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Air Pollution Caused by Crop Waste and its Effects on Human Health

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Abstract. Agriculture, and more specifically the combustion of crop waste, is now widely acknowledged to be a global environmental problem. Because of this, the issue was not initially brought to light. This literature review investigates crop residues as a potential source of air pollution and the associated health risks. This review will also investigate the factors that contribute to the contamination of water by crop residue. This article will discuss the pollutants that are emitted during the combustion of crop waste, how they affect the quality of the air we breathe, and how they affect the health of humans. This article provides a concise summary of the pollutants caused by the burning of crop waste. This analysis also investigates the effects that crop waste burning has on human health and the natural environment, as well as potential policy solutions and preventative measures.

Keywords:

1. Introduction:

Air pollution is a pressing concern that has widespread implications for human populations and the natural world across all global regions, posing substantial risks to both domains. The aforementioned practice, widely observed in agricultural regions worldwide, significantly contributes to pollutants in the air and emerges as a prominent source thereof. Crop waste is commonly incinerated [1]. It represents one of the numerous factors that contribute to air pollution. The aforementioned deleterious activity occurs subsequent to the culmination of the harvest period, wherein remnants of agricultural activities, including crop stalks, husk leaves, and straws, are deliberately ignited. The practice of burning crop waste can provide farmers with certain immediate benefits, including expedited field clearance, reduced susceptibility to diseases and pests, and improved land preparation for subsequent cultivation. Nevertheless, it is important to recognize that this practice has severe long-term consequences for the environment and the well-being of both humans and other animals [1],[2].

The combustion of crop residue leads to the release of diverse pollutants into the immediate surroundings, thereby causing substantial air pollution. The reason for this phenomenon can be attributed to the occurrence of a chain reaction upon the release of these pollutants into the atmosphere. Air pollution arises from various pollutants, encompassing particulates, greenhouse gases, organic solvents, polycyclic aromatic hydrocarbons, oxides of nitrogen, and sulphur dioxide [3]. Particulate matter is widely recognized as a prominent factor in the exacerbation of air pollution. Particulate matter consists of minuscule particles that are widely dispersed throughout the atmosphere. Due to their diminutive dimensions, these particles possess the capability to infiltrate the respiratory system profoundly, thereby potentially inducing various ailments. The act of inhaling greenhouse gases contributes to the greenhouse effect, which is responsible for the retention of thermal power in the atmosphere, leading to changes in the climate and global warming. The phenomenon known as the effect of greenhouse gases is accountable for the occurrence of the greenhouse effect. Ground-level ozone is a constituent of smog that arises from the reaction between volatile organic compounds, nitrogen oxides, ultraviolet rays, and various other environmental compounds [4]. The chemical structure of smog comprises a multitude of constituents. Moreover, the incorporation of contaminants into the atmosphere, such as polycyclic aromatic hydrocarbons and sulphur dioxide, adds an extra layer of complexity to the issue of air pollution.

The combustion of agricultural waste has considerable and pervasive adverse implications for human well-being, impacting a substantial population. The act of inhaling the byproducts produced from combustion has been associated with increased susceptibility to the development of cardiovascular and respiratory ailments, as well as conditions such as cancer, allergies, and asthma [4], [5]. The ingestion of these pollutants occurs as a result of the combustion process. The incineration of agricultural waste can yield negative consequences, particularly for

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

individuals who are susceptible to harm, such as youngsters, the elderly, and individuals with pre-existing respiratory ailments. These particular groups are more prone to experiencing adverse effects as a result of the practice [6]. The combustion of agricultural waste places these populations in a particularly vulnerable situation. Moreover, the release of pollutants into the atmosphere due to this practice has the potential to disperse over long distances, impacting not only nearby communities but also neighboring regions and even more distant areas.

In light of these deleterious effects on both the environment and human health, it is of the utmost importance to address the problem of burning crop waste and to look for alternatives that are environmentally friendly. Composting, mulching, and using crop residues for the production of bioenergy are all practices that can effectively manage agricultural waste while also minimizing the release of harmful pollutants. The promotion of these practices should be the primary focus of efforts to be made. We can reduce air pollution, protect public health, and preserve the environment for future generations if we stop burning agricultural waste and instead adopt more sustainable practices for waste management.

