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The legal implementation plan for banning of stalk burning: An empirical study of China's Xiayi County

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Abstract

The present study finds that nearly fifty percent of rural people of China's Xiayi county like to retain stalks on their fields instead of burning them, while thirty percent of farmers are still involved in burning crops. In our study, we find that there is a lack of labor for collecting stalks, no use of stalks in households, high stalk collecting cost, quickly preparing the land for the next crop plantation, poor monitoring, legal loopholes, and lack of support from government and other manufacturing companies to collect stalks are the loftiest reasons push farmers to burn stalks. This paper reveals that despite clear directions from the central and provincial governments, and frequent warnings from the local authorities, the stalk-burning problem is still severe in many parts of Xiayi county. This paper also finds legal gaps and other factors that obstacle the government's efforts to prevent and control open stalk burning. Therefore, in our study, we address these issues and propose some recommendations that could be helpful for the government and relevant authorities to combat the stalk-burning problem from a county level like Xiayi.

Keywords agricultural production; air pollution; Henan province; legal implementation; stalk burning.

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1 Introduction

As the leading agricultural country in the world, China alone produces nearly 600 million tons of agricultural detritus per year, which shares 18 percent of total global production and 63 percent in Asia (Li et al., 2017; Streets et al., 2003; Xiao et al., 2003). After harvesting, farmers leave nearly 30 percent of leftover stalks on their land yearly in China. Previous data show that from 1996 to 2013, nearly 2200 Tg of stalks were burnt in China, which released 2707 Tg of CO₂ (Sun et al., 2016). A 2001-2018 long-span study exhibits that the stalk burning cases reached high in April and October in northeast and east China (Yin et al., 2021). A study by Liu

et al. (2020) reveals that from 2013 to 2015, a total of 5995 stalk-burning cases were identified in 157 cities across China based on satellite data, and Henan province was reported to be 8.9 percent of stalk-burning cases. Despite increasing crop production, preventing and controlling agricultural stalks incineration has become a challenge for the government.

The central and local governments have taken numerous initiatives and implemented laws, policies, and regulations concerning the stalk burning issue. Farmers are encouraged to retain stalk residues to get multiple benefits. In their study, Chen et al. (2019) claim that the high retention rate of stalk residue will bring fortunes to society through carbon benefits such as soil organic carbon (SOC). In another study, Zhao et al. (2018) illustrate that governments' efforts to shift the farmers' traditional practice from burning to retaining stalks in the fields for SOC accumulation need a cost-benefit analysis. The study by Li et al. (2018) claims that Chinese farmers are reluctant to adopt stalk residues in rented lands, while they prefer their own contracted lands. However, another research data claims that the farmers of Northeast China require fewer incentives, while East China, Central China, and Northwest China require comparatively high incentives to transform the practice of retaining stalk residues into croplands (Chen et al., 2019). In addition, a problem like disproportionate subsidies for farmers also hinders the retaining stalk residues process.

Agricultural residue burning or stalk burning (SB) is a traditional method adopted by farmers worldwide to clear their fields for the cultivation of the next crop. The open field burning of the straws or stalks causes severe damage to the environment and public health. Stalk residue incineration is considered to cause haze pollution. The data released by World Health Organization (WHO) shows that the incineration of agricultural fields, which contributes to air pollution, takes away about seven million people annually worldwide (UNEP, 2021). Stalk burning is the source of dangerous pollutants like PM10, PM2.5, and greenhouse gases (GHGs) that severely affects humans and causes climate change (Cao et al., 2005; Li & Wang, 2013). The study finds that stalk burning contributes to the emission of carbon dioxide (CO₂) (Jia, 2007), which is a major source of black carbon that affects human life and threatens the environment. Black carbon, an element of PM2.5, enters the human body, such as in the lungs and bloodstream, and contributes to serious physical problems like heart disease, cancers, and several types of psychological and behavioral complications. The study says that although the presence of black carbon lasts for a few days or a week, it plays a crucial role in global warming rather than carbon dioxide. In developing countries, stalk burning is regarded as one of the open biomass burning emissions (Chen et al., 2019; Lin et al., 2010).

Existing studies mostly focus on the environment, human health, and economic issues as an impact of stalk burning across China. To the best of our knowledge, no study has explicitly addressed these issues from a legal point of view and has not come up with any legal solutions to prevent and control the open stalk burning problem in China's Henan province. We find that only a few studies touched on the stalk-burning issues with narrow legal perspectives. According to the study of Li et al. (2018), the rural land tenure system discourages farmers from conservation practices or retains stalks in the cropland. In their study, Ren et al. (2019) slightly mention the Air Pollution Control Act 2000 and the governments' guidance and notification about the legal consequences of stalk burning. Jin et al. (2016) refer that a low budget and few personnel to monitor the environmental problems, particularly stalk burning, hinder the implementation of government's environmental policy.

Although in our study we discuss those issues, the central focus of our paper is to evaluate the legal implementation plan of the Chinese government for stopping stalk arson. Our research aims to critically analyze the legal provisions adopted by the Chinese government, particularly the Air Pollution Prevention and Control Law and other relevant laws to prevent and control stalk arson in Xiayi county as a part of air pollution prevention. We also identify some barriers that hinder the prevention process, including legal and

policy gaps. In our study, we put forward some suggestions for controlling and minimizing stalk burning problems based on the study experiences of the local people. Therefore, the present study provides legal insights for preventing and controlling the stalk incineration problem in Xiayi county of China's Henan province, and the proposed recommendation could be applied in other parts of the country on an experimental basis.

