, high input prices, child labour and farmer's health issues, and lack of proper health facilities. They recommended the need for advanced research in these areas to solve these issues. According to the World Health Organization-Framework Convention on Tobacco Control (WHO-FCTC), [14] research is needed on social impeding i.e. child labour, deforestation, pesticide exposure and occupational health hazards like GTS disease caused by tobacco crop in developing countries. In a need assessment for WHO-FCTC implementation in Pakistan by European Commission [15], a gap was identified in the lack of proper policy administering the environment and health of tobacco farming households. Likewise, according to another cluster study report by Farooq *et al.* [4] improper disposal of tobacco byproducts and excessive use of chemicals result in health issues and loss of biodiversity. They suggested public sector to take urgent notice of the

health and other hazards involved in tobacco curing and emphasized strongly on research to address the persistent issue of health and resource degradation in tobacco farming. Rahman *et al.* [16] considered tobacco farmers' lack of awareness and guidance to tackle the hazardous tasks affecting their health and environment as serious factors that need to be studied behind exquisite tobacco farming. It is worth mentioning here that, threats caused by tobacco cultivation have been identified in Pakistan. Whereas, economic analyses of the crop are limited to cost of production and profitability.

There is a gap in research as per determination of the impact of tobacco farming in terms of health risks for the farmers in general and nursing/expecting mothers in particular, involvement of child labour, adoption of PPEs, support services provided by multinational companies involved in tobacco farming, issues related to soil degradation and water pollution are concerned. Findings of this study would help stakeholders involved in tobacco farming in the country in finding ways and means for controlling environmental threats, natural resource degradation, and health issues of farming households. Overall objective of the study is to document both the positive and negative environmental and socioeconomic impacts of tobacco production in the study area. While specific objectives of the research endeavor are; to highlight the socioeconomic characteristics of tobacco farmers in the study area; to determine farmers' awareness level regarding the impact of tobacco cultivation on the environment and human health; to gauge the incidence of child and women labour in tobacco farming; to determine the use of GTS gloves and other PPE by tobacco farmers; to document health hazards and estimate the incidence of sickness among the farming households due to pesticide exposure; to determine the impact of the growers socioeconomic, geographic & safety traits on the cost of treatment of the diseases caused by tobacco farming; and to examine the impact of tobacco farming on natural resources in the study area.

2. MATERIALS AND METHODS

The study is simultaneously exploratory and descriptive in nature. It has been carried out based on primary data, secondary sources of information,

and laboratory tests of soil and water samples. The primary data has been collected by designing a comprehensive survey tool. The data is collected through the purposive random sampling technique to give representation in data set to both contracted and non-contracted tobacco growers. Contracted sample farmers are interviewed randomly from the lists of contracted farmers provided by Phillip Morris Pakistan Limited (PMPKL), Mardan. Face-to-face interviews with 60 tobacco growers are conducted, including 40 contract farmers of PMPKL and 20 non-contract farmers. The contracted farmers were from the surrounding villages of Yar Hussain town, which is located at a distance of 25 km from headquarters of the Swabi district, while the non-contracted farmers were residents of Marghuz and adjoining villages. Marghuz is located 12.5 km away from headquarters of the Swabi district. The data for the study was collected at the end of tobacco season of year 2021. Field survey was conducted in August, 2021. The questionnaire covering the tobacco farming households' socioeconomic characteristics, health hazards caused by excessive use of chemicals, incidence of Green Tobacco Sickness (GTS), involvement of child labour, and nursing/ expecting mothers in tobacco farming was prepared, pre-tested, and modified accordingly.

Secondary information about the status of tobacco cultivation in the province has been collected from PTB Peshawar. Similarly, PMPKL, Mardan and PTC, Nowshera offices were visited to get details of services offered to the farmers, and to get technical input on the survey tool used for the study. To estimate the environmental impact of tobacco cultivation the methodology has been adopted from Kutab and Falgunee [17] in which different parameters of soil and water such as pH and DO (Dissolved Oxygen) in the study area were determined for the presence of different toxic chemicals such as Phosphorous and Potassium. The soil samples were taken 5 inches deep from different geographical points in the study area, while water samples from the canal and tube-well channels were taken to observe the presence of different toxic chemicals.