2. Related Work:

In recent years, several studies have been conducted to understand the effects of crop waste caused on human health. Rice-Wheat Cropping System (RWCS) is mainly found in Indo-Gangetic Plains (IGPs) in South Asia and China. Burning of Crop residue leads to the emission of Carbon dioxide, methane, and many other hazardous gases. Strong mixing of fine and coarse particles during the burning of crops creates a hazardous situation to deal with. Epidemiological studies have shown that due to crop waste, there is an imbalance in the atmosphere with the addition of pollutants, thereby having an adverse impact on human health [7]. These effects lead to respiratory problems/diseases like COPD, asthma, and lung cancer. It is not limited to such disease only, but also it is related to human mental illness and global warming. A climate change where we nowadays more often find natural calamities is the cumulative effect of such imbalance.

Open-field burning of the crop cannot be considered the only reason for this imbalance. Over-Usage of pesticide is also having its own contribution. Many crops have their residue which consists of molasses, husks, seeds, leaves, stem, straw, pulp, peel, roots, etc., and are used to feed cattle, as fertilizers, and various other processes [8]. A huge amount of crop residue is generated and majorly it is underutilized. It is underutilized mainly due to lack of knowledge, hence burning it is the step adopted by farmers.

The extent of the effect of toxic gases prevails across regions based on crop type, size, environmental conditions, and many other factors. World Health Organization (WHO) has admitted that 92% of the world's population lives in areas with unhealthy air [9]. Such unhealthy air leads to premature deaths mainly because of the change in nature every human is making. The analysis of 2017 also found that China and India together are responsible for over half of the total attributable deaths. The worst part is that, of total premature deaths in India, over 78% of deaths are due to open-field burning. These numbers are almost three times higher than other fatal diseases like Tuberculosis, Malaria. Another research has also concluded that Air pollution has a myriad of effects on pulmonary immune responses[10]. These effects are highly found in infants, children, pregnant women, and the aged. Straw stubble burning in the state of Punjab and Haryana of India in 2017 led to smog (smoke + fog) on the National Highway leading to low visibility. Reduced visibility triggered several road accidents leaving 16 deaths. Setting public health measures and assuring follow-up of policies are not the only role of government. It needs to strengthen itself by incorporating measures with technology.

The following are the latest studies in this area, which provide a comprehensive understanding of the current state of knowledge on this topic in Table 1.

Table 1. Summary of findings for various health issues due to air pollution.

Year	Technology Used	Data Set Attributes	Findings	Drawbacks	Results

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

2019[11]	Ordinary Least Square (OLS) and Robustness test	PM2.5 and PM10, China Migrant Dynamic Survey (CMDS)	The key indicators were individual characteristics [gender, age, marital status, etc.], economic characteristics and sociocultural variables [social interaction, hometown culture preservation, city culture, etc.]. In the robustness test, PM10 is used as an indicator for measuring the level of air pollution.	Not suitable for the high-regulation group.	It helps to understand the problem of air pollution and provides direction for the government and people.
2019[12]	IV-Oprobit Model	China Migrant Dynamic Survey (CMDS), NASA (2014)	The model used to state the relationship between air pollution and resident's health by nesting household registration data.	Is not applicable to all, as indicators have control variables like age, men vs women, urban vs rural	It provides one of the best practices one can provide with respect to climate change.
2021[13]	Standard Deviation	China Family Panel Studies (CFPS), WHO (2017)	Summary statistics are calculated for all the variables and further divide the sample into high-income and low-income groups to assess the impact of air pollution on residents' health at different income levels	Income Inequality will always be undetermined.	The study provides significant insights into PM2.5 levels in the context of income inequality and their respective average air pollutant concentrations.
2020[14]	Pollutant Standard Index (PSI) 2019	Medical Journal of Indonesia	To provide an ease and uniformity of ambient air quality information to the community at a certain location and time, the results of air quality monitoring are delivered into pollutant standard index.	Lack of Real-time Data, lack of interpretability	Water bombings, air patrols, and artificial rain are key features to control pollutants.
2020[15]	Quadratic deviation	EPA's AirNow Program by USA, (ILD, COPD, ED, MESA, CT, FeNO) data from Normative Study Boston, US and SAPALDIA study, Switzerland.	Complex interactions between exposure dynamics and personal characteristics. Pollutants are ubiquitous in both indoor and outdoor environments.	Lack of other information about mental disorders.	Almost a brief is provided in the context to the health system.