2 Study Area and Methodology

2.1 Study site

The study was conducted in Xiayi county, which is located in central China's Henan province and the east of Shangqiu city (see Fig. 1). Henan province is surrounded by hilly areas in the north, west and south parts, which makes its topography undulating (Xue, 2020), while the plain land of Xiayi county brings blessings for agricultural production. The People's Government of the Xiayi County data reveals that "Xiayi is one of the "Top 100 Counties in National Grain Production" and "National Commodity Grain Base County", with an average annual total grain output of 1.0457 million tons". Like other counties of the Henan province, agriculture is the backbone of Xiayi county, and to sustain the economy, wheat, corn, rice, millet, barley, kaoliang soybeans, sweet potatoes, vegetables, and so on are abundantly produced here. According to the National Bureau of Statistics of China (2020), the production of wheat and corn in Henan province is 5673 and 3818 million hectares, respectively, and Henan province alone produces 25% of national wheat (Wang et al., 2012). This vast number of crops also produces a huge quantity of stalks, and Xiayi county alone produces 1 million tons of crop straw yearly.

The geographical latitude and longitude of this county are 34.2383° or $34^{\circ} 14' 18''$ north and 116.1393° or $116^{\circ} 8' 21''$ east, respectively. The land area of this county is $1,481 \text{ km}^2$. According to the 2021 Statistical Yearbook, there are 896,600 residents living in Xiayi county. This county is divided into thirteen major towns (zhen 镇), eleven other townships (xiang 乡), and 731 administrative villages. The thirteen towns are Chengguan, Huodian, Huiting, Matou, Jiyang, Liji, Chezhan, Yangji, Handaokou, Taiping, Luozhuang, Beiling, and Guodian. Townships in this county include Caoji, Huqiao, Qihe, Yemiao, Zhongfeng, Sanggu, Heying, Wangji, Liudianji, Luoji, and Kongzhuang. There are mainly two seasons in Xiayi county, summer, and winter. Summer lasts from May to September, and winter from late November to early April. Summer is extremely hot, and the temperature rises at the highest of 41°C , while winter is cold and has mild snowfall with the lowest temperature of -8°C .



Fig. 1 Study area at Xiayi county of Shangqiu City in Henan province.

2.2 Data collection

In this present study, we descriptively analyzed the legal implementation plan of the central, provincial, and local governments to prevent and stop stalk burning in Xiayi county. To facilitate the study, we designed our own questionnaire as a primary source of data generation and conducted an online-based survey among the participants of Xiayi county about stalk burning on a random basis. The online survey participants were directly or indirectly involved in agricultural activities. Questionnaires were produced in a 5-point Likert scale format in Chinese, and a total of 42 questions were set during this survey. The questionnaire contains three segments. The first segment looks for demographic and basic information where farmer's education, earning members, cultivable land, cultivated crops, and laborers are highlighted. The second segment searches for information about stalk management, where farmers are asked how they manage the stalk after harvesting and what their experiences are about collecting, retaining, managing, and even burning stalks. Finally, the third segment defines legal enforcement and related issues where farmers are asked whether they are familiar with air pollution law or not, whether local authorities inform them or not about not burning stalks, whether they learn knowledge from electronic, print, and social media about the legal consequences of stalk burning, whether they receive support from government and local companies for stalk retention.

In random selection, the questionnaires were shared among the participants of eight towns and sixteen townships of Xiayi county through WeChat (a popular social media platform in China). The survey link was shared in different WeChat community groups of this county by using the Questionnaire Star APP, through which the fillers could fill in the questionnaires by scanning the QR code on their cell phones, which ensured the distribution rate and recovery rate of the questionnaires. The online survey was conducted from June 22, 2022 to July 06, 2022. There were a total of 62 participants took part in our online survey. The online survey data collected through questionnaires from 62 Xiayi county participants revealed a significant change in people's attitudes toward stalk burning in the county. However, factors like the illiteracy of the rural people and the lack of interest of farmers to disclose information also impacted our survey responses and made the sample size small. In addition, the pandemic and financial constraints blocked us from conducting the field survey.

2.3 Analysis data

In order to understand the current situation of stalk burning, find some problems in stalk burning, and provide the basis for formulating feasible strategies, the survey was conducted as part of this study. This investigation involves the household production situation, the way of handling stalks, and the hazards and policies of stalk burning. Among the villagers in Xiayi County, Henan Province, 62 valid responses were obtained from the participants, where the recovery percentage was 100. The survey details are analyzed below.

2.3.1 Family members' contribution to agriculture and earning

On average, there are 2.82 family members with income in each household, of which 43.55% work in Henan Province, 22.58% work outside Henan Province, and 33.87% work in and out of the province (see Fig. 2). Only 1.45 families participate in agricultural activities, and 69.35% of them believe that there is a shortage of labor in daily agricultural activities. In contrast, 30.65% do not feel labor shortage (see Fig. 3). To fill the labor scarcity, people choose to work longer hours, hire others or buy more convenient tools. For this group of people, 64.52% believe that the cost of labor is high, while 35.48% expressed their opinions in contrast (see Fig. 4).