Primary data has been analyzed for descriptive statistics viz. frequency distributions, mean values, percentage, etc. Health cost expressions (equations 1 and 2) used in this study have been adopted from Atreya [18] to determine the cost

incurred on farmers' health in monetary terms. As tobacco-related diseases have a negative impact on farmers' welfare as a result of illness, lost wages, medical treatment expenditures, decrease in farm productivity, and loss of income. The monetary loss to the farmers caused by the diseases is calculated by taking into account the wages of leaf pickers along with the missing working days of both patients and their attendants. Thus, health cost is estimated for contracted/ user of preventive measures/equipment and non-contracted farmers/ control group by expressions 1 and 2, respectively.

$$HC_u = SD_u * CI_u + PC_i \quad (1)$$

$$HC_n = SD_n * CI_n \quad (2)$$

Where HC_u and HC_n are health costs for users and non-users of preventive measures, respectively. Similarly, SD_u and SD_n are sickness days of users and non-users of preventive measures, respectively. CI_u and CI_n are the average cost spent on treatment of illness per day, including travel costs, opportunity cost of time spent in traveling to dispensaries/ clinics/ hospitals, doctors' consultation fees, hospitalization charges, medication costs, patients' dietary expenses, and lost work productivity of patient and its attendant, of users and non-users of preventive measures, respectively. PC_i is the cost of the PPE (masks, protective clothes, goggles, GTS gloves, shoes, etc.) per cropping season by the individual contracted farmers. Components of health cost were converted in US\$ on basis of the prevalent exchange rate at the time of data analysis i.e. January 2022 that was PKR.176.98 equivalent to one US\$, to make the findings comparable with the results of the studies conducted in other countries. To study the factors affecting the health cost, regression analysis has been carried out and the health cost function was estimated using a generalized model expressed by equation 3.

$$HC = f(S, IF, DPM) \quad (3)$$

Where HC represents the health cost, S is the socioeconomic characteristics of farmers such as age and education affecting health cost, IF are the institutional factors affecting health cost such as access to Hospitals, Basic Health Units (BHUs) and medical dispensaries, etc. DPM is the dummy variable for use of preventive measures/PPEs during harvesting, leaf picking and stick tying, or

otherwise. The specified double log health cost model used for the study is given by equation 4.

$$\ln HC_i = \beta_0 + \beta_1 \ln Age_i + \beta_2 \ln Dis_i + \beta_3 D_{pm} + \mu_i \quad (4)$$

Where HC is health cost, β_0 is a constant term, 'Age' is the age of the household head of respondent i, 'Dis' is the distance from the medical facility of respondent i, D_{pm} is the dummy variable for use of protective measures during tobacco farming by the respondent i, and μ_i is the usual error term. In reference to health costs, Dasgupta *et al.* [19] pointed out that blood testing is more appropriate to check the cause of the illness as self-reported symptoms are weak indicators of health impacts. But blood sampling in this study was not done due to technical and financial constraints on part of the research team.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of Tobacco Farmers

Socioeconomic characteristics of the sample tobacco farmers are presented in Table 1. Most of the tobacco growers were in the middle age group, i.e. 55 percent of contracted farmers, and 65 percent of non-contracted farmers were in the age bracket of 30 to 50 years. Mean education of sample contracted and control group farmers was 7 and 8 educational years, respectively. Similarly, literacy rates of contracted and non-contracted farmers were 60 and 75 percent, respectively. Thus, high literacy level indicates that tobacco leaf pickers may have awareness regarding the harmful effects of tobacco leaf picking. Since instructions prescribed by tobacco companies regarding Green Tobacco Sickness (GTS) on pesticide containers/bottles are written in English and Urdu so farming households, especially women with low/no literacy levels are unable to read instructions or even understand symbols given on poisonous materials and their levels of human health hazards. Knowledge about GTS disease, its precautions and self-protection measures were expected to be low among the tobacco leaf pickers in the study area. The findings of the study are in line with our prior expectations in the case of non-contracted farmers. One-half of the women leaf pickers from non-contracted farming households (50 %) are found

to have little knowledge of GTS disease. Tobacco growers in the Swabi district are resource-poor, as the monthly crop income of most of the sample farmers (98 % contracted and 95 % non-contracted) was less than 100 US\$ (PKR 17698). Thus, women and children are to participate in tobacco farming activities including stick tying, for which they are paid PKR 2.5 per stick.