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

By synthesizing the available literature, this review aims to contribute to a deeper understanding of the environmental and public health implications of crop waste burning. It also seeks to provide insights into possible measures that can be undertaken to mitigate air pollution from this source and promote sustainable agricultural practices. Ultimately, this review intends to inform policymakers, researchers, and communities about the urgent need for action and the potential strategies to reduce the detrimental effects of crop waste burning on both air quality and human well-being.

3. Proposed Methodology

Through the implementation of this comprehensive methodology, an examination of the health effects stemming from the combustion of crop waste can be conducted, thereby enhancing our comprehension of the hazards linked to this environmental concern.

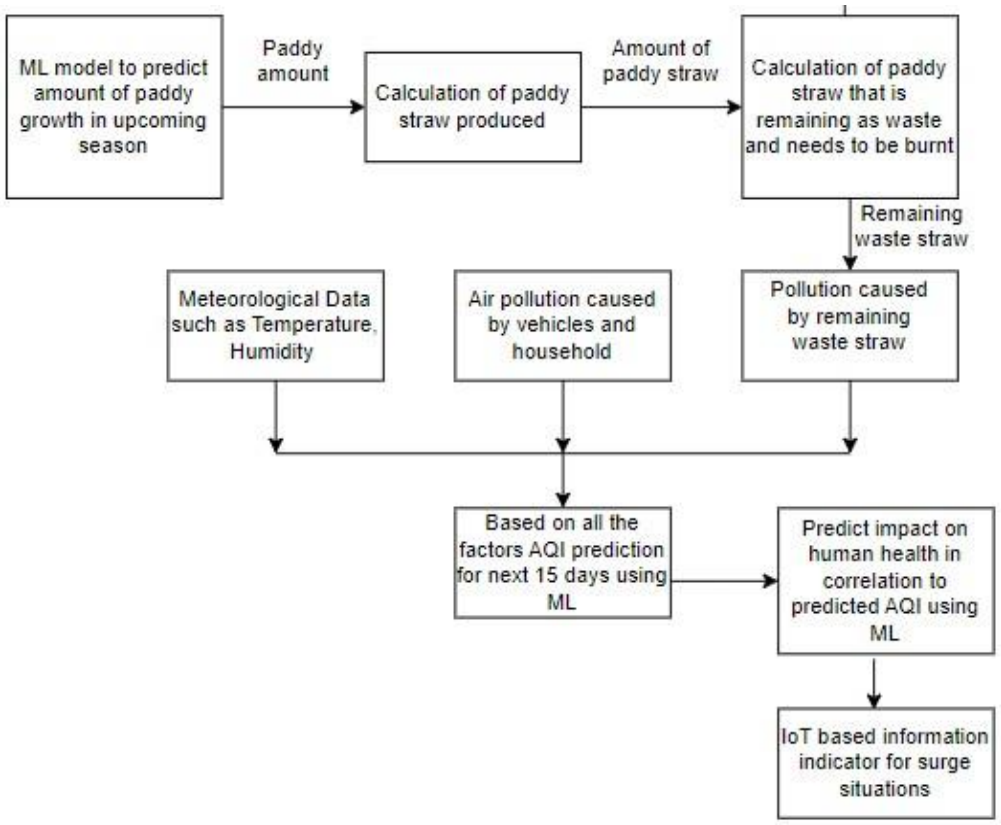

Fig 1. Machine learning model to predict the impact of air pollution caused by crop burning on human health

3.1 Calculation of Crop Production and Amount of Straw Produced

Acquire pertinent data pertaining to crop production through the utilization of agricultural surveys, records from the government, or farming databases. The dataset will encompass comprehensive information regarding the specific types and quantities of crops cultivated within the designated study region [16].