2.3.2 The stalk management process

There are various ways to deal with the stalk; in reality, 45.16% of the people choose to retain the stalk, 37.1% of the people choose to collect the stalk, and 30.65% of people choose to burn the stalk (see Fig. 5). Why do nearly one-third of people choose to burn stalk directly? According to the survey responses, 67.74% of people

think that collecting stalk is time-consuming and laborious, 50% think that the collected stalk occupies the family area, 25.8% think that burning stalk is convenient, 27.42% think that burning stalk can make the land more fertile, 24.19% believe that burning stalk saves time, labor and money (see Table 1). Our survey indicates that peoples' attitudes toward retaining stalk on the land have changed. In addition, government support also encourages the farmers to retain stalks instead of burning them. It can not be denied that still a small section of people helplessly choose the option of burning stalks to clear their fields. However, based on the above data, it can be summed up that the convenience of processing stalk largely determines the choice of farmers, and some farmers find burning is more convenient than collecting and selling.

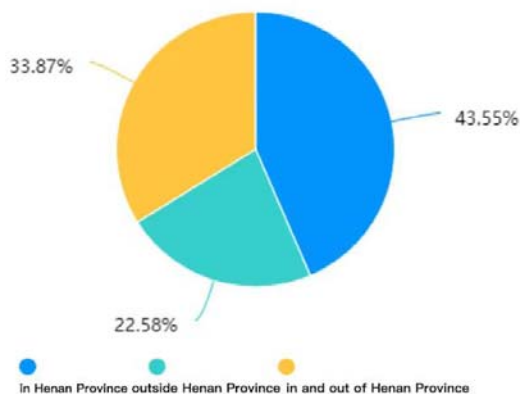


Fig. 2 Statistics of the workplaces of the earning members.

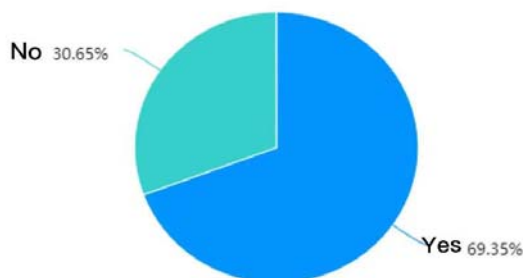


Fig. 3 Statistics of the labor in agricultural activities.

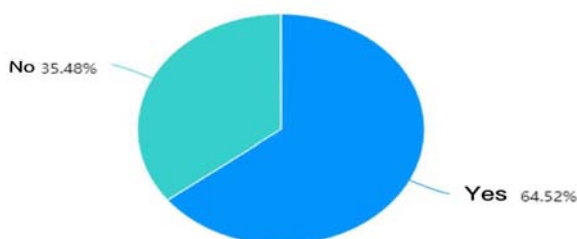


Fig. 4 Statistics of the labor cost.

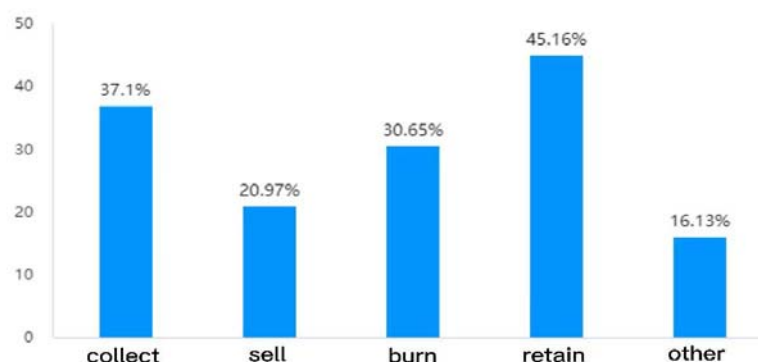


Fig. 5 Statistics of the way of handling straw.

Table 1 The statistics of the farmers' responses to staking management.

	Extremely agree	Agree	Partly agree	Disagree	Quite disagree
I collect stalks for household usage.	24.19%	32.26%	27.42%	9.68%	6.45%
I find collecting stalks occupies my household areas.	14.52%	35.48%	33.87%	12.9%	3.23%
Collecting stalks is time-consuming and laborious.	29.03%	38.71%	25.81%	4.84%	1.61%
I find burning stalks convenient for me.	12.9%	12.9%	20.97%	27.42%	25.81%
I was told that burning stalks make the land fertile.	11.29%	16.13%	16.13%	29.03%	27.42%
Burning stalks save my time, labor and money.	8.06%	16.13%	25.81%	19.35%	30.65%
I do not care if my stalks burning affects others' crops or properties.	8.06%	1.61%	12.9%	30.65%	46.77%
Causing air pollution from burning does not affect me.	8.06%	1.61%	8.06%	37.1%	45.16%
I do not have enough alternatives to burning.	11.29%	6.45%	14.52%	30.65%	37.1%

2.3.3 The hazards of stalk burning

In fact, from the survey results, 77.42% of people care about the impact of stalk burning on other people's crops or property; at the same time, 82.26% of people think that the air pollution caused by burning stalks has an impact on themselves, and 67.75% of people think that alternatives to combustion exist. Regarding the hazards of stalk burning, 93.55% of the people believe that burning stalk is harmful to the environment, 88.71% think it may cause fire, 74.19% think it would affect human health, and 64.52% think that burning stalk would destroy soil fertility (see Fig. 6). The above data points out that most of the villagers have a certain understanding of the harm of stalk burning on the environment, human health and soil.