3.2 Farmer's Awareness about the Impact of Tobacco Farming on Environment and Human Health

Findings about farming household awareness about the impact of tobacco cultivation on the environment and human health in the study area are ranked in Table 2. The results highlighted that tobacco farming is affecting farmers' and their families' health. Overall 93 percent of the respondents were of the view that tobacco farming/handling activities has a bad impact on human health. As per the data, 68 percent of the sample farmers reported that curing tobacco consumes a large amount of local firewood i.e. 800 kg firewood per barn, which ultimately results in deforestation. Sixty-three percent of the contracted farmers and eighty percent of the non-contracted farmers reported that tobacco farming is causing deforestation in the study area.

The difference in the response of contracted and non-contracted farmers is because tobacco companies prescribe their contracted farmers to use sustainable basis. They bound farmers to obtain approval for the use of fire wood. Similarly, tree plantation campaigns are organized annually by these companies to control deforestation, and this is the reason the contracted farmers perceive that tobacco farming is not an environmental threat in the study area. This implies that tobacco companies are playing a pivotal role in making their contracted farmers conscious to overcome the environmental impact caused by tobacco cultivation and curing, hence reducing biodiversity loss in the study area. Similarly, 68 percent of tobacco farmers in the research area said to use firewood on additional fertilizers, irrigations and pesticides for tobacco cultivation due to reduced soil productivity and high insect-pest infestation. About one-third of the farmers (35 %) were of the view that tobacco farming pollutes water to some extent due to dissolved oxygen. They reported that crop farming

Table 1. Socioeconomic characteristics of the sample farmers

Characteristics	Contracted (n=40)	Non- Contracted (n=20)	All (n=60)
Age (years)			
18-30	6 (15)	4 (20)	10 (17)**
30-50	22 (55)	13 (65)	35 (58)
50-70	12 (30)	3 (15)	15 (25)
Mean Age	43.0 ± 10.6	41.2 ± 10.2	42.4 ± 10.4
Education			
Illiterate	16 (40)	5 (25)	21 (35)*
Literate	24 (60)	15 (75)	39 (56)
Mean Education	6.5 ± 5.8	7.7 ± 5.7	6.9 ± 5.7
Family Size	7.8 ± 3.9	7.2 ± 4.3	7.6 ± 4.0
Monthly household income from tobacco crop			
Below 100US\$ (PKR17,698)	39 (98)	19 (95)	58 (97)**
Above 100US\$ (PKR 17,698)	1 (2.5)	1 (5)	2 (3)
Mean monthly household income from tobacco crop US\$ (PKR)	75.4 ± 24.4 (13344 ± 4318)	75.6 ± 19.5 (13380 ± 3451)	75.5 ± 22.7 (13362 ± 4017)

* and ** indicate that values are significantly different at 1 and 10 percent levels

Table 2. Farmer's awareness about the impact of tobacco farming on the environment and human health

	Contracted (n=40)	Non- Contracted (n=20)	All (n=60)	Overall Rank
Bad impact on human health	37 (93)	19 (95)	56 (93)	I
Causes deforestation	25 (63)	16 (80)	41 (68)	II
Increasing use of fertilizers, pesticides and irrigation	24 (60)	17 (85)	41 (68)	II
Causes water pollution	15 (38)	6 (30)	21 (35)	III
Reduces other crops productivity	5 (13)	5 (25)	10 (17)	IV
Deteriorate underground water quality	9 (23)	0 (00)	9 (15)	V
Loss of biodiversity	4 (10)	2 (10)	6 (10)	VI

Note: Figures in parenthesis are percentages

reduces the productivity of other crops (17 %), deteriorates the quality of underground water (15 %), and results in loss of biodiversity (10 %).

All this is due to preventive actions taken by Phillip Morris Pakistan Limited (PMPKL), Mardan to protect the environment, water, soil, health of farming households, and by providing lockups for keeping crop protection agents. PMPKL issues strict guidelines to the contracted farmers to install lockups 6ft above ground level to evade children's access. Farmers are guided not to dispose-off bottles of used toxic chemicals openly in canals, ponds, or in the garbage. They are instructed to either combust or bury these properly or return to PMPKL in exchange for household grocery items. The monitoring teams of PMPKL make regular field visits to the farmers and in case of violation, they

raise Prompt Action Issue (PAI) against farmers and cancel their contract license.

