Conference Proceedings „Innovative development of agricultural business and rural areas“, 2 – 3.10.2025, Sofia
DOI: https://doi.org/10.37075/idara.2025.15

AGRICULTURAL ACTIVITIES AS A SOURCE OF AIR POLLUTION

KRASTEV, ANTON[1]

Abstract
The problem of air pollution has many dimensions and causes. On the one hand, air pollution is caused by natural phenomena such as volcanoes, sandstorms, etc., and on the other hand, part of the pollution is caused by human activity. The agricultural sector is the basis for feeding the population on the one hand, but on the other hand, the development of agricultural activities has negative consequences on the quality of atmospheric air. In fact, emissions from agricultural activities are considered one of the main causes of air pollution worldwide, which is known to harm both the environment and human health.
Livestock and crop farming activities, through the use of pesticides and fertilizers, plowing, harrowing, burning biomass for energy and stubble, cultivation, sowing, harvesting, threshing, and grain processing, are examples of agricultural activities that are associated with the release of pollutants into the air, in particular particulate matter (PM), ammonia (NH3), methane (CH4), and carbon dioxide (CO2), which are often used as a proxy for all pollutants generated by intensive agricultural activities.
The main reason for the impact of the agricultural sector on air quality is the increase in the world population and the need for continuous development of the food sector, which in turn leads to excessive agricultural activities that have a negative impact on the atmosphere.
The aim of the publication is to track and analyze changes related to air quality caused by agricultural activities. The thesis that, in addition to being a major polluter of atmospheric air, the agricultural sector is also seriously affected by air pollution will also be examined. The publication includes the following sections: 1) Theoretical overview of the fundamental links between air pollution and the agricultural sector; 2) Analysis of the situation in the country regarding air pollution from agricultural activities 3) Identification of possible good practices that would have a beneficial effect on pollution levels. Based on the information collected, key findings and conclusions will be proposed.

Keywords: agricultural sector, pollution, air quality
JEL code: Q0, Q1, Q53

Link between the agricultural sector and air quality

The relationship between the agricultural sector and air quality has been studied by numerous authors. Some of them (Jacobson, 2008; Giannadaki et al., 2018) point out that the use of fertilizers is a major source of pollution from the sector, while

[1] Assistant, Dr. Anton Krastev, University of National and World Economy, Sofia, Bulgaria anton.krustev@unwe.bg

livestock farming has a lesser impact. Other authors (Borghi et al., 2023) have reached the same conclusions, sharing the theory that emissions from rural areas are considered one of the main factors contributing to global air pollution, which has serious adverse effects on human health and the environment. They examine the main activities in detail and conclude that those most closely linked to pollution are plowing, harrowing, cultivation, sowing, harvesting, threshing, grain processing, and the burning of agricultural waste. Another study reports that methane emissions into the atmosphere from livestock farming (the rearing of cattle, buffalo, pigs, sheep, and goats) are considered the most negative source. Other authors (Harizanova-Bartos, Stoyanova, 2018) also work in the field of the agricultural sector and its effect on atmospheric air. They observe a distinct connection between crop production and the use of fertilizers and pesticides in agricultural production. In addition, they identify and assess pollutants according to their impact. The relationship studied is two-way: on the one hand, quality affects the products produced (yields and quality), and on the other hand, the production itself affects the pollution of atmospheric air to a certain extent.

An analysis of random forests in 146 countries for the period 2010–2019 confirms that air pollution is among the most important predictors of agricultural productivity (Dong, Wang, 2023).

Other negative, now banned agricultural practices resulting from the deliberate burning of plant waste are also of interest (Pullabhotla, Souza, 2022). The main effect they report is related to risks to human health, some of which are associated with an increased risk of hypertension, affecting most often older people, smokers, and people who are already taking blood pressure medication.

