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Exploring Farmers' Perceptions of Smog and its Impacts on Human Health and Environment: Evidence from Punjab, Pakistan

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Abstract

Smog poses a catastrophic threat to human health and the environment and contributes to about 128,000 annual deaths in Pakistan. Its concentration exceeds 2.5 PM in major urban and agricultural hubs like Lahore. Agricultural practices like stubble burning and agrochemical overuse significantly accelerate this crisis, alongside transportation and industry. This study explores farmers' perceptions regarding smog and its subsequent impacts on health and the environment in Punjab, Pakistan using a mixed model approach. Random sampling technique was employed to select 218 respondents across two tehsils from district Sargodha. The data were collected from well structured survey instrument on five-point likert scale. The collected data were analyzed using SPSS. Results revealed a critical gap in awareness, though approximately 30% to 38% of respondents agreed that the excessive use of fertilizers and pesticides directly leads to air and water pollution, ultimately contributing to smog formation. Given the severe health risks and environmental degradation, there is an urgent need for institutional intervention. The government should devise targeted policy framework and educational campaigns to raise awareness among the farming community to encourage them for adoption of environment friendly sustainable agricultural practices to mitigate smog and to provide safeguard for human health.

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Introduction

Smog has been severely affecting individuals' health in Pakistan. At the same time, there are increased number of cases for asthma, chronic bronchitis, and pneumonia during smog time period (Iram et al., 2025). Through research, it has been observed that respondents most at-risk are; children, the elderly, and individuals with underlying health complications; this is due to breathing problems, eye irritation, and throat complications (Khamda et al., 2018). High levels of exposure to smog are likely to cause further development of heart diseases, lung cancer, and reduced immune response. In addition, there are social impacts of air pollution, such as reduced work efficiency, increased health costs, and disruptions to business and transport, causing changes in the national economy (Wang et al., 2020). Lahore, like many other cosmopolitan cities, has had to close schools, pre- and post-nurseries, due to harmful pollution levels that can affect kids and their learning environment (Ali and Butt et al., 2024).

To counter smog problem, policies including The Punjab Clean Air Action Plan, restrictions on brick kiln operations, especially during vulnerable smog periods, and the introduction and implementation of Euro 5 and Euro 6 standards for vehicle fuel to minimize emissions (Ahmad et al., 2025). As a result, there is a promotion of the consumption of renewable energy sources like solar and wind energy to reduce the use of fossil fuels. Thus, smog can only be fought if changes in urban planning occur, for instance, by increasing park sizes, modifying the public transport system, and tightening emissions standards. The problem's aggravation, however, requires continuous political support, public awareness, cooperation from relevant ministries and industries, and citizens' cooperation to improve air quality and sustainability in Pakistan (Javed et al., 2021).

In 2018 alone, 8.7million people died from fossil fuel-driven air pollution, equivalent to 20% of deaths worldwide (Vohra, 2021). This is not an anomaly. Every year, millions of humans, in both developing and developed countries, die at the hands of the 'invisible killer'. The problems relate to pollution produced by transportation, industry in major cities, and agricultural practices such as stubble burning. Lahore, the second largest city of Pakistan, is officially the most polluted in the world, with PM2.5 concentrations regularly 5x the World Health Organization's (WHO) safety limit (Khan, 2021). An estimated 128,000 deaths in Pakistan and 1 in 10 deaths in under-fives result from air pollution (Khan, 2021), signifying its seriousness. Therefore, the situation calls for a comprehensive study exploring the factors involved in smog formation and their effects on human health.

A research study in Lahore on smog in November 2016 found the highest NOx concentration. However, other pollutants were also present, such as SO_2, O_2, and CO (Jion et al., 2025). The study also observed that air quality was extremely poor during smog episodes, and the air quality index showed a six-fold increase in pollutant concentration compared with the baseline. A sample of 700 patients' waste was collected, of which one-fifth were suffering from dry eyes, 13% had eye irritation, and, surprisingly, 80% were suffering from corneal diseases (Sharma et al., 2023).

Jabeen et. al. (2021) observed in their study that more than two-fifths of the respondents were affected by winter smog. Labor during construction or road work faced significant difficulties due to the prevailing smog on high-intensity days. However, office workers are affected by a lack of awareness and adequate resources (Jabeen et al., 2021).