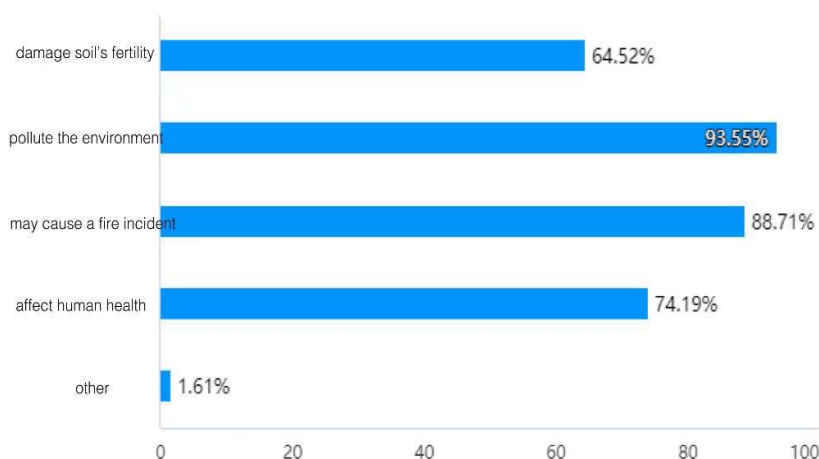


Fig. 6 Statistics of the hazards of stalk burning.

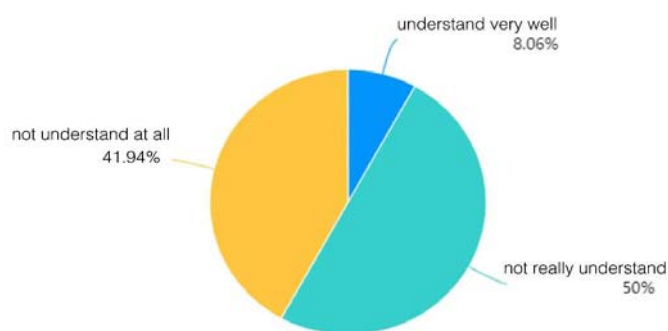


Fig. 7 Statistics of the people's awareness about air pollution prevention and control law.

2.3.4 The policies of stalk burning

The Air Pollution Prevention and Control Law was revised in 2018 to protect the environment, control air pollution, safeguard public health, and promote ecological civilization and sustainable socio-economic development. According to our survey result, only 8.06% of people are very aware of this law; on the contrary, 41.94% of people do not understand the law (see Fig. 7). Our survey reveals that 83.87% of the people have learned about the government's rules and regulations on not burning stalk and preventing air pollution through TV, radio, newspapers, online media, leaflets, seminars or other channels. Regarding the hazards of the burning stalk, 77.42% of the respondents said that the local authorities had warned them, and 22.58% said they had not (see Fig. 8). Regarding legal punishment, 16.13% of the people said they had been punished for burning stalk, and 9 out of 10 villagers who had been punished said they would make corrections. From the above-stated data, it can be seen that the villagers are not very familiar with the relevant regulations on not burning stalks. Although most of them have heard of it through various channels, it may be because the report is not specific, and most people still do not understand the relevant policy.

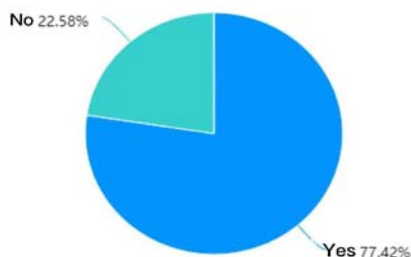


Fig. 8 Statistics of the people's acknowledgment of the local authorities' warning about stalk burning.

3 Results and Discussion

3.1 Role of legal systems in banning stalk burning

3.1.1 Laws at the national level

China has issued a special regulation on straw burning prohibition and comprehensive utilization, named "Management Measures on Straw Burning Prohibition and Comprehensive Utilization". The regulation has made specific and detailed provisions on the Prohibition of Straw Burning and Comprehensive Utilization, which has played an important role in law enforcement and management. But it has been repealed because of its apparent conflict with the latest air pollution laws. Although this special law has been abolished, China still has a relatively complete legal system for the comprehensive utilization of straws and banning straw burning. The relevant existing laws include the law on environmental protection 1979, the law on the prevention and control of air pollution 1987 (amended 2018), the agricultural law 1993 (amended 2002), the law on renewable energy 2005 (amended 2009), the law on the prevention and control of environmental pollution by solid wastes 2007 (amended 2020), the law on the promotion of circular economy 2008, the law on the prevention and control of soil pollution 2018, etc. In addition, administrative regulations include the Environmental Protection Ordinance 2009, and Urban Gas Management Ordinance 2010, and Local ordinances such as the Air Pollution Prevention and Control Ordinance 2016 are promulgated by various provinces.