This study aims to ascertain the quantity of straw generated as a byproduct during the process of crop harvesting. The estimation can be derived by utilising built proportions of straw-to-crop production specific to various crop types.

3.2 Calculation of Straw Residue after Burning:

To calculate how much straw will be left over after burning, either conduct your own field research or look at what has already been done in this area. Particulate matter and other contaminants that can contribute to smog formation can be released into the air when this residue is burned.

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

3.3 Estimation of Air Pollution from Waste Straw Burning:

Employ emission factors and scholarly research on the combustion of agricultural crop waste to approximate the atmospheric contamination resulting from the incineration of straw residue. These factors may encompass the release of fine particulate matter, nitrogen oxides, carbon monoxide, and organic compounds that are volatile [17],[18].

Utilise the derived quantity of straw leftovers and emission coefficients to estimate the cumulative atmospheric pollution arising from the combustion of straw waste.

3.4 Integration of Air Pollution Data and Meteorological Data:

Combine vehicle and household air pollution data with waste straw burning estimates. This incorporated dataset will show air pollution sources in the study area.

Add meteorological data like temperature, humidity, wind speed, and direction. Pollutants can be spread by weather.

3.5 Calculation of Air Quality Index (AQI) with Time Series Analysis:

Utilise time series analysis and statistical methodologies to compute the Air Quality Index (AQI) by leveraging an integrated dataset comprising air pollution and meteorological data. Time series analysis is a valuable method for examining air pollution levels over time, as it allows for the identification of trends, patterns, and seasonality. These insights are crucial for making accurate predictions regarding future Air Quality Index (AQI) values.

3.6 Correlation and Impact on Human Health:

Collect information regarding the health of people in the study area who have been diagnosed with breathing problems or cardiovascular conditions from records from hospitals or medical facilities.

Conduct statistical analysis to determine whether or not there is a correlation between the levels of the air quality index (AQI) and the prevalence and seriousness of breathing and cardiovascular illnesses. With the help of this study, we will determine the effects that air pollution has on the health of people living in this region [19].

3.7 Prediction of AQI for the Next 15 Days and Identification of Surge Events:

Utilise the established time series model to forecast the Air Quality Index (AQI) for the forthcoming 15-day period, drawing upon historical data and meteorological projections.

This study aims to discern patterns and occurrences of surge events in the Air Quality Index (AQI) that may potentially align with detrimental health impacts on the populace [20]. These patterns can facilitate comprehension of the health consequences associated with episodes of pollution and provide valuable insights for implementing timely interventions.

The methodology estimates crop production, calculates air pollution from waste straw burning, integrates air pollution data sources, develops an AQI prediction model with time series analysis, assesses human health, and predicts AQI. This thorough methodology can help understand the health and environmental impacts of crop waste burning and inform pollution prevention and health care decisions.

4. Crop waste burning: causes and practices

Burning of crop waste is a common practice in agricultural procedures due to a variety of factors that contribute to this practice. The economic side of things is one of the important factors. Farmers often burn crop waste to clear and prepare fields. Burning crop residues removes residue, eliminating the need for human labor and machinery. It eliminates residue. Because of this, the farmer is able to swiftly prepare the land for subsequent cultivation, which results in saving money for the farmer in the form of both time and the cost of labor [21]. The

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

influence of long-standing traditions is yet another factor that should be taken into account. In many agricultural communities, the practice of burning waste from crops has become deeply embedded as a typical method that has been enacted down through generations. This custom has been passed down through generations in many agricultural communities [21], [22]. It is deeply ingrained in the practices of disease prevention, pest control, and the management of croplands that have been passed down through history and culture. Because of the widespread, long-held conviction that this method achieves desirable results, its use has been handed down through the generations.