In Lahore, the air quality index is very high in areas of Jalo and Batapur, where the air quality is more than 60 times higher than the World Health Organization (WHO) standard (5µg/m³). Poor air quality in Lahore has also remained more than 20 times worse than the Punjab government's air quality standard (PEQS). In the Township area in 2022, the AQI reached 192.7µg/m3 on winter smog days, mainly due to low wind speeds, infrequent rainfall, and cold temperatures. A survey related to health risk was conducted between 2021 and 2024, which confirmed that there exists considerable health risk, especially related to respiratory issues, asthma issues, and cardiovascular issues, for the people residing in the smog areas because the health risk is above the standard in the smog areas (Mushtaq & Mahmood, 2024).

Research Objectives

The following were the study's research objectives.

1. To identify farming practices influencing farmers’ perceptions regarding smog and its impact on human health and the environment.
2. To assess the relationship between factors such as access to healthcare, environmental awareness, and social support and farmers’ perceptions of smog and its effects on human health and the environment.

Materials and Methods

Research Design: Overall, the study employed a mixed-methods research design for comprehensive analysis and measurement of the research objectives. However, present research article only describe the quantitative part of the analysis to keep the length of the article logical and under reasonable level.

Population and Computation of the Sample size: Collecting data from a complete count is always cumbersome. Instead, a sample study is a wiser decision. The sample is the group of individuals who will actually participate in the research and represent the whole population (Mc Combes, 2022). The overall population of farmers was prepared from the list obtained from the Punjab Agricultural Extension Department. The desired sample from the provided list of respondents was extracted through using the Cochran formula such as

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

Where:

n_0 = Required sample size

Z= Z-score i.e. desired confidence level which is here 1.96

p= Estimated proportion of population possessing the attribute of interest

e= Margin of error to be used and decided by the researcher how much precision one has to required in the selection of sample.

Next, appropriate sampling technique was used to reach each respondent for survey included in the selected sample.

In the present study Z was selected as 1.96 while p was taken as 0.6. Similarly value of e was taken as 0.065 i.e. 6.5%. Hence the resultant sample size was computed as 218 farmers. Simple random sampling technique was applied to select the final sample size from the two tehsils of Sargodha district which was purposively selected for the convenience of the researcher. Two tehsils were randomly selected out of seven tehsils of district Sargodha, and from each tehsil, 109 respondents (farmers) were selected to obtain the final sample size.

Survey Instrument: Survey instrument (interview schedule) was prepared on five-point Likert scale such as 1=Strongly Disagree to 5=Strongly agree. For content and face validity of the survey instrument (interview schedule), the Panel of Experts from the faculty of the Department of Agricultural Extension & Rural Studies at the University of Sargodha was nominated and found satisfactory. Reliability of the survey instrument was checked by test-retest with 20 respondents and revised the instrument based on the test-retest findings.

Results and Discussion

To address the problem, farming practices that influence farmers' perceptions of smog and its impact on human health and the environment were identified, and farmers' opinions were solicited during the survey to understand how these farming practices contribute to smog and shape farmers' perceptions. The results of the survey are described in the following tables.

Table 1. Frequencies showing farming practices that promote smog and influence farmers' perceptions

Farming Practice	Disagree	Neutral	Agree
	f (%)	**f (%)**	**f (%)**
Burning rice straw promotes smog	65 (29.8)	70 (32.1)	83 (38.1)
Burning wheat residues promotes smog	76 (34.9)	76 (34.9)	66 (30.3)
Burning cotton residues promotes smog	65 (29.8)	82 (37.6)	71 (32.6)
Excessive fertilizer use promotes smog	77 (35.3)	66 (30.3)	75 (34.4)
Excessive pesticide use promotes smog	79 (36.2)	69 (31.7)	70 (32.1)
Poor farm waste management causes smog	75 (34.4)	76 (34.9)	67 (30.7)

*Strong agree and strongly disagree has 0% respondent

Table 1 presents farmers' perceptions of smog and its effects on human health and the environment, revealing how some farming practices affect smog. The part is split into two broad categories: stubble burning and the overuse of fertilizers and pesticides.