The Chinese government has stringent legal policies to prevent stalk or straw-burning behavior. The act of burning stalk may violate a number of laws and be subject to different penalties. For example, in the case of the illegal burning of crop straw, according to Article 119 of the law of the People's Republic of China on the prevention and control of air pollution, the supervisory and administrative departments determined by the local government at or above the county level shall order correction and may impose a fine of not less than 500 yuan (US\$ 74.10) and not more than 2000 yuan (US\$ 296.40). If the intentional burning of crop stalks results in the destruction of forests and trees, compensation shall be made according to the law. In accordance with Article 74 of the Forest Law of the People's Republic of China, the competent Forestry Department shall order the cessation of illegal acts, replanting trees whose number of damaged trees is more than one time and less than three times may be punished with a fine of more than one times and less than five times the value of the damaged trees. To improve the environmental quality, article 41 of the Prevention and Control of Atmospheric Pollution Law (amended 2000) states that "In densely inhabited areas, the areas around the airports, the areas in the vicinity of main traffic arteries or the areas designated by local people's governments, the burning in the open air of stalks, fallen leaves or other substances that will cause smoke or dust pollution is prohibited"

(Prevention and Control of Atmospheric Pollution Law of China, 2000). In violation of this law, article 57 stipulates that any unit or individual who commits the crime shall be fined a maximum of 200 yuan (US\$ 29.64). A maximum of fifteen days of detainment shall be applied if the burning creates a fire.

Under article 104 of the Road Traffic Safety Law 2003 of the People's Republic of China, if the burning of straw on both sides of a road affects road traffic safety activities, the competent authority of the road shall order to stop the illegal acts and to restore the status of the road in original state. In accordance with the law, a fine may be imposed if any person, vehicle, or other property in transit suffers losses; he or she shall be liable for compensation (Road Traffic Safety Law of China, 2003). If any of the actions mentioned in the preceding paragraph affects road traffic safety activities, the Public Security Bureau Traffic Control Department may order the cessation of illegal acts and the prompt resumption of traffic. Article 63(2) of the Fire Protection Law 1998 stipulates that if straw burns near oil depots, gas stations, and liquefied petroleum gas stations, according to the People's Republic of China, a warning or a fine of up to 500 yuan (US\$ 74.10) shall be imposed for the use of open fire in violation of the regulations; if the circumstances are serious, shall be detained for not more than five days. In the case of a fire accident caused by the burning of straw, according to Article 64(2) of the Fire Protection Law of the People's Republic of China, a person shall be detained for not less than ten days but not more than fifteen days for "causing a fire by negligence", and may also be fined not more than 500 yuan (US\$ 74.10), if the circumstances are less serious, a warning or a fine of not more than 500 yuan (US\$ 74.10).

Whoever intentionally burns other people's crop straw and causes property loss shall, according to the provision of Article 49 of the Law of the People's Republic of China on Administrative Penalties for Public Security, if the individual "intentionally damaging property," shall be given a detention punishment maximum of ten days and a minimum of five days along with a fine of not more than 500 yuan (US\$ 74.10) may be imposed concurrently. In case of the gravity of the criminal offense, the detention time and fine shall be increased to fifteen days and 1,000 yuan (US\$ 148.20), respectively. In cases where the intentional burning of crop straw causes a fire that results in serious injury, death, or serious loss of public or private property, Article 115 of the Criminal Law 1979 of the People's Republic of China states that "Whoever commits arson, breaches a dike, causes explosion, spreads poison or inflicts serious injury or death on people or causes heavy losses of public or private property by other dangerous means, shall be sentenced to fixed-term imprisonment of not less than ten years, life imprisonment or death" (Criminal Law of China, 1979). The article also sets the provision for negligent committing of the crimes, as mentioned earlier, shall be given a punishment of a maximum of seven years imprisonment and a minimum of three years, but if the gravity of the crime is found minor, a maximum of three years punishment shall be given.

The first law on the comprehensive utilization of straw in China was the Agricultural Law, revised in 2002. The law states that straw and other residues of agricultural products after harvest should be comprehensively utilized and properly treated to prevent environmental pollution and ecological damage. The Circular Economy Promotion Law passed in 2008 also proposes the comprehensive utilization of crop straw. The Environmental Protection Law, which was amended in 2014, stipulates in Article 49 that relevant government institutions, especially the agricultural unit, shall expand the guidance towards farmers and agricultural operators in the scientific disposal of agricultural waste like crop stalks in order to avert pollution caused by agricultural non-point sources. The Air Pollution Prevention and Control Law, which was amended in 2015, stipulates in article 76 that governments at local levels, with the help of relevant departments, particularly the agricultural administration, shall encourage and mobilize the farmers to adopt modern and applicable agricultural technologies to comprehensive utilization of stalk and provide with financial subsidies to retain stalks on the land. Addressing the local government, article 73 of this Act states that

“Local people’s governments at all levels shall promote the transformation of agricultural production methods, develop an agricultural circular economy, increase support for the comprehensive disposal of waste, and strengthen control over the emission of atmospheric pollutants from agricultural production and business activities” (Air Pollution Prevention and Control Law of China, 2015).

China reformed its Air Pollution Prevention and Control Law (hereinafter Air Law) in 2016 to meet its air quality targets. This is the first law that focuses on controlling China’s greenhouse gases from all sources, including the agricultural sector. This law allows the local governments to formulate plans and implement them to achieve national air quality targets in a certain period. The National Action Plan on Air Pollution Prevention and Control of 2013, which lasted until 2017, showed significant progress in controlling air pollution in key regions. For instance, PM_{2.5} levels in Beijing dropped from 89.5 $\mu\text{g}/\text{m}^3$ to 60, and Pearl River Delta cut pollution by 15% in these four years. Among the 338 Chinese cities, only 107 cities met the World Health Organization’s recommended annual interim standard of 35 $\mu\text{g}/\text{m}^3$. The Three-year Action Plan on Blue Sky Defense Battle of 2018-2020 set a limit of PM_{2.5} levels to 35 $\mu\text{g}/\text{m}^3$; but 231 cities out of 338 have not met the government’s fixed level.