In addition to this, the lack of other possible solutions is an important variable that contributes to the ongoing practice of burning agricultural waste as a disposal method. Because farmers have inadequate availability of alternative waste handling techniques and limited infrastructure for effective residue utilization, burning is the most cost-effective and accessible option for them because it is the only option available to them. The absence of awareness and knowledge regarding agricultural practices that contribute to environmentally friendly farming is another factor that contributes to their preference for burning as the main form of disposal. When farmers are short on assets and expertise, they can opt to fall back on this tried-and-true method instead of seeking out alternative approaches because burning crop waste is a common practice among farmers [23]. In light of the aforementioned, it is of the utmost importance to be aware that there are methods of crop waste management that are both sustainable and responsible for the environment. Adopting alternative practices while getting assistance in the form of education, resources, and structures can lead to the gradual elimination of crop waste burning as a disposal option over time. Burning of crop waste will become less necessary as a result of this, which will allow for its gradual reduction.

5. Methodologies to detect air pollution caused by crop waste and its effects on human health:

One approach that could be used for looking into the link between the pollutants of the air resulting from crop residue and the effects it has on the health of people is to combine different research methods. This is one method that could be used. In the first place, determining the kinds and amounts of pollutants that escape when burning agricultural waste can be accomplished through the process of monitoring the quality of the air that is being breathed [24-26]. This requires monitoring stations in agricultural areas and a variety of instruments to quantify pollutants. Particles, gases, and other compounds are pollutants. The implementation of continuous monitoring over a predetermined duration would yield valuable insights into both seasonal fluctuations and specific instances of crop burning. Moreover, source characterization is a methodology employed to ascertain and quantify the emissions resulting from the combustion of agricultural residue [27]. The origins of these emissions can be traced again to their point of origin. The combustion of agricultural waste materials represents a potential origin of these emissions. In order to gather samples for after chemical analysis, it may be imperative to perform experiments within a laboratory setting, execute controlled burns, or obtain measurements in the field. In order to achieve the goal of identifying specific pollutants and comprehending their potential impact on human health, employing sophisticated techniques such as gas chromatography-mass spectrometry can be advantageous. This endeavour can potentially be executed with favourable outcomes.

A health impact evaluation can determine how burning crop residue produces air pollutants and how this contamination affects humans. This assessment can also determine how agricultural waste affects human health. To complete this task, health data from agricultural waste-burning regions must be collected. After collecting this data, the next thing to do is to determine if air pollution exposure is related. Surveys, medical exams, and pulmonary function tests can assess asthma, cardiovascular, lung, and cancer symptoms [28]. Then, statistical and risk assessments can determine the health effects of agricultural waste-burning contaminants. These studies can determine how farming waste-burning pollutants affect health. In addition to these field methods, mathematical modelling may replicate the dispersal and movement of crop waste-burned pollutants. This can be done in place of the methods that are currently being implemented in the field. This kind of modelling can be helpful for understanding the spread of contaminants, evaluating possible exposure paths for those contaminants, and forecasting the impact those pollutants have on the quality of air and human health under a wide variety of unique circumstances [28], [29]. Finally, in order to provide a deeper comprehension of the connection between the

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

combustion of crop waste, the resulting contamination of the air, and the negative impacts on human health, a comprehensive review of the literature as well as a comprehensive review of previous studies can be carried out.

6. Mechanisms of Air Pollution Formation

When agricultural waste is burned, it creates air pollution, which is caused by a complex array of processes that trigger the generation and dispersion of contaminants. This pollution is caused by burning agricultural waste. Burning agricultural waste pollutes. Burning agricultural waste causes several elementary procedures, each of which releases air pollutants [22], [26].

6.1 Combustion Processes and Emissions

The combustion process of burning plant materials, such as agricultural waste, leads to the release of a diverse range of pollutant substances into the atmosphere. The process of burning can be influenced by several factors, including the level of moisture content, temperature, fuel composition, and the efficiency of the combustion process. Each of these components possesses the potential to exert influence on the ultimate outcome of the combustion process. Combustion releases volatile organic compounds (VOCs), particulate matter (PM), and other byproducts. These emissions may be combustion byproducts. Several emissions are produced, including carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides (NOx), sulphur dioxide (SO2), organic volatile compounds (VOCs), and particulate matter (PM) in the form of ash, soot, and aerosols.

