RESEARCH ARTICLE

Socioeconomic and Environmental Impacts of Tobacco Farming in Bangladesh

Anupam Roy, Sabrina Naz, and M. G. Mostafa*

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Abstract

Tobacco farming is relatively economically profitable compared to other field crops but has many negative environmental impacts. The study was conducted to compare the socioeconomic conditions of tobacco farmers (TF) and non-tobacco farmers (NTF) and explore the environmental impacts of tobacco farming. Data were collected using a well-structured questionnaire. The average monthly household income of TF (Tk18052 ± 1552) was significantly higher than NTF (Tk15980 ± 2235), which made TF more empowered than NTF in terms of housing conditions, weekly fish/meat consumption, and Eid/festival expenditure. Although there were no significant differences between the two groups on credit borrowing, residential ownership, television and freeze ownership, cellphone and internet use, drinking water sources, and type of latrine used. In 2021, total GHG emissions from tobacco farming in Bangladesh (Global warming potential for a 100-year time horizon) (710664 ± 19414) tCO_2e, which was 0.26% of total national annual emissions. That is, about (7.7 ± 0.21) kg of CO_2e was emitted to produce one kg of tobacco leaves in Bangladesh. Disruption of family peace and happiness, increase in fire incidence, and increase in nicotine addiction among the youth and adolescents of tobacco farm families were the direst social problems caused by tobacco cultivation. Increased perspiration, weakness and fatigue, and headache were the most common symptoms of GTS effects. The prevalence of GTS effects largely depended on the nutritional status, age, and gender of the farmers. Although tobacco cultivation made TF relatively safer in socioeconomic conditions compared to NTF, it caused health damage to the farmers as well as degradation of the physical, biological, social, and cultural environment. Governments should develop strategies to improve farmers' livelihoods or switch to more profitable cash crops.

Keywords: Environmental impact, Health impact, Socioeconomic impact, Tobacco farming

Highlights

- Compared the socioeconomic status of tobacco and non-tobacco farmers
- Explored the social, cultural, and environmental impacts of tobacco cultivation
- Estimated the emissions of CO_2e from tobacco production and curing
- Explored the status of human health of tobacco farmers

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Introduction

Tobacco, the 6th major cash earning but 2nd top most exporting crop, lies in the world at 14th position in acreage and 12th position for production (1.3% of global tobacco production) in Bangladesh, which are mostly grown in Rangpur, Meherpur, Kushtia, Chuadanga, Jashore, Gazipur districts, and Chattogram hill tract region. In addition to this, it extends to Lalmonirhat, Nilphamari, Jhenaidah, and Rajshahi. Some tobacco varieties, such as jati and motihari, are predominantly cultivated in the Rangpur and Bandarban districts, while virginia is commonly grown in the Kushtia district. The area under tobacco cultivation in Bangladesh is still only 0.22% of the total land and employment is less than 0.5% (FAO, 2010). Tobacco cultivation is economically profitable as compared to other field crops and plays a vital role in the local economy (Ali *et al*., 2015; Karim *et al*., 2016). According to PRI (2012), the average income of TF was about 30% higher than that of NTF. The high rate of profit from tobacco cultivation and the higher land acquisition by TF led to significantly higher incomes. Among the five major crops in Bangladesh (rice, jute, wheat, tobacco, and pulses), tobacco had the highest per-acre income. Socioeconomic status is dependent on income: the more income, the better socioeconomic status. Tobacco farming has many negative impacts on both the environment and tobacco farmers, mostly associated with social and health problems (Lecours *et al.,* 2012). Tobacco plants absorb more phosphorus, potassium, and nitrogen than other field crops, resulting in reduced soil fertility. Topping and de-sugaring of tobacco fields are two types of specialized intercultural practices used to obtain more leaves with high nicotine levels that greatly reduce soil fertility. Excessive use of agrochemicals in tobacco cultivation creates high N and P concentrations in surface water, leading

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to entropic conditions, reducing biodiversity, and destroying aquatic ecosystems. In Vietnam, Minh *et al.,* (2009), stated that tobacco growing had a great effect on the environment. WHO (2022) reported that tobacco cultivation was responsible for about 5% of total deforestation and released about 80 million tons of CO_2 into the environment every year. Each cigarette emits about 14 gm of CO_2 over its entire life cycle (WHO, 2022). The green tobacco sickness (GTS) report was first published in 1970 in Florida as "cropper sickness" (Weizenrecker and Deal, 1970). It was seen due to the absorption of nicotine from wet tobacco and made public as GTS. Several countries around the world, such as the USA, Brazil, China, India, Pakistan, Poland, and Japan, have published reports of GTS symptoms among tobacco farm workers. However, no work has been done on the GTS effect in Bangladesh. Nicotine from the tobacco plant is drawn up through the skin and distributed throughout the body directly through the blood. It changes parts of the brain, causing headaches, vomiting, nausea, dizziness, abdominal pain, diarrhea, pallor, chills, increased perspiration, prostration and salivation, a feeling of weakness, breathlessness, and occasional lowering of blood pressure as reported earlier by Fotedar and Fotedar (2023); Lecours *et al.,* (2012). Age, type of labor performed, personal tobacco use, and environmental conditions were also identified as the risk factors for GTS. A tobacco grower absorbs about the same amount of nicotine as 50 cigarettes (WHO, 2022). The worldwide prevalence of GTS ranged from 8.2 to 47% and the average duration of illness was 1 to 3 days (WHO, 2022). According to Ali *et al.,* (2018), studies on the socioeconomic condition of tobacco farming in Bangladesh were not available, which was a big research gap. Moreover, only through an overall socioeconomic comparison between TF and NTF and an in-depth analysis of the environmental impacts of tobacco farming can a decision be made "whether tobacco farming will expand in Bangladesh in the future or not". The study aimed to compare socioeconomic conditions between TF and NTF and explore the impacts of tobacco cultivation on the environment, including human health.

Materials and Methods

Research area and sample size

The study area, Kushtia district, has an area of 1621.15 sq km and lies between $23^0$42′ and $24^0$12′ north latitude and $88^0$42′ and $89^0$22′ east longitude. It is a district in the Khulna administrative division of western Bangladesh. The study was exploratory, combining primary and secondary data. As the study area was very large, the researcher used the sampling method to conduct the study to save money and time. Kazihata village of Dharampur union of Bheramar upazila and Kamalpur village of Payarpur union of Daulatpur upazila under Kushtia district were chosen as research areas, as 54.63% of people were engaged with tobacco cultivation in those two villages (Roy *et al.*, 2024). A representative sample size was obtained by using the "Taro Yamane equation, 1967" (Adam, 2020) as (1):

$$n = \frac{N}{1+(N\times e^2)} \quad (1)$$

Where n=Size of the sample; N= Population size, and e=Sampling error

According to this formula, the total desired sample was 144 TF. To compare the basic socioeconomic traits, about 72 NFT (about 50% of the TF sample size) were also considered as a sample (PRI, 2012; Rahman *et al.*, 2019; Talukder *et al.*, 2020). From the field survey report, the average age, household size, education level, own cultivated land, and farm size of the respondents were 47.10 years, 5.23 members, `can sign only to PSC pass,' 0.97 acres, and 2.37 acres for TF and 46.38 years, 4.79 members, `can sign only to PSC pass', 1.02 acres and 1.99 acres for NTF, respectively. The male and female respondents were 82.64% and 17.36% for TF and 80.56% and 19.44% for NTF, respectively.