China believes that promoting the integrated use of straw or stalk is the key to eliminating stalk burning, so there are many policies in China that encourage the integrated use of straw, and they can not be enumerated.

3.1.2 Laws and policies of Henan Province

Since 2014, at the convening of each session of the Henan Provincial People’s Congress, the Henan People’s Congress delegates repeatedly proposed as soon as possible to formulate a bill on straw burning and utilization. They think that straw burning not only causes resource waste but also pollutes the air, which limits the sustainable development of the rural economy and the construction of rural ecological civilization. In recent years, the provincial government has formulated some anti-burning measures that have reduced straw-burning sites yearly.

In 2015, the Henan Provincial Government published the implementation plan for a straw burning ban and comprehensive utilization, which not only makes a detailed plan for the straw burning ban, but the paper also emphasizes the importance of improving the utilization ratio of straws to promote the completion of straw burning prohibition. To solve the problem of comprehensive utilization of straws, the fundamental way to do well is the work on banning straw burning. Therefore, the scheme makes a detailed regulation on how to promote the comprehensive utilization of straw and puts forward the direction of a mechanized straw return to the field and the development of straw feed. To support the local governments, the program also proposes to increase funding for this work, and the government should give priority support to projects related to the comprehensive utilization of straw and subsidies for the purchase of agricultural machinery used to return straw to the fields should be increased. Every year since then, the Henan Provincial Government has issued the implementation plan for the straw burning ban and comprehensive utilization, continuously strengthening the work of straw arson ban and comprehensive utilization and reducing the air pollution caused by straw incineration, effectively protecting urban and rural ecological environment and promote sustainable development of agriculture.

At the beginning of 2020, the Department of Agriculture and Rural Areas of Henan Province formulated and issued a work plan for banning straw burning in Henan Province and planning and arranging the work for the whole year. Since then, it has held five meetings to deploy the anti-burning work throughout the year and each season. By 2020, fire incidences had dropped by 18 percent compared with the previous year, and the province’s comprehensive utilization of straw had reached more than 90 percent (Xiaoxiang Morning News, 2021). This not only completed the annual work goals but also for the atmospheric governance of Henan Province has made great contributions.

However, to promote the government's "Blue Sky" campaign, article 3 of the Air Pollution Prevention and Control Law states that "Local people's governments at all levels shall be responsible for the quality of the atmospheric environment in their respective administrative regions, formulate plans, take measures to control or gradually reduce the emission of atmospheric pollutants, so that the quality of the atmospheric environment meets the prescribed standards and is gradually improved" (Air Pollution Prevention and Control Law of China, 2015). The local government has adopted a two-fold policy- mobilizing people and legal punishments, to make the air clean in the province. The deputy department-level leader of the Department of Agriculture and Rural Affairs of Henan Province, Zhou Chenliang, says that in 2000

"a total of 25.52 million copies of clear paper were distributed throughout the province, 4.57 million slogans were posted, 1.1 million banners were hung, 2.62 million small hands were held, 8.7 million mobile phone text messages were sent, and 300,000 propaganda vehicles were preached. A total of 229,200 yuan was fined to the parties to the ignition, 15.05 million yuan (US\$ 2221500.00) was deducted from the financial resources of the county and township governments, 88 people were administratively detained, and 463 people were found responsible for accountability" (Xiaoxiang Morning News, 2021).

3.1.3 Laws and policies of Xiayi county

As one of the country's leading grain-producing counties, the People's Government of Xiayi County responded positively to higher-level policies in 2015 by banning stalk burning. In 2016, the People's Government of Xiayi County promulgated a policy banning straw incineration in the summer season, which harms air quality. The main purpose of this policy is to improve air quality and prevent further air pollution. The plan aims not only to protect the atmospheric environment but also to increase the income ratio of the farmers. The plan intends to comprehensively improve the level of banning and comprehensive utilization of stalks and effectively improve the environmental air quality. It has also established a long-term management mechanism of strictly banning stalk and waste incineration. As a measure of implementation and comprehensive banning, there will be no fire, no smoke, and no burning in a field. To monitor "zero fire point" and air pollution and air quality, environmental and meteorological satellite and a provincial "blue sky guard" will be introduced.

The plan includes providing technical measures and support policies in prohibition and comprehensive utilization of straw and waste. To make aware of the common people about the harm of burning stalks and the benefits of comprehensive utilization of stalks, the Xiayi county government has taken initiatives to widely publicize the plan. The county government has used print, electronic, and social media platforms as publicity tools, such as posting slogans, setting up no-burning signs, hanging banners, and distributing clear papers, publicity vehicles, loudspeakers, the internet, text messages, and WeChat to engage mass people in fighting against air pollution through stalk incineration. To reach a broader level and increase the involvement of mass people, it has set up a 24/7 stalk burning ban reporting telephone hotline number (6210657) where anyone can send supervision and monitoring-related information.