6.2 Atmospheric Transformation and Secondary Pollutants

After being released into the atmosphere, primary pollutants go through a series of chemical reactions that ultimately result in the production of secondary pollutants. For example, nitrogen oxides (NOx) combine with volatile organic compounds (VOCs) and sunlight to produce ground-level ozone (O3), which is a significant element of smog [28], [30]. In addition, secondary organic aerosols (SOA) are produced when crop waste is burned because this causes the oxidation and transformation of volatile organic compounds (VOCs), which are released into the atmosphere. These secondary pollutants may have their own unique chemical compositions and may make a sizeable contribution to the problem of air pollution and the adverse health effects that it causes.

6.3 Dispersion and Transport of Pollutants

After being emitted into the environment and undergoing various transformations, the pollutants disperse and propagate throughout the atmosphere. Meteorological factors such as wind patterns, atmospheric stability, temperature inversions, and topography can significantly influence the movement and transportation of pollutants. Pollutants possess the capacity to undergo spatial displacement, thereby exerting influence on the air quality within both localized and regional domains. The spatial distribution and concentration levels of a pollutant are contingent upon the extent of its distribution [31]. Due to pollutant dispersion, crop waste combustion may affect remote communities.

Understanding the processes involved in agricultural waste combustion is necessary to assess air pollution and its health effects. Thus, understanding agricultural waste combustion's air pollution is crucial. Understanding air pollution levels is crucial.

7. Health Effects of Crop Waste Burning

Burning agricultural waste pollutes the air. These pollutants harm humans over time. Burning agricultural waste is bad for your lungs. Burning agricultural waste generates particulate matter and harmful substances that upset the airways, causing coughing, sneezing, and feeling short of breath. Chemicals inhaled may cause symptoms. Asthma and COPD patients may worsen. These pollutants can also cause bronchitis over time [30],[32]. Fine particulates in the lungs also worsen respiratory diseases and lung function.

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

The cardiovascular system may also be negatively affected by exposure to air pollutants from crop waste burning. Particularly small particles can pass through the respiratory system and into the bloodstream, where they can cause systemic inflammation and oxidative stress. Cardiovascular diseases like heart attacks, strokes, and high blood pressure are made more likely by this inflammation. Plaque buildup in the arteries, known as atherosclerosis, can be exacerbated by pollutants such as nitrogen oxides and volatile organic compounds. These effects on the heart emphasize the need to lessen the air pollution caused by the burning of crop waste.

Agricultural waste combustion releases toxic chemicals that harm more than just the heart. PAHs and other products of combustion increase lung cancer risk. Carcinogens have a long history. In hypersensitive people, these emissions may cause allergic reactions and asthma symptoms. Thus, asthma symptoms may worsen [33]. Burning crop residue has long-term health effects on people with asthma, allergies, and cancer.

Agricultural residue incineration releases toxic substances that pose health risks beyond cardiovascular issues. Pollutants like polycyclic aromatic hydro carbons (PAHs) and other combustion byproducts increase lung cancer and other breathing cancer risk. These carcinogenic agents have a long history. These emissions can also cause allergic reactions and asthma symptoms in hypersensitive people. Thus, asthma symptoms may worsen. Burning crop residue has long-term health risks for cancer, allergies, and asthma.

8. Mitigation Strategies and Interventions

The air pollution brought on by the burning of crop waste can be reduced through the use of a number of different strategies and interventions. Technology-based solutions, alternative applications, policy and regulatory approaches, and community participation and education are all covered in this section.

8.1 Technological Solutions for Crop Waste Management

New technological developments provide hope for eco-friendly and effective crop waste disposal. Mechanized harvesting and residue processing equipment are two examples of cutting-edge methods that can help collect and dispose of crop residues without resorting to burning [34]. Bioenergy production via anaerobic digestion or thermal processes are two examples of biomass conversion technologies that can provide alternative uses for crop waste and thus reduce the incentive for burning. Investment in R&D is essential for bringing these technological solutions to fruition, as are incentives and capacity-building programs for farmers.