In a study from 2017, pollution in and from the agricultural sector in Vietnam began to negatively affect the sector's own resource base, potentially impacting soil fertility and yields, the effectiveness of chemicals in pest and disease control, the health and productivity of farmers, the ecological status, and food safety. At the same time, the population is becoming increasingly aware of the negative impact of pollution in agriculture on human health and the environment (Nguyen, Cassou, 2017).

The link has also been studied by other authors, who argue that nutrients from agricultural sources, mainly from crop fertilization and manure from livestock farming, affect environmental health in the United States through air pollution (Rossi, Hoque, Ji, Kling, 2023).

In addition to being a polluter, the agricultural sector can also be considered a victim of air pollution from other sources. A study of peripheral agriculture in the city of Varanasi, India, found elevated levels of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3). Their main sources are industrialization and urbanization, which threaten not only production but also food quality (Agrawal, Singh, Rajput, Marshall, Bell, 2003).

This connection has also been examined by other authors, who argue that air pollution is a significant problem in the 21st century and has a considerable impact on the agricultural community, particularly on farmers and crops (Pandya, Gadekallu, Maddikunta, Sharma, 2022).

Other authors (Gheorghe, Ion, 2011) prove that atmospheric pollutants can have a direct or indirect toxic effect on the sector by changing the pH of the soil, followed by the dissolution of toxic salts from various metals. In this way, the particles cover the leaves of plants and reduce light penetration, having a strong impact on the process of photosynthesis, the rate of which decreases rapidly.

The relationship between the clay industry and automotive emissions on tropical plants is also of scientific interest (Sukumaran, 2014). The negative impact is manifested in changes in stem circumference, bark area, heartwood, xylem, and fiber length.

One of the most researched links is related to the influence of the agricultural sector and its effect on the climate. Research in this area shows that greenhouse gas emissions due to agricultural practices lead to climate change (Aqsa Abbasi, Ayesha Sajid, Namra Haq, Sammia Rahman, Zujaja-tul Misbah, Gul Sanober, Muhammad Ashraf & Alvina Gul Kazi, 2013). In addition, genetically modified crops, according to the same study, raise safety concerns due to gene flow. This also has a major impact on biodiversity. Waterborne and airborne diseases and cancer are major health problems faced by agricultural workers.

Types of pollutants from agricultural activities

In addition to the sources of pollution, it is important to study the types of pollutants in order to identify those that have the most negative impact on air quality.

Such a study found that the main pollutant from agricultural activity is ammonia (NH3), mainly from livestock farming and the associated processing of animal manure (Giannadaki et al., 2018). According to them, ammonia affects air quality through several multiphase chemical processes, forming ammonium sulfate and ammonium nitrate, which contributes to the total amount of fine particulate matter (PM).

Authors Susanne E. Bauer, Kostas Tsigaridis, and Ron Miller (2016) also demonstrate in their study that agriculture is a major source of ammonia (NH3) and combustion is a major source of nitrogen oxide (NOx) (Bauer, Tsigaridis, Miller, 2016).

As a result of various activities (plowing, harrowing, cultivation, sowing, harvesting, threshing and grain processing), various pollutants are emitted in the agricultural sector: particulate matter (PM), ammonia (NH3), nitrogen dioxide (NO2), carbon monoxide (CO), inorganic dust, organic dust (containing microorganisms or allergens), decomposition gases, and pesticides (Borghi et al., 2023). For these reasons, agricultural workers may experience various health problems, such as asthma, chronic bronchitis, and other respiratory dysfunctions.