Focusing on the comprehensive utilization of straw, a three-level responsibility system has been formed: at the county, township, and village levels. It urges the relevant authorities responsible for the inspection and supervision of the township's air quality and air pollution to execute assigned tasks with full responsibility. According to this plan, to prevent fire incidents in summer, relevant departments of each township and county government need to be formulated feasible emergency response plans for stalk incineration, increase the number of firefighting equipment, and ensure proper utilization of this plan. The village authorities need to form a voluntary village fire protection organization to cooperate with the main firefighting units.

From 2016 to the present, the Xiayi County government has published an implementation plan for the stalk burning ban every year, requiring all township governments to conscientiously implement it in light of actual

conditions. In addition, every year, before the wheat or corn harvest, Xiayi County will hold “Three summer” or “Three autumns” production work conferences and stalk burning work conferences. At the meeting, officials will review the ban on stalk burning in the past year, report and criticize the sites of stalk burning, and make specific arrangements for future work, such as the stalk incineration ban and grain production. In addition, article 96 of the Air Law urges the county governments to urgently adopt plans and measures to stop fireworks and other activities that cause harm to the atmospheric environment. This specific, clear and detailed regulation and arrangement have greatly reduced the situation of stalk incineration in Xiayi county to meet the requirement of the central government.

3.2 Way forward to overcoming the challenges

From the above analysis, we can see that there are still gaps in the legal implementation and conveying to the farmers the rules and regulations for protecting the environment. Such gaps hinder the government’s effort to combat the open stalk burning problem and indirectly instigate stalk arson. There are other factors such as economic migration of rural people to the cities, less demand for stalks in rural areas, ineffective use of straw-based methane projects and costly collection of stalks, time-consuming for the farmers, shortage of labor and high wages of labor also contribute to stalk incineration. Moreover, the economic issue primarily exacerbates the problem. Additionally, there are some common misconceptions from the farmer’s side that the burning of stalks will increase the fertility of the land, although no scientific study has been found in favor of this logic. They also believe that burning helps prevent and control diseases and pests, but many agricultural-friendly pests die due to such burning. Consequently, farmers burn the stalks in the fields to save labor and money, which causes severe air pollution.

Clearing agricultural detritus through burning has multiple disadvantages. Burning stalks lower the fertility of the soil and shrink the water retention capability to a large extent. The stalk burning impacts agricultural fields to become unfertile by losing different vital elements of the soil, namely nitrogen, phosphorus, sulfur, potassium etc. This ultimately compels the farmers to spend much money to recover the land’s fertility. Since black carbon has a deep connection with air pollution; therefore, stalk burning assists in causing floods, droughts, and other natural calamities. Stalk burning is a primary contributor to poor air quality and can be very detrimental to human health. In 2019, a study by the International Journal of Epidemiology found that people living in northern India, where stubble burning was most common, experienced a three-fold higher risk of acute respiratory infection (Chakrabarti et al., 2019), including short-term coughing and wheezing, weakness, vomiting, upset stomach, headaches, dizziness, confusion, chest pain and tightness, shortness of breath, lung, eye, throat, and nose irritation, irregular heartbeat, increased risk of respiratory infection, more frequent and intense asthma attacks. It also has longer-term health effects of respiratory illness and chronic lung disease, neurological disease, chronic obstructive pulmonary disease (COPD), emphysema, increased carcinogenesis risk, change in lung function, cardiovascular illness, and premature death. Stalk incineration also contributes to high concentrations of toxic air pollutants, including carbon dioxide, carbon monoxide, nitrogen oxides, sulfur oxides, methane, PM10, PM2.5, and black carbon (Abdurrahman et al., 2010).

The common practice of Chinese farmers is burning stalks after harvesting crops during the summer and autumn in many parts of China. As an agricultural-based province, Henan is also burdened with this problem since stalk burning is still prevalent in rural areas. Burning stalks cause adverse effects on the air quality of this region. Although many technological innovations like combining harvester machines have been introduced to relieve the problems of the farmers cutting the stalks, but such machines run on fuel aggravates air pollution. While collecting wheat, the harvester machines leave the remaining stalks and chaff on the land. These stalks and chaff must be cleared before the next stalk planting, either manually collecting or burning them off. To evade such a problem, many farmers still choose burning stalks as an easy option. It is a general truth that there

is a huge shortage of human labor in Chinese rural areas for agricultural activities since many rural people leave villages to do temporary jobs in cities.

The stalk-burning problem is more acute in Henan, Shandong, and Liaoning provinces than in other provinces of China. Since stalk burning is one of the diffuse sources of pollution; therefore, authorities face challenges in tackling this problem. The Ministry of Environmental Protection (MEP) encourages the local governments to promote the “no burn” campaign in which farmers will be discouraged not to burn their stalks after harvesting. Similarly, the provincial government has also addressed this problem and offered guidelines to county officials. The action of the local governments is not satisfactory in combatting the stalk burning problem. Counties are fined for their inappropriate action to control crop burning at the county level. However, the local government enforces laws breaching and encourages the farmers to retain stalks.