The large proportion of farmers in the category of burning stubble concur that burning of the rice straw, wheat residues, and cotton residues to prepare the following crop is causing smog in the region. In particular, 38.1% of them concur with the statement on rice straw, 30.3% concur with the statement on wheat residues, and 32.6% concur with the statement on cotton residues. Nonetheless, most of the respondents are neutral or disagree with that, and are mixed in their awareness. For example, 34.9 percent are indifferent to the burning of wheat residue, and 37.6 percent are indifferent to the burning of cotton residue.

In the second section, which addresses the excessive use of fertilizers and pesticides, the trend is clearer. 34.4% of respondents agree that excessive fertilizer use leads to smog due to emissions such as ammonia and nitrogen oxides, whereas 30.3% are noncommittal. Similarly, there is agreement that excessive pesticide use may lead to smog and poor health, but 31.7% express no opinion. Regarding poor farm waste management, 30.7% of respondents agree that it causes smog, while 34.9% are indifferent.

Generally, the information indicates that farmers have a moderate understanding of the role some practices play in smog. Though many recognize the impact, many remain doubtful, which explains why more people should be educated and trained in sustainable farming methods.

Table 2. Frequencies showing perceptions of farmers about smog promoting environmental damage

Farmers' Perceptions	Disagree	Neutral	Agree
	f (%)	**f (%)**	**f (%)**
Smog degrades air quality	70 (32.1)	72 (33.0)	76 (34.9)
Smog increases crop diseases and pests	66 (30.3)	81 (37.2)	71 (32.6)
Smog reduces crop yield	70 (32.1)	78 (35.8)	70 (32.1)
Smog reduces photosynthesis	76 (34.9)	69 (31.7)	73 (33.5)
Smog degrades soil health	64 (29.4)	74 (33.9)	80 (36.7)
Smog hinders farm operations	72 (33.0)	73 (33.5)	73 (33.5)
Smog contributes to climate change	81 (37.2)	68 (31.2)	69 (31.7)
Smog causes respiratory problems	77 (35.3)	70 (32.1)	71 (32.6)

* Strongly agree and strongly disagree have 0% of respondents

Table 2 presents farmers' perceptions of smog's environmental impact. These responses indicate an average level of awareness, as the majority of farmers were either in agreement or neutral about the adverse effects.

On the question of air quality, 34.9 percent opine that smog kills it, 33.0 percent are indifferent, and 32.1 percent say they are not. In the statement that smog encourages diseases and pests to attack crops, the neutral and agree responses are 37.2% and 32.6%, respectively. Similarly, for crop yield and productivity, 35.8% are neutral, and 32.1% say smog adversely affects it.

Regarding photosynthesis, 33.5 percent concur that smoggy environments inhibit photosynthesis, but a large percentage (34.9) do not. Another issue is soil health and soil fertility, in which 36.7% of the respondents agree that smog harms it, and 33.9% are neutral. Also, 33.5% agree that smog hinders agricultural activities, while the neutral level is high at 33.5%.

Farmers are not in agreement on climate change; 31.7% agree that smog is part of long-term environmental damage, and 37.2% do not. Finally, 32.6% support the view that smog causes respiratory problems, with 35.3% discordant. Generally, the answers indicate that, although farmers are somewhat aware of the environmental and health effects of smog, a large percentage are either uncertain or disagree. It shows that targeted awareness efforts will be necessary to enhance understanding of the general impact of smog on the environment and human health. Cluster Analysis was further applied to describe the relationships among the different factors involved in the study. The results have been presented and discussed in the following tables.

Table 3. Formation of farmer clusters based on their perceptions regarding negative impacts of smog on human health and environment

Cluster Analysis	High I	High II	Low
Environmental impacts			
Crop damage	3	2	2
Reduced visibility	4	5	4
Climate change	4	4	4
Ecosystem damage	3	2	3
Health impacts			
Respiratory problems	2	3	3
Heart diseases	4	4	4
Chronic diseases	4	4	3