In their 2018 study, authors Hristina Harizanova-Bartos and Zornitsa Stoyanova (Harizanova-Bartos, Stoyanova, 2018) identify methane, ammonia, and carbon dioxide as the main pollutants from the agricultural sector, followed by non-methane volatile organic compounds, nitrogen oxides, and nitrogen oxides (Nox).
Other authors have also studied the sources of atmospheric pollution in detail. In their interim report to IIASA, they point out that livestock farming is the largest source of ammonia (NH3) emissions in all European countries, typically accounting for around 80% of all such emissions. The authors also point to the use of mineral fertilizers in the sector as another source. Livestock farming, in addition to crop production, is also a source of nitrous oxide (N2O) and methane (CH4) emissions. Another source of nitrous oxide (N2O) is the use of fertilizers in various agricultural activities (Klimont, Z. Brink, C., Modeling of Emissions of Air Pollutants and Greenhouse Gases from Agricultural Sources in Europe, 2004).
A study of the agricultural sector in Vietnam identifies animal feed, animal waste, wastewater management practices, the use of fertilizers and pesticides, and the burning of crops as the main sources of pollution (Nguyen, Cassou, 2017).
In Delhi, India, one of the main sources of fine particulate matter (PM) pollution is considered to be the burning of fields in preparation for subsequent planting (Cusworth, Mickley, Sulprizio, Liu, Marlier, DeFries, Guttikunda, Gupta, 2018). The same has been studied in California, where the main pollutants are CO (carbon monoxide) and CO2 (carbon dioxide) (E. F. Darley, F. R. Burleson, E. H. Mateer, J. T. Middleton & V. P. Osterli, 2012).

Methodology

The objective of this research is to characterize and investigate the link between Bulgaria's agricultural sector and ambient air quality (2019-2023), with an emphasis on the key sources and patterns of emissions, as well as feasible mitigation strategies. The assignments include collecting and harmonizing official emission data for CO_2, CH_4, NH_3, and NOx, interpreting changes in sector practices and regulations, identifying best practices with clear implementation pathways, comparing annual dynamics and emission amounts, and synthesizing the conceptual links between agricultural activities and key pollutants.
In order to assure solid directionality of results, the descriptive and comparative methodology makes use of fixed-base indices (2019), average yearly change, and short-series trend checks. Identification of lead contaminants and activities, differentiation of scale versus technique impacts, and a succinct list of workable solutions are anticipated results. Clear indicator definitions, sector-specific triangulation, and sensitive conclusion-making are used to solve limitations (short horizon, national aggregate). The methodology of the paper is presented in table 1.

Table 1. Methodology of the article

Section	What is examined	What is sought (research questions)	Indicators/data
1. Introduction and Aim	Context, rationale, 2019–2023 scope	Why is air quality affected by agriculture? What are the goals and limitations?	Scope statement, definitions
2. Conceptual Background	Links from farm activities to pollutants; two-way effects	What causes emissions, and what potential effects may ambient pollution have on agriculture?	Brief literature synthesis
3. Data and Method	Sources and operationalization of indicators	How are concentrations and emissions quantified and compared?	CO_2, CH_4, NH_3, NOx; 2019 base indices; intensities (per ha/LU/GVA)
4. Status and Dynamics in Bulgaria	Annual emissions and trends, 2019–2023	Which pollutants and activities are most harmful? Trends	Annual totals, average annual change, trend checks
5. Sources by Subsector	Crop production, livestock, residue burning, fuel use	Which practices could contribute the most?	Breakdown by source (where available)
6. Sectoral Implications	Potential impacts on yields/productivity	Are there indications of feedback from air quality to agriculture?	Qualitative evidence aligned to data
7. Good Practices	Measures to reduce NH_3/CH_4/NOx/PM	Which interventions are applicable and cost-effective in Bulgaria?	Precision fertilization, manure management, burning restrictions, energy solutions
8. Conclusions and Recommendations	Synthesis of findings	What are priority actions for policy and practice?	Ranked, actionable recommendations

Source: Created by the author

Analysis of the relationship between the agricultural sector and air quality

The relationship between the agricultural sector and air quality is multifaceted and has evolved over the years, involving both positive and negative aspects. This relationship can also be analyzed as bilateral, since the agricultural sector is viewed as both a source of pollution and a victim of it.