3.3 Involvement of the Farm Families in Tobacco Farming

Findings about involvement of the household members in tobacco farming are presented in Table 3. The data shows that 70 percent of adults, including 27 percent of nursing/expecting mothers participate in tobacco farming related activities. Similarly, a little more than one-third of the sample households (35 %) reported children's involvement in tobacco farming. Adults and expecting/ nursing women are reported to perform all types of tobacco farming activities from leaf picking, grading of green leaves, stick tying till barn loading. While, children are being involved in green leaf and

Table 3. Involvement of sample households in tobacco farming

Involvement in tobacco farming	Contracted (n=40)			Non-contracted (n=20)			All (n=60)		
	Adults (M+F)	Nursing/ Expecting mothers	Children	Adults (M+F)	Nursing/ Expecting mothers	Children	Adults (M+F)	Nursing/ Expecting mothers	Children
Overall	25 (63)	13 (33)	11 (28)	17 (85)	9 (45)	10 (50)	42 (70)	22 (27)	21 (35)
Stick tying	25 (63)	7 (18)	11 (28)	17 (85)	4 (20)	10 (50)	42 (70)	11 (18)	21 (35)
Green leaves' grading	25 (63)	0 (0)	2 (5)	17 (85)	2 (10)	7 (35)	42 (70)	2 (3)	9 (15)
Barn loading	25 (63)	6 (15)	0 (0)	17 (85)	3 (15)	0 (0)	42 (70)	9 (15)	0 (0)
Leaf picking	25 (63)	0 (0)	0 (0)	17 (85)	2 (10)	0 (0)	42 (70)	2 (3)	0 (0)
Reasons for nursing/expecting mothers' involvement in tobacco farming									
Reasons	Contracted (n=40)			Non-contracted (n=20)			Overall (n=60)		
Financial reasons	28 (69)			20 (100)			50 (83)		
Non-availability of labour	12 (31)			0 (0)			10 (17)		

Table 4. Precautionary measures

Measures	No. of tobacco farmers		
	Contracted (n=40)	Non-contracted (n=20)	All (n=60)
Use of GTS gloves for leaf handling	38 (95)	10 (50)	48 (80)**
Use of PPEs (protective masks, goggles, long shoes, protective uniform, GTS gloves etc.)	35 (88)	2 (10)	37 (62)*
PPE's provided by tobacco companies	39 (98)	0 (0)	39 (65)**

* and ** indicate that values are significantly different at 1 and 10 percent levels, respectively

stick tying. Involvement of nursing/ expecting mothers and children in the farming was low at contracted farming as compared to non-contracted ones. Thirty-three and forty-five percent of the tobacco farming households reported involvement of nursing/expected women, respectively. In the same way, the involvement of children in tobacco farming was reported by twenty-eight and fifty percent of the contracted and non-contracted farming households, respectively. Low involvement of nursing/expecting mothers and children at the contracted farms is due to consistent efforts of tobacco companies i.e. PMPKL and PTC. The companies have been launching various campaigns among the tobacco farming households to limit the involvement of vulnerable household members in the farming, to use Personal Protective Equipment (PPE) & Lockups for storage of Crop Protection Agents (CPAs), and regularly monitoring the tobacco farms. Companies play an important role in corporate social responsibility to reduce children (those who are generally on summer vacations) and nursing/expecting mothers' involvement in

crop farming. Summer schools for children and embroidery centers for women of contracted households are launched. Attendance records of these institutions are regularly monitored to ensure the attendance of children and women. Irrespective of farming categories i.e. contracted and non-contracted farmers, 83 percent of them reported that children and women are involved in tobacco leaf picking and other leaf handling activities, such as barn loading, stick tying due to limited financial resources and due to non-availability of labour during tobacco season.

3.4 Precautionary measures adopted by tobacco leaf pickers

The use of precautionary measures by the leaf pickers at the farms of contracted growers was higher than that of non-contracted tobacco ones (Table 4). The use of precautionary measures includes; installing CPA lockups six feet above the ground level, to avoid kids' access to hazardous chemicals that are used in tobacco farming, wearing

protective masks, goggles, long shoes, protective uniform and gloves by the leaf pickers. Ninety-five percent of the contracted tobacco farmers and fifty percent of the non-contracted farmers reported the use of gloves by the leaf pickers at their farms to prevent Green Tobacco Sickness (GTS) during harvesting the crop. Similarly, the use of Personal Protective Equipment (PPE) was reported by ninety-five of the contracted growers and by just ten percent of the non-contracted growers. Though, the use of PPEs is considered to reduce injurious effects on their health due to exposure to pesticides, and other pollutants during leaf picking. While low use of protective measures puts the lives of tobacco pickers especially the children and nursing/expecting mothers at risk. Generally, tobacco leaf pickers perceive that few health hazards are associated with exposure to pesticides and consider leaf picking and handling as a normal and safe working activity. Therefore, the adoption of preventive measures among non-contracted leaf pickers is minimal, while the opposite is true in the case of contracted farmers. The use of GTS gloves & PPE was statistically different among contracted and non-contracted farmers (Table 4).