Data collection method, data processing, and analysis

To collect the desired data, a well-structured questionnaire was developed based on the review of the literature and a pre-examination of actual field situations. A random sampling technique was used to select the sample. The primary data were collected by using a questionnaire survey on face-to-face interviews, focus group discussions (FGD), expert opinions, and observations. To ensure the accuracy of the data, care and vigilance were taken during the collection of data. Data collection began on July 3 and ended on July 21, 2023. The data were transferred to the master sheet and then compiled for tabulation. Data were analyzed as mean, standard deviation (SD), and t-test through a Microsoft Excel Worksheet 2016 using the following formulae:

$$\bar{x} = \frac{1}{n}\sum_1^i f_i x_i \quad (2)$$

$$S = \sqrt{\left(\frac{\sum_1^i (x_i-\bar{x})^2}{n-1}\right)} \quad (3)$$

$$t = \frac{\left|\left(\bar{x}_1-\bar{x}_2\right)\right|}{\sqrt{\frac{{s_1}^2}{n_1}+\frac{{s_2}^3}{n_2}}} at(n_1+n_2-2df) \quad (4)$$

Where $\bar{x}$ = Mean value of the samples, x= Sample value, f= Frequency, s= Standard deviation, n= Size of the sample, and df = Degree of freedom.

Estimation of Greenhouse gas (GHG) emissions from tobacco cultivation and tobacco leaf curing in Bangladesh

In the study, from the application of nitrogen-containing fertilizer in tobacco fields, nitrous oxide (N_2O) gas emission was estimated using the methodology outlined by the Intergovernmental Panel on Climate Change (IPCC, 2006) (Hussain *et al.,* 2017), which was based on the following equation (5).

$$tCO_2e = EF \times N \times CF_N \times CF_C \quad (5)$$

Where $tCO_2e = N_2O$ emission that is converted into metric ton CO_2 equivalent, RF= Emission factor of N-fertilizer to N_2O-N (default value=0.01), N= Metric ton of N is applied, CF_N = Conversion factor from N_2O-N to N_2O (default value=1.571), and CF_C = Conversion factor from N_2O to CO_2e (default value=310) (Hussain *et al.,* 2017).

On the other hand, to estimate the total GHG emission from tobacco leaf curing, the methodological approach outlined by IPCC in 1994 (Alam and Starr, 2008; Hussain *et al.,* 2017) was adopted, which was based on a series of formulae (6-12) as follows.

$$TC_r = TB_b \times B_{ax} \times B_c \quad (6)$$

Where TC_r= Total carbon released (ton carbon), TB_b = Total biomass burnt (ton dry-matter), B_{ax} = Fraction of biomass oxidized (default value = 0.9), and B_c = Biomass carbon content (default value=0.5-ton carbon present per ton of dry matter).

Non-CO_2 GHG (CH_4, CO, NO, N_2O, and NO_x) were also estimated using a series of formulae (7-11) as follows (Alam and Starr, 2008; Hussain *et al.,* 2017).

$$CH_4 = TC_r \times ER \times \frac{16}{12} \quad (7)$$

$$CO = TC_r \times ER \times \frac{28}{12} \quad (8)$$

$$NO = TC_r \times ER \times \frac{N}{C} \times \frac{30}{14} \quad (9)$$

$$N_2O = TC_r \times ER \times \frac{N}{C} \times \frac{44}{28} \quad (10)$$

$$NO_x = TC_r \times ER \times \frac{N}{C} \times \frac{46}{14} \quad (11)$$

Where ER= Emission ratio (default value as, CH_4 =0.012, CO =0.06, N_2O =0.007, NO =0.121 and NO_x =0.121), $\frac{N}{C}$ The nitrogen-carbon ratio in biomass (default value=0.01).

Total emissions of CO_2 were calculated from the total carbon released minus the carbon released as CH_4 and CO, and multiplied by the CO_2-C molecular ratio as the following formula (12).

$$CO_x = TC_r - \left(CH_4 - C + CO - C\right) \times \frac{44}{12} \quad (12)$$

To upscale estimation of annual total GHG emissions (t/year) and CO_2-equivalent (global warming potential for a 100-year time horizon) from total tobacco production and tobacco leaf curing in Bangladesh in 2021, these converting factors for non-CO_2 GHG into CO_2e were taken: global-warming potential (GWP) for CH_4= 21, and N_2O= 310 (IPCC, 2006), GWP for CO= 2.348 (Alam and Starr, 2008), and average GWP for NO_X= 8.5 (Lammel and Grabi, 1995). But NO was not included due to the unavailability of the conversion factor.

RESULTS AND DISCUSSION

Socioeconomic impacts of tobacco production in Bangladesh

A total of 10 traits were selected to compare the socioeconomic status of TF and NTF. These are average monthly family income, making loans, residential ownership, residential status, sources of drinking water, type of latrine used, television and freeze ownership, mobile phone and internet use, weekly fish/meat consumption, and expenditure in Eid/festival. To analyze the significant difference between the two independent groups, a t-test was carried out (Baliwada *et al.,* 2018; Srinivas *et al.,* 2020 and 2022) and the results were represented in Table 1, Table 2, and Table 3.

Average monthly family income, and making loan

Socioeconomic status is dependent on income; the more income, the better the socioeconomic status. Table 1 demonstrates that average monthly household income was significantly higher to TF than NTF as the calculated t-value (7.06) was higher than the tabulated $t_{0.05}$ value at 214 df and $\bar{x}_1 > \bar{x}_2$. The highest number of TF households belonged to the upper-middle income (Tk 15001-30000) category (43.75%), while NTF households belonged to the low-middle income (Tk 9001-15000) category (52.78%) with a mean of (TK 18052 ± 1552) and (Tk 15980 ± 2235), respectively. Similar results had been reported by Karim *et al.,* (2016) in Bangladesh; Baliwada *et al*., (2018); Kumar *et al.* (2023); Srinivas *et al*. (2020 and 2022) in India. TF earned on average, about 50% more than NTF as reported by PRI (2012). Appau *et al.,* (2019) in Malawi, Kenya, and Zambia showed that TF was aimed at economic growth and increased farm income compared to NTF. Conversely, Kibwage *et al.* (2009), in Kenya showed that the average monthly household income of NTF was US$16.47 higher than that of TF.