The main sources of pollution can be considered as follows:

- Livestock farming – raising animals in agriculture is one of the main sources of methane (CH4) and ammonia (NH3), which are mainly caused by the digestive system and manure disposal;

- Fertilizers and pesticides – their use leads to the release of ammonia (NH_3) and other volatile organic compounds;
- Burning of plant waste and biomass – the burning of crops, wood, and biomass, both for heating and for land improvement, is the main source of fine particulate matter (PM), carbon monoxide (CO), and carbon dioxide (CO_2) in the atmosphere.

On the other hand, the agricultural sector is one of the most affected by various sources of pollution, which have serious consequences for the health and development of animals and plants, the quality of animal and plant products, and the soil. Some of these are:

- Transport;
- Industrial activities;
- Burning of fossil fuels;
- Use of fertilizers and pesticides;
- Acid rain.

To study the link between the sector and air quality, the main elements of pollution in tons for the period 2019–2023 were analyzed: carbon dioxide (CO_2), methane (CH_4), ammonia (NH_3), and nitrogen oxides (NO_x). The other types of pollutants not listed in the table are not covered in the publication, as their impact is insignificant according to the statistics.

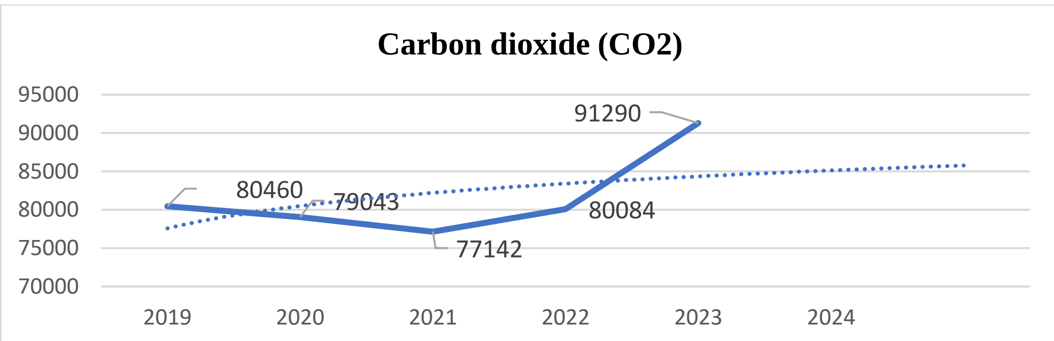

Fig. 1. Air pollution with carbon dioxide (CO2)

Source: NSI, Emissions of harmful substances into the air from agriculture

Between 2019 and 2022, there was a decline in carbon dioxide (CO_2) emissions, but in 2023, there was an increase of 13.4% compared to the base year and 18.1% compared to the year with the lowest emissions. The trend line is upward.

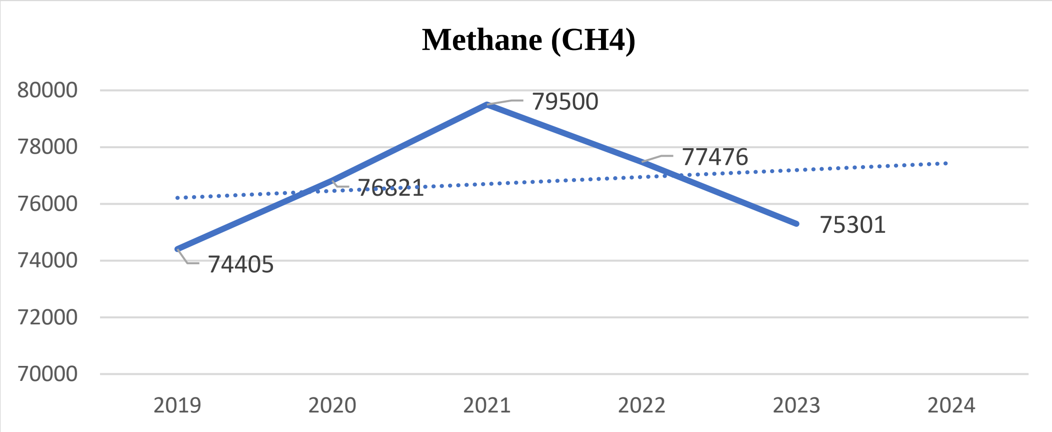

Fig. 2. Air pollution with methane (CH4)