As tobacco companies are playing key role in creating awareness about health hazards in tobacco farming families. Out of the total sample of sixty tobacco farmers, 80 and 62 percent of the farmers reported the use of GTS gloves and PPE, respectively. Almost all of the contracted farmers surveyed for the study (98 %) reported that tobacco companies provided them the personal protective equipment. Tobacco companies are playing role in improving the use of PPEs by the farmers' overtime. Khan *et al.* [8] assessed the risk of pesticide exposure on the health of tobacco farmers in the Swabi district of Khyber Pakhtunkhwa province of Pakistan and reported that few farmers use shoes (31 %), masks (14 %), and gloves (9 %) during pesticides spray and tobacco leaf handling activities.

3.5 Incidence of Sickness among the Farming Households due to Pesticide Exposure

Khan *et al.* [8] in the Swabi district of Khyber Pakhtunkhwa and Silva *et al.* [20] in Brazil reported that exposure to tobacco leaves causes an increase in GTS among tobacco leaf pickers during harvesting season. Most common symptoms of GTS in farm

workers due to tobacco farming include headache, weakness, dizziness, and nausea/vomiting. Their clothing becomes saturated from tobacco that is wet from rain or morning dew, or perspiration. Though all the sample households reported GTS in their family workers due to tobacco farming. However, most of the time its impact on human health is temporary. The impact of the disease on the workers' health and their inability to perform farm operations was reported by 35 percent of contracted farming households and 90 percent of non-contracted households (Table 5). Thus, the impact of the disease on farmers' health was more severe on non-contracted farms than on contracted ones, mainly due to little or no use of PPE. Similarly, the frequency and number of cases per household was also higher among non-contracted farmers than their counterparts. Contracted farmers are obligated to use of precautionary measures during tobacco production, harvesting, and curing by the tobacco companies. As already mentioned, these households are provided PPEs by the companies and are frequently monitored for their use. Charges for PPE are deducted by the companies at the end of each season. The cost of PPE at the contracted farms was much higher (US\$ 18.0) than at non-contracted ones (US\$ 2.0).

All the sample farmers reported having access to health facilities, including Basic Health Units (BHUs)/ dispensaries and hospitals. Mean distance of BHUs/dispensaries from the tobacco farms was less than one kilometer. However, the mean distance of contracted farms from hospitals was more (21.6 km) than non-contracted farms (18.1 km). Half of the sample respondents reported to consult health staff/ doctors for a formal treatment of the diseases caused by tobacco farming in the crop season 2021. As the impact of the disease at the contracted farms was low, and the mean distance of hospitals from the contracted farm was comparatively more, thus they reported consulting health staff/ doctors less (45 %) than non-contracted farmers (60 %). People having less immunity i.e. children, under-nourished women, particularly nursing/expecting mothers, old aged persons are more susceptible than adults to various diseases caused by tobacco farming due to the presence of pesticide fumes, dust and allergens, etc. at farms. Tobacco leaf picking can cause both temporary and chronic impacts on human health. Another, reason for a high incidence

of GTS reported by women respondents is that in spite of their awareness of the disease, they consider stick tying without gloves easy and quick way in comparison to that of wearing gloves. Similarly, in a few farm households where expecting/nursing mothers were experts in stick tying and the ones in which they can't afford to hire labour, these women continue to remain involved in operations and the situation may turn out to be worse.

In international literature, a wide range of GTS incidence has been reported by various researchers, ranging from a few cases to a large number of tobacco workers. As an example, Sujoso and Martiana, [21] reported sufferings from GTS among 11 % of tobacco farmers in Indonesia. While Oliveira *et al.* [22] reported GTC incidence in 82 % of the farmers in Brazil. As review of the literature reveals that the incidence of the disease depends on dewfall, rainfall, air humidity, and the use of PPE. Similarly, a clear description of the criteria for reporting the incidence also matters much, as the symptoms of the disease vary from dizziness, and headache to nausea/vomiting. Guddad *et al.* [23], and Saleeon *et al.* [24] reported a direct relationship between GTS incidence and increased humidity during tobacco crop harvesting in the monsoon (rainy) season. They reported that moisture helps to enhance nicotine absorption through the skin. Although the researchers were unable to quantify this relationship. Similarly, Oliveira *et al.* [22] described that number of patients having GTS symptoms and signs increases during rainy days. Gehlbach *et al.* [25] and Ghosh *et al.* [26] stated that nicotine absorbed in dew drops affects persons who work in the tobacco fields in the morning, particularly those harvesting tobacco leaves. While, on the other hand, farm workers in shed tobacco farms had substantially fewer GTS symptoms [27].