Credit Borrowing is a vital factor affecting farmers' agricultural production. The majority of the TF (47.92%) and NTF (44.44%) were out of borrowing credit. Most TF farmers borrowed between Tk 1 to 2 lakh (19.44%) and NTF farmers borrowed between Tk 2 to 3 lakh (22.22%) (Table 1). Although there was no significant difference in making loans between TF and NTF, as calculated t-value (1.53) was smaller than the tabulated $t_{0.05}$ value at 214 df (1.96). Interestingly, most TF took their loans from banks (67.42%) but NTFs took their loans from NGOs or local moneylenders (63.89%). This finding was in line with the results of Srinivas *et al*., (2020 and 2022). From Table 1, it can be concluded that the higher income-generating capacity of the tobacco farmers was due to high economic benefits from tobacco crops *i.e*., TF were comparatively more empowered in socioeconomic status than NTF. The extent of borrowing had no relationship with tobacco cultivation, but TF was more aware of the source of borrowing.

Residential ownership, residential status, sources of drinking water, and type of latrine

Residential ownership and residential status are two important indicators for measuring a person's standard of living and socioeconomic status. Table 2 delineates that there was no significant difference in residential ownership between TF and

Table 1: Effect of tobacco production on average monthly family income and making loan

Attributes	Classification	Tobacco farmer			Non-tobacco farmer			Statistical analysis	
		Frequency	Percent (%)	Mean ± SD	Frequency	Percent (%)	Mean ± SD	Calculated t-value	$t_{0.05}$ value at 214 df
Average monthly Family income	Ultra Low Income (<Tk 3,000)	0	0	(18052 ± 1552)/=	0	0	(15980 ± 2235)/=	7.06	1.96
	Low Income (Tk 3,001–9,000)	7	4.86		7	9.72			
	Low-Middle Income (Tk 9,001–15,000)	60	41.67		38	52.78			
	Upper-Middle Income (Tk 15,001-30,000)	63	43.75		21	29.17			
	High Income (>Tk 30,000)	14	9.72		6	8.33			
Making loan	Have No Loan	69	47.92	(0.95 ± 0.45) Lakh	32	44.44	(1.06 ± 0.52) Lakh	1.53	1.96
	Loan Have <Tk 1 Lakh	18	12.50		10	13.89			
	Loan Have Tk 1–2 Lakh	28	19.44		11	15.28			
	Loan Have 2–3 Lakh	25	17.36		16	22.22			
	Have>Tk 3 Lakh	4	2.78		3	4.17			

Note: According to Bangladesh Bank, 1 US$=110.84 BDT (Tk) on November 12, 2023.

Table 2: Effect of tobacco production on residential ownership and condition, sources of drinking water, and type of latrine used

Attributes	Classification	Tobacco farmer			Non-tobacco farmer			Statistical analysis	
		Frequency	Percent (%)	Mean ± SD	Frequency	Percent (%)	Mean ± SD	Calculated t-value	$t_{0.05}$ value at 214 df
Residential ownership	Have no Own house (0)	0	0	1.83 ± 0.07	0	0	1.81 ± 0.10	1.52	1.96
	Own house without adequate space (1)	25	17.36		14	19.44			
	Own house with adequate space (2)	119	82.64		58	80.56			
Residential status	Straw/mud house (1)	0	0	2.94 ± 0.12	0	0	2.79 ± 0.17	6.70	1.96
	Teen-shed house (2)	29	20.14		18	25.00			
	Semi-pucca building (3)	94	65.28		51	70.83			
	Pucca building (4)	21	14.58		3	4.17			
Drinking water sources	Have own tube-well/ motor (1)	137	95.14	0.95 ± 0.08	67	93.06	0.93 ± 0.11	1.37	1.96
	Other's Tube-well (0)	7	4.86		5	6.94			
Type of Latrine	No latrine (0)	0	0	2.39 ± 0.13	0	0	2.42 ± 0.19	1.21	1.96
	Kutcha latrine (1)	28	19.44		15	20.83			
	Semi-pucca latrine (2)	32	22.22		12	16.67			
	Pucca latrine (3)	84	58.33		45	62.50			

NTF, but there was a remarkable difference between the two groups in residential condition, as the calculated t-value (6.70) was greater than the tabulated $t_{0.05}$ value at 214 df. The highest number of TF and NTF residences belonged to the "own house with adequate space" category, which accounted for 82.64% and 80.56%, respectively as well as farmers' residential status was semi-pucca buildings, which accounted for 65.28% for TF and 70.83% for NTF. The residential status score of TF was significantly higher than NTF, so it can be deduced that the socioeconomic status of TF was better than NTF. These findings are in accordance with Baliwada *et al.,* (2018). Since income is an important indicator for measuring a person's standard of living, it may be that tobacco farmers have become more economically prosperous by growing tobacco and tend to have better housing conditions.

Drinking water sources and type of toilet are two important indicators for measuring quality of life. Table 2 indicates that most participants had their tube-well/motor as a source of drinking water, which was recorded as 95.14% for TF and 93.06% for NTF. In the case of the type of latrine, no one was found who did not have a toilet. A maximum number of TF (58.33%) and NTF (62.50%) had pucca latrines. These findings are in accordance with Ali *et al.,* (2018); who stated that 98.70% of tobacco farmers used tube-well for drinking water and 26.80% used pucca latrines. According to the population and housing census (2022), about 85.66% of people used tube-well (deep/shallow) as a main source of drinking water and 68.88% of people used pucca latrines in the Kushtia district. However, in both cases, the calculated t-values (1.37 and 1.21) are smaller than the tabulated $t_{0.05}$ value, *i.e.,* there is no significant difference between TF and NTF groups in terms of drinking water sources and type of toilet used. This may be because both TF and NTF were aware of their source of drinking water and used toilets, and the government gave utmost importance to these issues.

Television and freeze ownership, mobile and internet use, weekly eating of fish/meat, and expenditure on the festival

Television, freeze, and mobile ownership, and internet use were not the basic needs of people earlier; many people used them as a luxury, but nowadays, they have become an integral part of people's lives. They are considered as an important indicator of social status. Table 3 displays that only 16.67% of TF and 23.61% of NTF neither had a television nor refrigerator but 38.89% of TF and 41.67% of NTF both had a television and refrigerator, *i.e.,* 2.78% more NTF than TF have both television and refrigerator. On the other hand, 94.54% of TF and 93.06% of NTF used cell phones, in which 31.25% of TF and 36.11% of NTF used the internet in their cell phone *i.e.*, 4.86% more NTF than TF used the internet. These findings are in accordance with the population and housing census (2022); which showed that on average, 89.34% of people used mobile phones and 38.16% of people used the internet in the Kushtia district. According to the report "Economics of Tobacco Farming in the Philippines", 90.5, 86.2, and 36.12% of TF used TV sets, cellular phones, and refrigerators, respectively (Chavez *et al.,* 2016). Though statistically there was no significant difference between the two groups to use them. A possible reason may be that people's preferences and inclinations are less dependent on income; rather, people tend to use modern technology as they become educated.