Source: NSI, Emissions of harmful substances into the air from agriculture

There is a noticeable pyramid-shaped increase in methane (CH4) emissions for the period, rising by 6.8% until 2021, followed by a 5.5% decline. The trend line is upward.

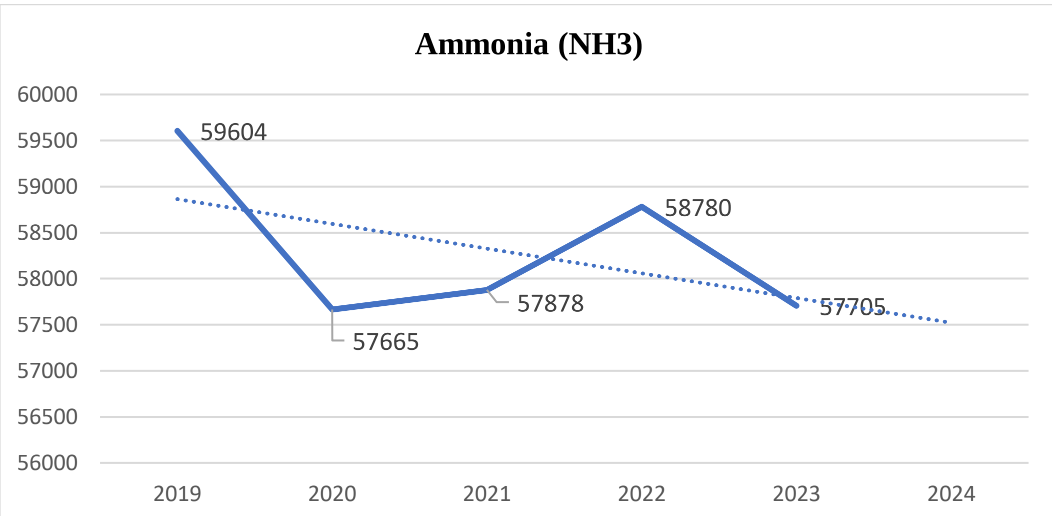

Fig. 3 Air pollution with ammonia (NH3)

Source: NSI, Emissions of harmful substances into the air from agriculture

We see dynamics in the pollution of atmospheric air with ammonia (NH3) over the years. In the second year, the quantities fell to their lowest levels for the period, by 3.3%, followed by an increase of up to 2% in the next two years. In the last year, there was another drop in emissions, by 1.8% compared to the previous year, 2022 and by 3.2% compared to the base year, 2019. The trend line is downward.