As far as sickness cases from tobacco farming in the study area are concerned, few of the contracted tobacco farmers reported adverse impacts on the health of the farm workers (35 %) due to proper use of PPE in comparison to non-contracted growers (90 %). However, the results should be taken with a bit of caution, as sickness in the farm workers may also be due to factors other than that of tobacco leaf picking. Similarly, healthy workers can be less vulnerable to bad impacts of tobacco leaf picking than those who have already certain health

issues or have less immunity i.e. farmers workers under 18 years of age, nursing/expecting mothers and aged persons are more vulnerable to nicotine absorption due to tobacco leaf picking and thus to various diseases. Mean treatment cost of diseases per farm household per season is US\$ 8.3 and US\$ 29.2 for contracted and non-contracted farmers, respectively. Similarly, Hussain *et al.* [28] reported that medical treatment cost for contracted tobacco farmers in Bangladesh was also low as compared to their counterparts due to the use of personal protective equipment. When farmer workers notice costs associated with exposure to pesticides and green tobacco leaves in the form of illness symptoms and associated costs, they tend to use precautionary measures in true letter and spirit [29].

3.6 Impact of the Growers' Socioeconomic, Geographic & Safety Traits on Cost of the Medical Treatment

Double log model has been estimated to find out the impact of growers' socioeconomic, geographic & safety traits on cost of treatment of the diseases caused by tobacco farming. The results of the model are presented in Table 6. F-value indicates that the test is statistically significant. The value of the R-squared indicates that about 20 percent variability in the dependent variable i.e. treatment cost (US\$) of the diseases caused by tobacco farming is explained by the variable considered in the regression model. This means that the treatment cost of tobacco-related diseases depends to a considerable extent on the general health status of the workers, their immunity level, number of children, nursing/expecting mothers, and old aged persons involved in the farming. The coefficient of age of the household head has an expected negative sign and is statistically significant. It means that aged heads of tobacco farming households are experienced in tobacco farming, thus have better know-how to avoid health issues. The coefficient of distance has a negative sign. Understandable reason for this is low treatment costs in contracted farming households than in their counterparts. While the mean distance of contracted farms was higher than non-contracted ones. However, the coefficient of distance from the hospital is statistically insignificant. Dummy variable for the use of PPE has an expected negative sign and is

statistically significant. The value of its coefficient indicates that an increase in the use of precautionary measures/ personal protective equipment results in a decrease in treatment/ health-related costs.

3.7 Impact of Tobacco Farming On Natural Resources

Results of lab tests of soil and water samples to gauge the quality of natural resources, and assess the impact of tobacco cultivation on them are reported in Table 7. Although, the pH level of both tobacco and other crops' soils in the study areas is higher than the ideal range of 6.5 to 7.5; however, soils are alkaline and are ideal for tobacco cultivation. The level of Nitrate (NO_3) is less than the standard range, which indicates the imbalanced use of fertilizers by the growers and the leaching of excessive nutrients down to root zones and water courses. Leaching of Nitrate and Phosphate in water courses can stimulate algal and other water plants' growth. Thus, it lowers the productivity or fertility of such an ecosystem, thus farmers are to apply higher levels of fertilizers to improve soil fertility and crop productivity. While the level of Potassium is found higher than the tolerable range both in soils used for the production of tobacco and other crops. Higher level of Potassium affects the absorption of

other critical nutrients by plants. While lowering soil potassium can also prevent excess Phosphorus from running into waterways.

Both canal and hand pump water in the study area are found alkaline in nature, having pH levels of 7.5 and 7.6, respectively. These levels fall almost in the ideal range; thus, the water quality of hand pumps is good for drinking by humans as well as animals, and that of canal water is fair for the production of tobacco and other crops in the study area. Similarly, levels of Sodium Chloride in drinking water are in the ideal range, while in the canal water is much higher than the acceptable limit.