Table 3 also represents a comparative picture of weekly fish/meat consumption and festival expenditure between TF and

Table 3: Effect of tobacco production on television and freeze ownership, mobile and internet use, weekly fish/meat consumption, and expenditure in the festival

Attributes	*Classification*	*Tobacco farmer*			*Non-tobacco farmer*			*Statistical analysis*	
		Frequency	*Percent (%)*	*Mean ± SD*	*Frequency*	*Percent (%)*	*Mean ± SD*	*Calculated t-value*	*$t_{0.05}$ value at 214 df*
Television and freeze ownership	Have no television and freeze (0)	24	16.67	1.22 ± 0.12	17	23.61	1.20 ± 0.17	0.89	1.96
	Have only Television (1)	60	41.67		24	33.33			
	Have only freeze (1)	4	2.78		1	1.39			
	Both have television and freeze (2)	56	38.89		30	41.67			
Mobile and internet use	Have no Cell phone (0)	8	5.56	1.26 ± 0.12	5	6.94	1.29 ± 0.18	1.28	1.96
	Have a cell phone but don't use internet (1)	91	63.19		41	56.95			
	Have cell phone And use internet (2)	45	31.25		26	36.11			
Weekly fish/meat consumption	Eat fish/meat Less than 3 days	49	34.03	3.77 ± 0.30	31	43.06	3.62 ± 0.43	2.66	1.96
	Eat fish/meat Within 3–5 days	59	40.97		21	29.17			
	Eat fish/meat Within 6–7 days	36	25.00		20	27.78			
Expenditure in the last eid/festival	Spent<tk 5,000	28	19.44	(17430 ± 1415)/=	18	25.00	(16320 ± 1943)/=	4.31	1.96
	Spent between Tk 5,000–25,000	46	31.94		22	30.56			
	Spent >Tk 25,000	70	48.61		32	44.44			

Note: According to Bangladesh Bank, 1 US$=110.84 BDT (Tk) on November 12, 2023.

NTF groups and it is observed that the maximum number of TF (40.97%) consumed fish/meat 3 to 5 days per week but the maximum number of NTF (43.06%) consumed fish/meat less than 3 days per week with an average of (3.77 ± 0.30) and (3.62 ± 0.43), respectively. In terms of festival spending, a maximum of 48.61% TF and 44.44% NTF spent more than Tk 25000 last Eid with an average of Tk (17430 ± 1415) and Tk (16320 ± 1943), respectively. In both cases, the calculated t-values (2.66 and 4.31) were higher than the tabulated $t_{0.05}$ value. Hence, there were significant differences between the two groups in weekly fish/meat consumption and festive expenditure. As ($\bar{x}_1 > \bar{x}_2$), it can be concluded that TF leads to a better standard of living than NTF. This may be because the income of TF-growing farmers was higher than that of NTF. This result was in good compliance with the findings of Baliwada *et al.,* (2018); Kibwage *et al.,* (2009). Minh *et al.,* (2009), stated that tobacco farmers financially benefited from tobacco cultivation in Vietnam. From this chapter, it can be concluded that TF was relatively stronger in terms of socioeconomic status than NTF (Srinivas *et al.,* 2020 and 2022) which was due to higher economic profit from tobacco farming.

Environmental impacts of tobacco farming in Bangladesh

Impacts of tobacco farming on the physical and biological environment

- *Respondent's perception about the effect of tobacco farming*

From Fig. 1, it can be seen that the maximum number of respondents felt that tobacco cultivation was reducing soil fertility day by day (72.92%), polluting the surrounding water (51.39%), and polluting the surrounding air due to tobacco leaves curing (65.28%). But in terms of the biological environment, the majority of the respondent farmers were unaware of the ecosystem impact and loss of biodiversity which were 46.52 and 45.14%, respectively. About 65.28% of the respondents felt that tobacco farming was causing food insecurity, while 67.36% felt that tobacco cultivation had no adverse effect on livestock and poultry rearing. Rashida Begum of Kazihata, a goat-rearing farmer, said that 'goats eat inflorescences and buds obtained from topping and de-sugaring during tobacco cultivation and give more milk'.

Tobacco farming required a huge number of chemical fertilizers (645 kg/acre), which were 2.02 times, 2.48 times, and 1.48 times higher than boro rice, wheat, and winter maize cultivation (Roy *et al.,* 2024). Therefore, soil erosion in tobacco fields is much faster than in traditional crop fields. Intensive use of agrochemicals in tobacco cultivation can leach into rivers, lakes, and groundwater, leading to water pollution and affecting aquatic ecosystems, causing long-term damage to flora and fauna and posing risks to human populations dependent on those water supplies. The curing process of tobacco leaves involves burning fuels, which release CO_2, volatile organic compounds, and other harmful gases into the air, contributing to air pollution. The use of agrochemicals in tobacco production poses risks to non-target organisms, including beneficial insects, birds, aquatic animals, and soil microorganisms. Tobacco cultivation leads to soil degradation, loss of soil fertility and productivity, disrupts the water cycle (WHO, 2017), and threatens food crop cultivation (Akhter, 2011). According to the survey report, tobacco farmers mostly used Mango wood (*Mangifera indica*), burflower (*Anthocephalus indicus*), acacia (*Acacia spp.*), epil-ipil (*Leucaena leucocephala*), rain tree (*Samania saman*) as firewood during curing. These trees were highly vulnerable in their locality. Mongora reported in 2005 that tobacco plantations accounted for 3.5% of annual deforestation and tobacco curing required an average of 23 m^3 of fuel wood per season, which accounted for another 3% of deforestation. Tobacco farming leads to soil degradation, deforestation, ecological disruptions that cause a loss of ecosystem services, climate change, and negative effects on human health (Lecours *et al.,* 2012). In fact, tobacco farming creates huge negative effects on the physical and biological environment, yet farmers are not aware, they always consider the visual gain and decide to crop production.