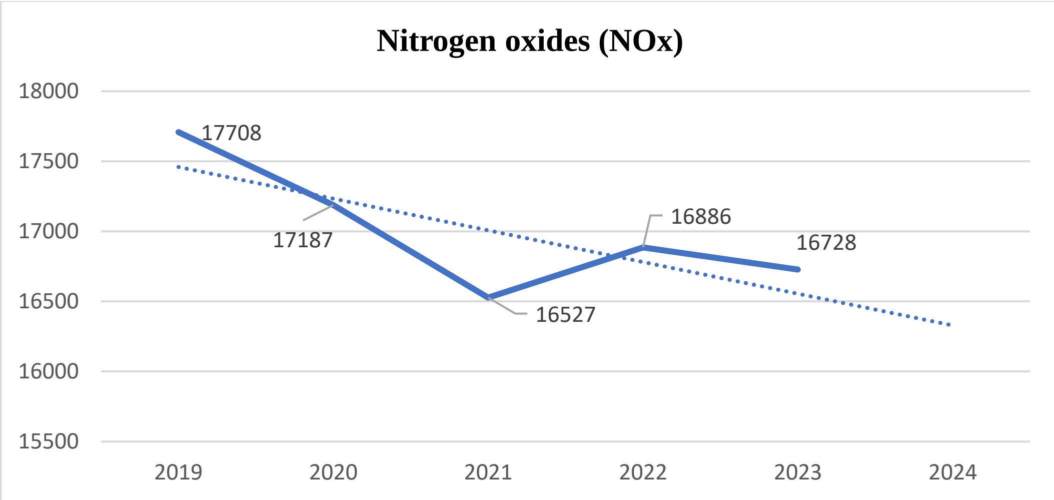

Fig. 4 Air pollution with nitrogen oxides (NOx)

Source: NSI, Emissions of harmful substances into the air from agriculture

The amount of nitrogen oxides (NOx) has been decreasing over the years compared to the base year, reaching its lowest level in 2021, down 7.1%. In the following two years, 2022 and 2023, minimal increase of 2% and 1.2% are reported compared to the year with the lowest amounts, which is why the trend line in the graph is negative.
Based on the analysis of pollution sources and changes in their quantities between 2019 and 2023, we can conclude that the trend is positive for two of the elements and negative for the other two. The reason for the downward trend in the quantities of ammonia (NH3) and nitrogen oxides (NOx) can be found in the reduced number of farms and the changed requirements for the sectors regarding the types of plant protection products.

Good practices

Some authors (Unsworth & Ormrod, 1982) study the impact of air pollution on agricultural produce by offering options for separating farmland into places where there are no potential air pollution hazards and thus no effect on the growth of their biotechnology (Omasa, et al., 2012), physiological characteristics, pigment, biomass,yield (Agrawalet al, 2003) and damage to crops (Kozioł & Whatley, 1984). Using two-way panel regression models covering 146 countries for the period 2010–2019, it has been proven that a 1% increase in the concentration of fine particulate matter (PM) and tropospheric ozone (O3) would lead to a decline in total factor productivity in agriculture by 0.104% and 0.207%, respectively. It has also been found that temperature has a moderating effect on this relationship. The harmful effects of fine particulate matter (PM) pollution are weaker (stronger) in warmer (cooler) climates (Dong, Wang, 2023).

According to studies of good practices in the sector, agricultural insurance can not only encourage farmers to adopt green production technologies and improve production efficiency but also achieve the goal of reducing the use of chemicals to protect the environment (Li, Tang, Cao & Guo, 2022).

The control and reduction of ammonia (NH3) emissions can be achieved by reducing its content in animal feed; biofiltration (air purification) of the air extracted from animal housing; introducing purification technologies at the end of the fertilizer production process (Klimont, Z., Brink, C., 2004).

Using theoretical analyses and experiments in their study (Mariano Gonzalez-de-Soto, Luis Emmi, Carmen Benavides, Isaias Garcia, Pablo Gonzalez-de-Santos, 2016), the authors reveal that the use of HES (exhaust gas system) in precision farming with robotic tractors improves exhaust gas quality and energy consumption. They also conclude that the use of a hybrid energy system improves energy consumption and reduces atmospheric pollution emissions from internal combustion engines, which have been reduced by almost 50% in the best-case scenario.

Main findings and conclusions

The agricultural sector is one of the leading sectors in the economy, playing a key role in providing food resources for the population. In the publication, it is analyzed by many authors as one of the major sources of air pollution. As a result of various processes such as livestock farming, the use of fertilizers and pesticides, and the burning of plant waste and biomass, it has become a major source of carbon dioxide (CO2), methane (CH4), ammonia (NH3), and nitrogen oxides (NOx). On the other hand, the sector is also considered a victim. Air pollution from sources such as transport, industrial activities, burning of fossil fuels, etc., has a negative impact on the health and development of animals and plants, the quality of animal and plant products, and the soil.