8.2 Alternative Uses of Crop Waste

It is critical to reduce the reliance on burning as a disposal method by promoting alternative uses for crop waste. Composting, mulching, and returning crop residues to the soil as organic matter are all viable options for making use of crop residues. These actions improve soil quality and sequester carbon in the process of reducing pollution emissions [30], [31]. It is possible to incentivize farmers financially to adopt sustainable waste management practices by investigating the potential for value-added products made from crop waste, such as bio-based materials or biofuels.

8.3 Policy and Regulatory Approaches

Air pollution from crop waste burning is a serious problem, and it can only be mitigated through policy and regulatory measures. Regulations can be put in place and enforced by governments to limit or prohibit the burning of crop waste and encourage more environmentally friendly alternatives. Farmers who adopt cleaner technologies and practices may be eligible for government subsidies and incentives as a result of these policies [34]. Regulations compliance also requires the establishment of monitoring and enforcement mechanisms. Effective policies that are in line with environmental and public health goals can only be developed and implemented through collaborative efforts between government agencies, agricultural associations, and research institutions.

8.4 Community Engagement and Awareness

Int. J. Advanced Networking and Applications
Volume: 15 Issue: 04 Pages:100-200 (2023) ISSN: 0975-0290 (Special Issue – ASCIS 2023)

For mitigation efforts to be effective, it is crucial to involve local communities and raise awareness about the dangers of burning crop waste. Sustainable waste management practices can encourage behavioural change if farmers, agricultural workers, and local communities are educated about the advantages of these methods and the risks associated with burning [33], [34]. Alternative practices and technological developments can be widely disseminated through the implementation of extension programs, training workshops, and information campaigns. To ensure the inclusion of diverse perspectives and to foster a sense of ownership and responsibility in addressing the issue, it is important to involve stakeholders, such as farmers' associations, environmental organizations, and health agencies, in the decision-making processes.

Future Scope

More studies and action are needed to resolve the problem of crop waste burning contributing to air pollution. In terms of potential future reach, many avenues exist. Improvements in crop waste management technology are one example. More study and experimentation can lead to better, cheaper answers. For instance, better utilization of crop waste can be achieved through developments in biomass conversion technologies like enhanced anaerobic digestion or thermal processes, which in turn reduces the need for burning. Potentially useful alternatives for reducing pollution output can be found in the study of cutting-edge technologies like plasma gasification and advanced combustion methods.

Sustainable agriculture is another area to investigate. Reduce crop waste to reduce burning. Crop breeding, precision agriculture, and residue management can reduce crop waste in future research. Cover crops, conservation tillage, and crop rotation may improve residue incorporation and nutrient cycling. Effectively addressing crop waste burning requires strong policy and governance. It is crucial to fortify existing policy structures and regulatory mechanisms. More work needs to be done in the future to discourage burning and encourage sustainable waste management practices by creating and implementing stricter regulations, monitoring systems, and enforcement mechanisms. Furthermore, policymakers can design targeted interventions to reduce air pollution from crop waste burning by evaluating the efficacy of existing policies and identifying gaps. The problem of air pollution from crop waste burning can be further addressed by investigating technological developments, sustainable agriculture practices, and strengthening policy and governance. These ongoing efforts can aid in the creation of all-encompassing remedies for this practice's negative effects on the environment and human health.

Conclusion

Air pollution has negative effects on human health and the environment, and burning crop waste is a major contributor to this problem. The mechanisms of air pollution formation, health effects associated with exposure, and potential mitigation strategies have all been discussed in this review paper. Technology advancements, alternative uses of crop waste, policy interventions, and community engagement are all necessary to solve this problem comprehensively. Alternative uses can help reduce the need for burning, and technological solutions present promising opportunities for efficient waste management and utilization. Enforcement of regulations and promotion of sustainable practices rely heavily on policy and regulatory measures. Cleaner agricultural practices will not be adopted without widespread public support, which can be achieved through community outreach and education. While some advancements have been made, there is still room for more study, cooperation, and the application of long-term solutions. Technologies, sustainable agricultural practices, policy frameworks, and stakeholder engagement should be the focus of future work. We can protect people's health, develop a more environmentally friendly agricultural system, and reduce air pollution from crop waste burning if we take a comprehensive and cooperative approach.

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Int. J. Advanced Networking and Applications
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