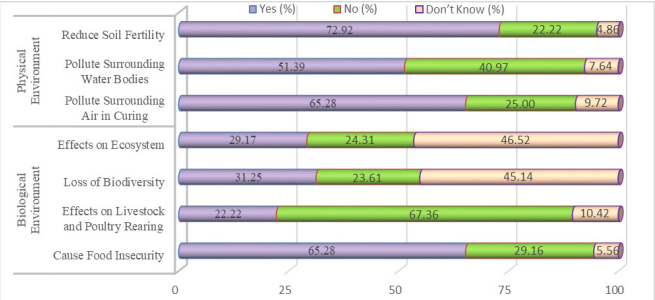

Fig. 1: Effect of tobacco production on the physical and biological environment

Estimation of greenhouse gas (GHG) emission due to tobacco cultivation and curing

According to BBS, 2022, in FY2021-22, the total acreage under tobacco cultivation in Bangladesh was 100365 acres, of which joti 19881 acres (19.81%), motihari 10378 acres (10.34%), and virginia 70106 acres (69.85%) as well as total production was 92327 tons. Among the three cultivated varieties, only virginia tobacco requires flue-curing with wood. The survey showed that on average, farmers applied (112 ± 8.76) kg of N per acre of tobacco field and used (6.3 ± 0.17) tons of dry fuel wood *i.e.,* (5.04 ± 0.14) tons of dry matter (dm) (assuming 80% dm in dry firewood) was used for one acre of tobacco leaves curing. Although Lecours *et al.,* (2012) estimated 7.8 kg of firewood for curing one kg of tobacco leaf. Hence, in FY2021-22, the annual deforestation associated with tobacco curing in Bangladesh was (543591 ± 14849) m^3 of wood biomass (assuming a wood density value of 0.65 tdm per m^3) (Alam and Starr, 2008; Hussain *et al.,* 2017). Table 4 illustrates that in FY2021-22, tobacco cultivation was responsible for (53154 ± 4155) t of CO_2 equivalent (tCO_2e) gas emissions, and tobacco leaf curing was responsible for (541025 ± 14779) tCO_2, (22260 ± 608) tCO, (2544 ± 70) tCH_4, (17.49 ± 0.48) tN_2O, (412 ± 11) tNO, and (632 ± 17) tNO_X in Bangladesh. According to the ECR (2023), Bangladesh emitted a total of 276.80 million tons of CO_2e in 2021. Total GHG emissions in Bangladesh in 2021 from tobacco cultivation and tobacco leaf curing was (710664 ± 19414) t CO_2e, which accounted for 0.26% of total GHG emissions, *i.e.,* an average of (7.7 ± 0.21) kg of CO_2e was emitted per kg of

Table 4: Upscale estimation of total annual GHG emissions (tons per year) and CO_2-equivalents (Global warming potential for a 100-year time horizon) by tobacco farming in Bangladesh in 2021

CO_2 equivalent emissions (t CO_2e) due to tobacco cultivation in Bangladesh			*Greenhouse gas (GHG) emissions (t) due to tobacco curing in Bangladesh*							
Average N required (kg) per acre of tobacco field	Total N required (t) in Bangladesh for tobacco production[a]	Total CO2 equivalent emissions (t CO_2e)	Total wood required (t dm) for tobacco leaf curing	Name of greenhouse gas emitted during tobacco curing in Bangladesh						Total CO_2e[b] emission (t CO_2e) due to tobacco cultivation and curing
				CO_2	CO	CH_4	N_2O	NO	NO_X	
112 ± 8.76	11241 ± 879	53154 ± 4155	353334 ± 9652	541025 ± 14779	22260 ± 608	2544 ± 70	17.49 ± 0.48	412 ± 11	632 ± 17	710664 ± 19414

Note: [a] =Total tobacco cultivation in Bangladesh was 100365 acres in which FC virginia tobacco was 70106 acres and [b]= NO is not included due to the unavailability of the conversion factor.

tobacco leaf production and curing in Bangladesh. The findings were in accordance with Alam and Starr (2008), who showed that the total annual CO_2e emitted by brick manufacturing industries (BMI) in Sudan was 455666 tons per year. Tobacco releases 80 million tons of CO_2 into the atmosphere every year, as reported earlier by WHO (2022). Hussain *et al.,* (2017), also found that annual deforestation associated with tobacco leaf curing in Pakistan was 152721 m^3 woody biomass; total annual CO_2e emission was 176564 tCO_2e, and an average of 5.88 kg of CO^2e was released into the air for only curing of each kg of tobacco leaf. From this chapter, it can be inferred that tobacco farming results in extensive damage to the environment by emitting GHG and destroying forests in Bangladesh.

Impacts of tobacco farming on the social environment

A set of questions with 14 attributes was put to the tobacco farmers to know the effects of tobacco cultivation on the social environment and their realization is presented in Fig. 2. The maximum 91.67% of the respondents believed that the direct effects of tobacco farming were hindering family peace and happiness. It may be that tobacco cultivation is so labor-intensive that overworked tobacco farmers are always in a bad mood from plant production to sale. Curing tobacco leaves is the most tedious and laborious job (Manyanhaire and Kurangwa, 2014), during which men, women, and children of tobacco farming families cannot eat and sleep properly for 72 hours continuously. Then, the maximum number (90.28%) was conscious of not growing tobacco in the following year. About

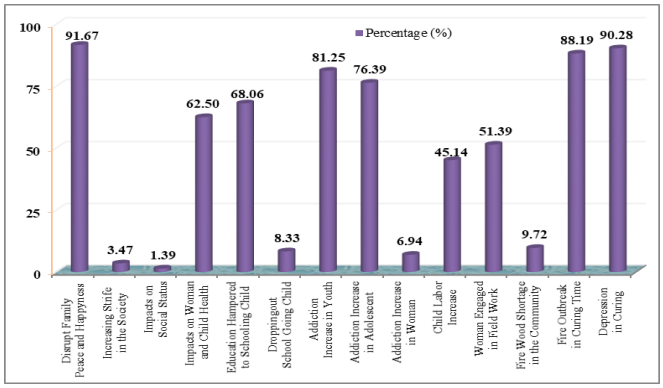

Fig. 2: Impacts of tobacco farming on the social environment

88.19% also perceived that firewood outbreaks had a high probability during curing as well as it had occurred many times in their community. Another major concern for society was the increase in nicotine addiction among tobacco-growing youths (81.25%) and adolescents (76.39%), as they came into contact with tobacco plants while working in the field and thereby got nicotine into the body due to the GTS effect. On the other hand, tobacco cultivation has a moderate impact on society in terms of education-hampered schooling children (68.06%), impacts on women and children's health (62.50%), women engaged in fieldwork (51.39%), and increase in child labor (45.14%). Ali *et al.,* (2015 and 2018), previously stated that tobacco farming families are always under stress, which disturbs the peace and happiness of the family as well as youths are addicted to nicotine at a rate of 76.30%, while women are addicted at a rate of only 5.47%. Singha and Kanna also reported in India in 2022 that farmers who work in tobacco farming are more likely to become addicted to smoking due to their regular exposure to tobacco. The economics of tobacco farming in Zambia, Goma *et al.,* (2017), reported that about 22.5% of children were engaged in tobacco production activities on their farms. These results were in accordance with the findings of the study.