For these reasons, measures and good practices to reduce air pollution must act on two levels: the negative impact of the agricultural sector and the negative impact of other sectors and activities on it.

References

Giannadaki, D., Giannakis, E., Pozzer, A., & Lelieveld, J. (2018). Estimating health and economic benefits of reductions in air pollution from agriculture. Science of the Total Environment, 622, 1304–1316.

Sukumaran, D. (2014). Effect of air pollution on the anatomy of some tropical plants. Applied ecology and environmental sciences, 2(1), 32–36.

Borghi, F., Spinazzè, A., De Nardis, N., Straccini, S., Rovelli, S., Fanti, G., Oxoli, D., Cattaneo, A., Cavallo, D. M., & Brovelli, M. A. (2023). Studies on Air Pollution and Air Quality in Rural and Agricultural Environments: A Systematic Review. Environments, 10(12), 208. https://doi.org/10.3390/environments10120208

Harizanova-Bartos, H., & Stoyanova, Z. (2018, September). Impact of agriculture on air pollution. In CBU International Conference Proceedings (Vol. 6, pp. 1071-1076).

Jacobson, M. Z. (2008). Short-term effects of agriculture on air pollution and climate in California. Journal of Geophysical Research: Atmospheres, 113(D23).

Pullabhotla, H. K., & Souza, M. (2022). Air pollution from agricultural fires increases hypertension risk. Journal of Environmental Economics and Management, 115, 102723.

Agrawal, M., Singh, B., Rajput, M., Marshall, F., & Bell, J. N. B. (2003). Effect of air pollution on peri-urban agriculture: a case study. Environmental Pollution, 126(3), 323-329.

Pandya, S., Gadekallu, T. R., Maddikunta, P. K. R., & Sharma, R. (2022). A study of the impacts of air pollution on the agricultural community and crop yield (Indian context). Sustainability, 14(20), 13098.

Dong, D., & Wang, J. (2023). Air pollution as a substantial threat to the improvement of agricultural total factor productivity: Global evidence. Environment International, 173, 107842.

Gheorghe, I. F., & Ion, B. (2011). The effects of air pollutants on vegetation and the role of vegetation in reducing atmospheric pollution. The impact of air pollution on health, economy, environment and agricultural sources, 29, 241–80.

Li, H., Tang, M., Cao, A., & Guo, L. (2022). Assessing the relationship between air pollution, agricultural insurance, and agricultural green total factor productivity: Evidence from China. Environmental Science and Pollution Research, 29(52), 78381–78395.

Klimont, Z., & Brink, C. (2004). Modeling of emissions of air pollutants and greenhouse gases from agricultural sources in Europe.

Nguyen, T. H., & Cassou, E. (2017). An overview of agricultural pollution in Vietnam.

Bauer, S. E., Tsigaridis, K., & Miller, R. (2016). Significant atmospheric aerosol pollution is caused by world food cultivation. Geophysical Research Letters, 43(10), 5394–5400.

Gonzalez-de-Soto, M., Emmi, L., Benavides, C., Garcia, I., & Gonzalez-de-Santos, P. (2016). Reducing air pollution with hybrid-powered robotic tractors for precision agriculture. Biosystems Engineering, 143, 79–94.

Cusworth, D. H., Mickley, L. J., Sulprizio, M. P., Liu, T., Marlier, M. E., DeFries, R. S., ... & Gupta, P. (2018). Quantifying the influence of agricultural fires in northwest India on urban air pollution in Delhi, India. Environmental Research Letters, 13(4), 044018.

Darley, E. F., Burleson, F. R., Mateer, E. H., Middleton, J. T., & Osterli, V. P. (1966). Contribution of burning of agricultural wastes to photochemical air pollution. Journal of the Air Pollution Control Association, 16(12), 685–690.