This cluster analysis table categorizes farmers into three groups High I, High II, and Low based on their perceptions of the negative effects of smog on the environment and human health. The results highlight both similarities and variations across clusters, reflecting differences in awareness and perceived severity. For environmental effects, crop damage is rated moderately in High I (3), slightly lower in High II (2), and Low (2), suggesting that not all farmers link smog with yield reduction equally. Reduced visibility, however, is perceived as a more severe issue, especially by High II (5), compared to High I (4) and Low (4). This indicates that visibility loss is a widely recognized challenge during smog. Changing climatic patterns receive equal ratings (4) across all clusters, showing a consensus that smog contributes to broader environmental disruptions. Damage to the ecosystem is rated higher in High I (3) and Low (3) than in High II (2), suggesting variation in the prioritization of ecological impacts. Regarding health effects, respiratory problems are perceived as less critical by High I (2) but more significant for High II (3) and Low (3). Heart-related problems are uniformly rated high (4) across all clusters, reflecting common awareness of cardiovascular risks. Chronic diseases, including cancer, are rated highest in High I and High II (4 each), but slightly lower in the Low cluster (3), suggesting differences in long-term health risk perception. Overall, the analysis reveals that while all clusters acknowledge the harmful impacts of smog, the High I and High II groups perceive more severe consequences. In contrast, the Low cluster shows relatively reduced concern, particularly regarding chronic health impacts.

Table 4. ANOVA for Cluster analysis

	Cluster		**F**	**Sig.**
	Mean Square	**df**		
Crop damage	28.103	2	70.957	.000
Reduced visibility	14.733	2	29.277	.000
Changing climatic patterns	1.480	2	3.465	.033
Damaging ecosystem	21.061	2	57.788	.000

Respiration problem	14.554	2	30.663	.000
Heart related problems	5.044	2	9.553	.000
Chronic diseases (e.g. cancer)	6.069	2	14.331	.000

The above ANOVA table shows the results of clusters of the farmers regarding their perceptions about the adverse impact of smog on human health and the environment. The outcomes indicate whether there are significant differences in the clusters' responses to each variable.

Concerning the environmental effects, the findings are highly significant. The F-value for crop damage is 70.957 with a significance of 0.000, indicating a significant difference among clusters. On the same note, lower visibility (F = 29.277, Sig. = 0.000) and harm to the ecosystem (F = 57.788, Sig. = 0.000) also show high variability in perceptions. Alteration of climatic patterns, however, registered a comparatively low F-value (3.465) with Sig. = 0.033, which implies a weaker yet statistically significant difference between clusters. It means that although farmers are more or less aware of the effects of climate, the perceived intensity across groups is lower than for other environmental aspects.

Regarding health outcomes, respiratory issues (F = 30.663, Sig. = 0.000) and cancers and other chronic illnesses (F = 14.331, Sig. = 0.000) differ significantly across clusters. There are also significant differences in heart-related problems, but the F-value is lower (9.553). These findings suggest that farmers do not share the same perception of health effects, as some groups are more concerned about smog-related diseases than others.

Overall, the ANOVA results indicate that farmers' perceptions are not homogeneous. The statistically significant values for most variables indicate that there are specific groups of farmers who differ in their degrees of concern regarding environmental degradation and the health risks of smog. This highlights the need for tailored awareness and policy responses to the diverse perceptions among farming communities.

Table 5. Number of Cases in each Cluster

Cluster	**High I**	75.000
	High II	77.000
	Low	66.000
Valid		218.000
Msing		.000

In this table, the number of farmers was classified into three groups based on their perceptions of the negative impacts of smog on health and the environment. Among the 218 valid cases, 75 fell into the High I cluster, 77 into the High II cluster, and 66 into the Low cluster. None of the cases were missed, which guarantees data reliability.

Conclusions

The study concluded that, among environmental effects, reduced visibility and climate-changing patterns were matters of grave concern for the farmers, and their perceptions of these issues were high. In addition, regarding the effects of smog on human health, chronic symptoms and heart disease were of great concern to the farmers. Their perceptions were high regarding heart diseases caused by smog. Hence the study revealed that farmers must be urged to avoid those farming practices which promote smog during field operations. Immediate medical care should be available in rural areas, especially during smoggy season, to avoid any inconvenience.

Based on the finding listed below are some recommendations:

i. Government should launch massive awareness campaigns among farming community to stop stubble burning to minimize smog and its impacts on health and the environment
ii. Capacity building for extension field staff should be initiated to enable consistent interventions that guide farmers and prevent stubble burning.
iii. Rural healthcare services must be strengthened to prevent serious health problems for farmers during the smoggy season.

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