Impacts of tobacco farming on the cultural environment

Tobacco-growing communities had a detrimental effect on the cultural environment. Overdependence on tobacco as a cash crop had led to the gradual erosion of traditional cultural practices and values. As communities become increasingly dependent on tobacco for their livelihoods, the cultivation of this cash crop overshadows and displaces other essential elements of their cultural heritage. Negative perceptions linked to tobacco production may degrade these cultures, promote social divisions, and worsen the overall deterioration of the region's cultural environment. Furthermore, tobacco cultivation is very laborious work. Most of the time they do not have time to perform traditional cultural practices as they are busy with tobacco cultivation. As a result, instead of sitting in one place chatting, organizing sports, music programs, fairs, and other cultural events, they are becoming busier to watch TV and social media such as Facebook at leisure period at home. According to Fig. 3, the maximum number of participants (67.36%) felt that farmers were so busy with their tobacco-related activities that the cultural events, which were organized earlier in their communities, had reduced considerably. Conversely, 18.06%

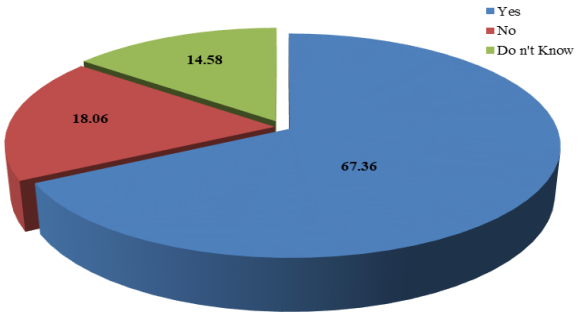

Fig. 3: Impacts of tobacco production on the cultural environment

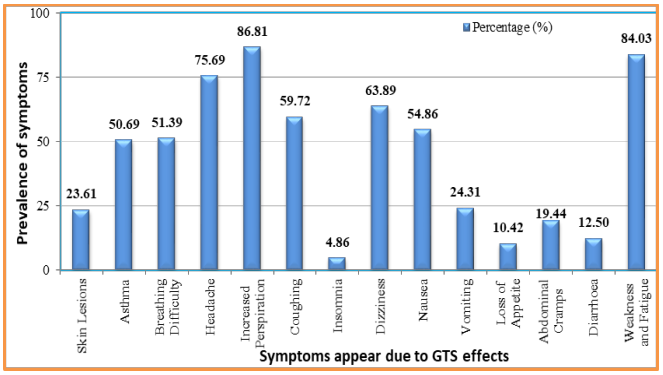

Fig. 4: Impacts of tobacco farming on human health caused by GTS

believed that tobacco cultivation was not the reason for the decline of cultural activities in the region.

Impacts of tobacco farming on human health

Prevalence of health problems due to green tobacco sickness (GTS)

GTS, an acute poisoning, is an occupational hazard caused by skin absorption of nicotine from wet tobacco plants. GTS, known worldwide as a disease, is not only caused by skin absorption but also by inhalation of nicotine. About 26% of TF suffer from health problems from tobacco cultivation in Bangladesh (Karim *et al.,* 2016), and 25% of TF in the world (WHO Reports, 2022). A set of 14 questions was put to the tobacco farmers to know the impact of GTS effect on human health and their perceptions are presented in Fig. 4. It can be depicted from Fig. 4 that among the symptoms, increased perspiration (86.81%), weakness and fatigue (84.03%), and headache (75.69%) were the most common symptoms of GTS effects reported by tobacco workers. On the other hand, dizziness (63.89%), cough (59.72%), nausea (54.86%), breathing difficulty (51.39%), and asthma (50.69%) were the moderate symptoms revealed to tobacco workers due to the GTS effect. Furthermore, the effects of GTS were manifested in very low levels of vomiting (24.31%), skin rash (23.61%), abdominal cramps (19.44%), diarrhea (12.50%), loss of appetite (10.42%), and insomnia (4.86%) in tobacco workers. According to Minh *et al.*, (2009) in Vietnam, nine incidences out of 16 health problems was significantly higher in TF than in NTF. Singha and Kanna (2022) in India, reported symptoms of vomiting (52%), increased sweating (54%), insomnia (54%), and increased salivation (54%) due to GTS effects. The field survey report showed that only 29.17% of the tobacco workers used protective equipment such as hand gloves, gum boots, and waterproof cloths during topping and de-sugaring along with PGR application. But, only 19.44% of workers used protective measures during pesticide application. According to Lecours *et al.,* (2012), tobacco farmers had a high prevalence of GTS and pesticide poisoning due to insufficient training, little knowledge of protection systems, lack of protective equipment, casual attitudes, and dissatisfied safety practices with basic protective use. In Brazil, Fassa *et al.*, (2014) reported that only 35.3% of women and 23.4% of men always used protective clothing, and 49.7% of women and 24.9% of men used protective gloves when working in tobacco fields. Conversely, a study conducted by the British America Tobacco Company Limited (BAT) in 2022 on the impact of tobacco farming reported that 100% of BAT tobacco farmers received training in the use of their PPE, about 97% of farmers always wear PPE during harvesting and 61% of farmers do when handling agrochemicals. However, Brazilian farmers were more aware of GTS than Bangladeshi and Kenyan farmers.

Factors affecting green tobacco sickness (GTS) effect

From Fig. 5, it can be depicted that the prevalence of the GTS effect mainly depended on the nutritional status of the farmers (90.97%) and the age and gender of the farmers (89.58%), *i.e.*, farmers with poor nutritional status, young aged and women were highly susceptible to GTS symptoms. On the other hand, farmers with less working experience with tobacco, hot sunshine, longer working hours, skin-scarred farmers, and non-smoker farmers were moderately susceptible to GTS symptoms, which were 66.67, 63.19, 59.03, 55.56, and 52.78%, respectively. However, relatively fewer GTS symptoms were observed when tobacco leaves were wet (10.42%). In Korea, Park *et al.* (2018) reported that the prevalence of GTS (37.5%) was significantly higher among youth, women, and non-smoking workers than men. Generally, GTS symptoms show after 3 to 17 hours of work, and the half-life of nicotine varies from 2 to 2.5 hours to 4 to 5 hours. In Brazil, Silva *et al.* (2018) also reported that GTS symptoms varied based on gender, age, schooling, smoking status, and experience in tobacco fields.

Analyzing the overall situation, it can be seen that the economic development of all the people in these areas is very important. While tobacco farming has some advantages, such as a handsome net return, there are also some disadvantages, such as causing fatal damage to health and the environment.

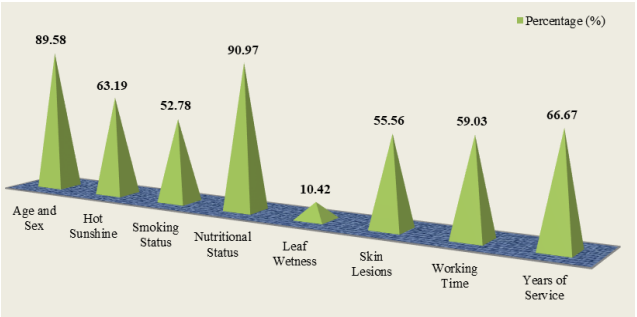

Fig. 5: Factors affecting GTS effect

Article 17 of the WHO FCTC stated the need to offer economically sustainable livelihood options by declining tobacco and the FCTC Article 18 emphasized the need to protect the environment and farmers' health from the adverse effects of tobacco cultivation. Considering these identified *pros and cons* of tobacco cultivation, policymakers should adopt strategies to shift away from tobacco cultivation to contemporary high-value crops gradually. Due to a shortage of time and money, this research could not cover a wide area to collect data, further studies can be carried out in a wider area.