Higher level of Chloride in canal water interferes with nitrogen uptake by plants, reduces crop growth, and stops plant reproduction. Possible reasons for a high level of Chloride in canal water are higher use of fertilizers and disposal of sewerage water and trash in canals. Levels of Dissolved Oxygen are higher than acceptable standards both in hand pump and canal water. This is harmful to animal health and hinders plant root growth as plants are getting everything, they need with a smaller surface area. Total dissolved solids (TDS) in hand pump water (< 300 ppm) indicate

Table 6. Impact of the farmers' characteristics on the medical treatment cost

Variables	Unit	Mean (SD)	Coefficients
Age of Household Head	Years	42.4 \pm 10.4	-1.428 (0.090)**
Distance from hospital	Km	20.4 \pm 10.8	-0.125 (0.448) ^{ns}
Precautionary measures	Dummy (Users: 1, Non-users: 0)	62	-1.160 (0.007)*
	Users %		8.291 (0.010)*
	Constant		0.195
R ²	F Value		4.266*

* and ** indicate that values are significant at 1 and 10 percent levels, and ns stand for non-significant

Table 7. Soil and Water Quality in the study area

Parameters	Tobacco Crop Land	Other Crop Land	Permissible Limits	Sources
I. Soil Parameters				
pH	7.6	7.9	6.5-7.5	Nabi <i>et al.</i> [30]
Nitrate (NO ₃)	0.46	1.16	11.0 to 20.0 mg /kg	Pattison <i>et al.</i> [31]
Phosphate	5.79	6.14	4.0 to 7.0 mg/kg	Wall and Plunkett [32]
Potassium	138	140	40 to 80 mg/kg	
II. Water Parameters				
Parameters	Hand Pump	Canal	Permissible Limits	Source
pH	7.6	7.5	6.5 to 8.5	WHO, [33]
Chloride (ppm)	196.8	794.2	< 250	
Dissolved Oxygen (ppm)	11.00	11.23	6.5 to 8.0 mg/L	
TDS (ppm)	201.9	786.2	1000 ppm	

that it is excellent for drinking. While TDS in the canal water is in a fair range (600 to 900 ppm) and its consumption can be harmful to animal health. Higher levels of TDS in water make it unfit for consumption and may cause several diseases like nausea, lung irritation, rashes, vomiting, dizziness, etc. Few of the farmers perceived that tobacco farming is polluting the water. However, analysis of water samples revealed that the quality of pumped water is good, while canal water is harmful to animal and plant health due to the presence of high levels of dissolved solids.

4. CONCLUSION

Though the tobacco crop is profitable for the farming households in the study area; however, it also has various socioeconomic and environmental implications for them. They are to face Green Tobacco Sickness (GTS) and other agrochemical-related health hazards. Furthermore, the imbalanced use of agrochemicals is resulting in the degradation of land and water resources. Private companies are playing an important role by creating awareness among contracted growers, providing them with Personal Protective Equipment (PPE), and properly monitoring their use. Similarly, summer schools for children and embroidery centers for women of tobacco farming households are organized to limit their involvement in tobacco-related activities. Resultantly, the use of precautionary measures during tobacco leaf picking and handling is relatively fair among contracted farming households. While workers at farms of non-contracted households face bad health impacts due to improper handling of the crop. This can be attributed to a lack of institutional support for the creation of awareness about tobacco-related health hazards, and training them to take proper precautionary measures during crop handling. A voluntary cadre of health workers can also be developed to give first aid to affected farm workers. In this reference, local support organizations, public sector education, agricultural extension, and health departments must come forward to the maximum possible extent. Findings of the study can be used as a benchmark for designing programs for proper handling of GTS and other tobacco-related diseases. Similarly, these can be helpful to develop monitoring and evaluation programs that would help in the generation of national-level

data sets to counter environmental degradation and deforestation. Findings of the study are based on a single crop season; thus, these should be taken with a little caution and must be reaffirmed with a multi-seasonal or panel data study. The study is based on health-related data of tobacco leaf pickers. It is suggested that the impact of tobacco farming on health-related issues of whole farming households should be covered in future studies. Furthermore, symptoms of GTS incidence should be based on a clearly defined criterion of headache, nausea, and vomiting separately, instead of taking these as a whole.

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6. CONFLICT OF INTEREST

The authors declare unanimity in the findings of the study and description of the results.

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