CONCLUSION

The economy of Bangladesh is largely dependent on agriculture. Agricultural production mainly depends on nature and farmers but farmers are not aware of protecting their health and environment. The average monthly household income of TF households (TK 18052 ± 1552) was significantly higher than NTF (Tk 15980 ± 2235), which made TF more empowered than NTF in terms of housing conditions, weekly fish/meat consumption, and Eid/festival expenditure. However, tobacco farming had no significant effect on borrowing credit, housing ownership, source of drinking water, type of latrine used, ownership of television, refrigerator, and mobile phone, and internet usage. Many respondents felt that tobacco cultivation is reducing soil fertility (72.92%), polluting the surrounding water (51.39%) and air (65.28%), creating food insecurity (65.28%), and reducing cultural activities in society (67.36%), but maximum of them were unaware of environmental pollution (45.52%), loss of biodiversity (45.14%). Tobacco cultivation in Bangladesh accounted for annual (543591 ± 14849) m^3 of wood biomass deforestation and (710664 ± 19414) tCO_2e gas emissions (which was 0.26% of the total national annual GHG emissions). That is, about (7.7 ± 0.21) kg of CO_2e was emitted to produce one kg of tobacco leaf in Bangladesh. Disruption of family peace and happiness, increase in fire incidence, and increase in nicotine addiction were the direst social problems caused by tobacco cultivation. Increased perspiration, weakness and fatigue, and headache were the most common symptoms of GTS effects. The prevalence of GTS effects largely depended on the nutritional status, age, and gender of the farmers. Only 29.17% of the tobacco workers used protective equipment during topping and de-sugaring along with PGR application. Communities have rights to clean water and, fresh air and safe food, whereas tobacco violates the fundamental human rights to the environment and human health. Although TF was relatively stronger in terms of socioeconomic conditions compared to NTF due to higher economic returns from tobacco farming, it damaged the physical and biological environment, caused massive deforestation, emitted significant amounts of GHG, degraded the social and cultural environment, and disrupted farmers' health. Considering these identified *pros and cons* of tobacco farming, policymakers should adopt strategies to shift away from tobacco cultivation to contemporary high-value crops to improve farmers' livelihoods.

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AUTHORS CONTRIBUTION

AR: Research designing, questionnaire preparation, data collection, data analysis, table and graph making, data compilation, and writing of the first original draft of the manuscript, reviewing, and editing; **SN:** Manuscript correction and reviewing; **MGM:** Helping research designing and questionnaires preparation, manuscript correction and editing, finalization of the draft, and manuscript submission.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

Adam, A. M. (2020). Sample size determination in survey research. *Journal of scientific research & reports*, 26(5):90-97. http://doi.org/10.9734/jsrr/2020/v26i530263.

Akhter, F. (2011). *Tobacco Cultivation and its impact of food Production in Bangladesh*, UBINIG. 1-11, http://www.fairtradetobacco.org/wpcontent/2011/07/FaridaAkhterTobacco-to-Food Production.

Alama, S. A., Starr, M. (2008). Deforestation and greenhouse gas emissions associated with fuel-wood consumption of the brick-making industry in Sudan. *Science of the total environment*, 407(2): 847-852. http://doi.org/10.1016/j.scitotenv.2008.09.040·

Ali, M. Y., Islam, M. F., Rahman, M. R., Akhtar, M. R., Ara, I., Toppo, A., Javed, A., Das, S. (2018). Socioeconomic impact of tobacco farming in Bangladesh. *Journal of sociology and anthropology*, 2(1):31-35. http://doi.org/10.12691/jsa-2-1-6.

Ali, M. Y., Islam, M. F., Rahman, M. R., Sheema, M. K., Akhtar, M. R. (2015). Tobacco farming in Bangladesh and its impact on the environment. *Journal of environmental science, toxicology, and food technology,* 9(12):27-33. http://doi.org/10.9790/2402-091232733.

Appau, A., Drope, J., Goma, F., Magati, P., Labonte, R., Makoka, D., Zulu, R., Li, Q., Lencucha, R. (2020). Explaining why farmers grow tobacco: evidence from Malawi, Kenya, and Zambia. *Nicotine & tobacco research,* 22(12):2238-2245. http://doi.org/10.1093/ntr/ntz173/5564389.

Baliwada, H., Reddy, D. D., Krishna, S. K., Subbaiah Y., Kumari N. A. (2018). Socioeconomic impact of flue-cured tobacco in the northern light zone of Andhra Pradesh. *Indian journal of extension education*, 54 (1):65-71.

BBS, (2022). *Agriculture Census 2019*, Statistics and Informatics Division, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh. https://www.bbs.gov.bd.

BBS, (2022). *Preliminary report on Population and Housing Census 2022*, Statistics and Informatics Division, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh. https://www. bbs.gov.bd.

BBS, (2022). *Yearbook of Agriculture Statistics 2022*, Statistics and Informatics Division, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh. https://www.bbs.gov.bd.

BAT, (2022). *Integrated annual report 2022 on sustainable development for a better tomorrow*. British American Tobacco Company Limited. https://www.bat bangladesh.com/group/sites/BAT9T5FQ2. nsf/vwPagesWebLive/DOA53FZC.

Chavez, J. J., Drope, J., Li, Q., Aloria, M. J. (2016). The economics of tobacco farming in the Philippines. *Quezon City: Action for economic reforms and Atlanta: American cancer society*, 1-56.

DAE, (2023). *Yearly Reports on Tobacco Cultivation Status*, Department of Agricultural Extension, Ministry of Agriculture, Khamarbari, Kushtia, Bangladesh.

ECR, (2023). *Emissions database for global atmospheric research, CO_2 and GHG*

emissions by country, European commission reports. https://edgar.jrc.ec.europa.eu/report_2023#emissions_table.

Fassa, A. G., Faria, N. M. X., Meucci, R. D., Fiori, N. S., Miranda, V. I., Facchini, L. A. (2014). Green tobacco sickness among tobacco farmers in Southern Brazil. *American journal of industrial medicine*, 57:726-735. http://doi.org/10.1002/ajim.22307.

FAO, (2010). *Projections of tobacco production, consumption, and trade*, Food and Agriculture Organization, Rome, Italy. https://ftp.fao.org/docrep/fao/006/y4956e/y49 56e00.pdf. FAO.

Fotedar, S., Fotedar, V. (2023). Green tobacco sickness: a brief review. *Indian Journal of Occupational and Environmental Medicine,* 21(3):101-104. http://doi.org/10.4103/ijoem. IJOEM_160_17.

Goma, F., Drope, J., Zulu, R., Li, M. Q., Chelwa, G., Labonte, R. and Banda, J. (2017). The economics of tobacco farming in Zambia. *The University of Zambia school of medicine and the American cancer society.*1-26.

Hema, B., Reddy, D. D., Reddy, K. V., Srinivas A., Krishna, S. K. (2021). Impact assessment of flue-cured virginia tobacco in Mysore and Hassan Districts of Karnataka. *Indian journal of extension education*, 57(2):76-81. http://doi.org/10.5958/2454-552X.2021.00072.4.

Hossain, M. M., Rahman, M. M. (2013). A socioeconomic analysis on tobacco cultivation in Kushtia District of Bangladesh. *Social Sciences*, 2(3):128-134. http://doi.org/10.11648/j.ss.20130203.14.

Hussain, M., Malik, R. N., Taylor, A., Puettmann M. (2017). Hazardous pollutants emissions and environmental impacts from fuelwood burned and synthetic fertilizers applied by tobacco growers in Pakistan. *Environmental technology & innovation*, 7:169–181. http://dx.doi.org/10.1016/j.eti. 2017.02.003.

Joardar, J. C., Fathema, K., Basu, S. (2022). Effect of tobacco cultivation on soil fertility and farmer's profitability in the socioeconomic perspective of Bangladesh. *Research square*, 1-17. https://doi. org/10.21203/rs.3.rs-1388464/v1.

Karim, R., Nahar, N., Shirin, T., Rahman, M. A. (2016). Study on tobacco cultivation and its impacts on health and environment at Kushtia, Bangladesh. *Journal* of *bioscience* and *agriculture* research (JBAR)*,* 8:746–753. http://doi.org/10.18801/jbar.080216.89.

Kibwage, J. K., Odondo, A. J., Momanyi, G. M. (2009). Assessment of livelihood assets and strategies among tobacco and non-tobacco growing households in south Nyanza region, Kenya. *African Journal of Agricultural Research,* 4(4):294-304. http://www.academicjournals.org/AJAR.

Kumar, A. K., Kumar, A., Vaidhyanathan, R., Kushwaha, H. L., Chakraborty, D., Tomar, B. S. (2023). Demographic and socioeconomic of the tobacco farmworkers in Andhra Pradesh, India. *The Pharma Innovation Journal*, 12(5):1090-1092.

Lammel, G., Grabi, H. (1995). The greenhouse effect of NO_X. *Environmental science* and *pollution research* (ESPR), 2:40-50. http://doi.org/10.1007/BF02987512.

Lecours, N., Almeida, G. E. G., Abdallah, J. M., Novotny T. E. (2012). Environmental health impacts of tobacco farming: a review of the literature. *Tobacco control*, 21:191-196. https://doi:10.1136/tobaccocontrol-2011-050318.

Mangora, M. M. (2005). Ecological impact of tobacco farming in miombo woodlands of Urambo District, Tanzania. *African Journal of Ecology,* 43(4):385-391. http://doi.org/10.4103/ijoem.IJOEM_160_17.

Manyanhaire, I. O., Kurangwa, W. (2014). Estimation of the impact of tobacco curing on wood resources in Zimbabwe. *International journal of development and sustainability.* 3(7):1455-1467.

Minh, H. V., Giang, K. B., Bich, N. N., Huong, N. T. (2009). Tobacco farming in rural Vietnam: questionable economic gain but evident health risks. *BMC public health*, 9:24. http://dx.doi.org/ 10.1186/1471-2458-9-24.

Park, S. J., Lim, H. S., Lee, K., Yoo, S. J. (2018). Green tobacco sickness among tobacco harvesters in a Korean village. *Safety and health at work*, 9(1):71-74. http://dx.doi.org/10.1016/j.shaw.2017.06.007.

PRI, (2012). *Tobacco cultivation: an assessment of socioeconomic and environmental impacts.* Report by Policy Research Institute (PRI) of Bangladesh and Nielsen Bangladesh, commissioned by British American Tobacco Bangladesh, 1-23.

Rahman, M. Z., Kabir, M. H., Alam, M. M., Islam, M. S. (2019). Determinants of tobacco cultivation in Kushtia district, Bangladesh. *International journal of agricultural extension*, 07(03):239-246. http://dx.doi.org/10.33687/ijae. 007.03.2977.

Roy, A., Naz, S., and Mostafa, M. G. 2024. Tobacco Farming and its Socioeconomic Determinants in Kushtia District of Bangladesh. *Journal of Sustainability and Environmental Management (JOSEM)*, 3(1):9-18.

Silva, M. S. M., Carvalho, M. G. C., Moreira, J. C., Barreto, E. O., Farias, K. F., Nascimento, Silva, C. A., F. M. N., Andrade, T. G., Luiz, R. R., Neto R. S. M., Ribeiro F. L. (2018). Green tobacco sickness among Brazilian farm workers and genetic polymorphisms. *BMC research notes,* 11:20. https://doi.org/10.1186/s13104-018-3135-x.

Singha, R., Kanna, Y. (2022). Tobacco farming, addiction, promotion of gender equality quality, wellbeing and monopoly of the Indian market. *Journal of international women's studies*, 23(5):154-172. https://vc.bridgew.edu/jiws/vol23/iss5/11.

Srinivas, A., Reddy, D. D., Reddy, K. V., Hema, B. Krishna, S. K. (2020). Socioeconomic impact assessment of motihari tobacco in West Bengal. *Tobacco research*, 46(2):69-74.

Srinivas, A., Reddy, D. D., Reddy, K. V., Hema, B., Krishna, S. K. (2022). Impact assessment of bidi tobacco in Gujarat. *Indian journal of extension education*, 58(2):144-148. https://doi.org/10.48165/ IJEE.2022.58235.

Talukder, A., Haq, I., Ali, M., Drope, J. (2020). Factors associated with cultivation of tobacco in Bangladesh: A multilevel modelling approach. *International journal of environmental research and public health*, 17(12):4277. http://doi.org/10.3390/ijerph17124277.

Weizenrecker, R., Deal, W. B. (1970). Tobacco cropper's sickness. *Journal of the Florida medical association***, 5**7:13-4.

Wisnujati N. S., Patiung, M. (2023). Analysis of socioeconomic of tobacco farmers in Probolinggo Regency Java, Indonesia. *Agricultural socioeconomic journal*, 2(1):101-109. http://dx.doi.org/10.21776/ub.agrise.2023.023.1.13.

WHO, (2017). *Tobacco and its environmental impact: an overview.* World Health Organization (WHO), Rome, Italy. https://creativecommons.org/licenses/by-nc-sa/3.0/igo.1-72.

WHO, (2022). *A report on throughout its life cycle, tobacco pollutes the planet and damages the health of all people. World Tobacco Day, 2022*. 1-20. World Health Organization (WHO). Rome, Italy. https://WNTD-2022_Brochure_ENG-Web_0.pdf