For many farmers, stalk retention is time-consuming and an economic burden that demotivates them to retain other than burning. Once the stalk was considered a treasure and used for various purposes, but today, the socio-economic development in rural areas has turned the straw into a useless thing. Providing all kinds of support to the farmers is essential to prevent stalk burning and make stalks a valuable part of agricultural production. In fact, without the farmers’ willingness, stalk retaining and stopping stalk burning can not be possible. Educating and informing the farmers about the negative consequences of stalk burning and the advantages of stalk retaining is essential. Many recent studies show that stalk straw retention helps to improve soil fertility and yield production, ultimately benefiting farmers. Even though stalk return in China is not an easy task, many factors are involved in the process that need to be solved. For instance, in China, stalk production is a challenge to meet the demand of the huge population. Retaining stalks on the field and scientifically decomposing them is challenging for the farmers. In addition, this process takes time, affecting the farmers to prepare the land for the next stalk cultivation. The stalk retaining process needs to be done within a short period since most farmers cultivate two seasonal stalks in rotation over a year; therefore, clearing the field in the quick possible time is important for them. Moreover, farmers generally bear stalk retention costs that force them to adopt a quick and easy step, burning stalk, to save money and time.

Although government’s stalk incineration banning policy compels the farmers to retain stalk (Huang et al., 2019), but financial subsidies need to be increased among the farmers to inspire them to retain stalk. Government’s initiatives to encourage the farmers to retain the stalk in lands through providing subsidies for purchasing agricultural machinery are not appropriately implemented and distributed. The research data of Chen et al. (2019) claims that the farmers of Northeast China require fewer incentives, while East China, Central China, and Northwest China require comparatively high incentives to transform the practice of retaining stalks in the stalk lands (Chen et al., 2019). Many countries have initiated payments for environmental services (PES) intending to preserve the natural ecosystem (Alix-Garcia et al., 2018). This kind of service encourages the farmers to participate in the stalk retain process, but for many farmers of Henan and Heilongjiang province, the PES amount is too low to bear the cost of stalk retain production (Yang et al., 2020). In 2016, the Henan government spent 80 million yuan (US\$ 11848000.00) to provide farmers with stalk-retained compensation and assist with stalk-retaining agricultural machinery (Yang et al., 2018), which is a very small number to successfully prevent the stalk-burning problem.

Government’s air control implementation policy has tightened in the last couple of years to prevent and control the air pollution problem, particularly from open stalk burning (Jin et al., 2016). Article 23 of China’s 14th Five-Year-Plan (2021-2025) stipulates increasing comprehensive stalk cultivation and harvesting mechanization. It also stipulates developing innovative agricultural technology to ensure a smart agricultural system. In addition, as a dream of the government’s “Blue Sky” campaign to fight against air pollution, the government has issued “Three-Year Action Plan for Winning the Blue Sky Defense War” that highly

emphasizes the local governments to carry out their responsibilities to stop open stalk incineration during the summer and autumn harvesting time.

Government initiative to support environment-friendly companies is seen in many parts of the country, including the Henan province. Manufacturer companies are producing different products from straws such as cotton coats, grass rope, grass curtains etc. According to China's Ministry of Agriculture and Rural Affairs, the comprehensive straw utilization rate will reach over 80% by 2020 (China's People's Daily, 2017). Such steps help to improve the air quality of the Henan province, and Xiayi county has improved its air quality at a significant level. According to Xiayi County People's Government, on July 18, 2022, the air quality index (AQI) records in Xiayi county were 94. Although the recorded AQI level indicates a moderate level of pollution in the county (see Table 2) (source: <http://www.globalfiredata.org>), the overall air quality of Xiayi county is much better than any other county in the city. However, Xiayi county still needs to improve its air quality in many aspects because the data shows that PM_{2.5} 79 $\mu\text{g}/\text{m}^3$ and PM₁₀ 117 $\mu\text{g}/\text{m}^3$ have been recorded in the county recently (airquality.com, 2022).

Table 2 Estimate emissions in Xiayi county until April 10, 2022.

Estimate Emissions	
Carbon	833 Gg
Carbon Monoxide	277 Gg
Carbon Dioxide	2670 Gg
Methane	11 Gg
Dry Matter	1792 Gg
Particulate Matter	27 Gg

3.2.1 Recommendations

Considering the above-raised issues, we propose some recommendations hoping that these recommendations could help the government mitigate the stalk-burning problem.

(1) Involve the local companies in collecting stalks instead of letting the farmers burn stalks and help the farmers plow the land for free. Incentives from the government may inspire the recycling crop stalks companies to collect agricultural stalks, and household garbages for generating eco fuel or electricity. This win-win approach benefits both parties.

(2) Establish research-based organizations that contribute to the sustainable utilization of stalks to produce oil or other things. Establishing such research organizations will not only contribute to improving the air quality but also benefit the farmers.

(3) Introduce more unmanned aerial vehicles to identify the crop-burning sites. These aerial vehicles will monitor the incidents of crop burning and inform the concerned authority quickly to prevent burning.

(4) Mobilize the rural residents about the government's policy toward a clean environment and make them conscious of the harmful effects of stalk burning. The local government can launch campaigns against burning stalks, spread leaflets and posters, and use local media and online tools to create public awareness of making the environment clean and hazard-free by not burning crop stalks.

(5) Install corn-stalk burning cook stoves instead of coal burning. Coal-burning stoves create a negative impact on air quality and cause air pollution. Every year 500,000 people die due to indoor air pollution caused by using coal-burning stoves in the kitchens of Chinese rural areas (Clafin, 2015). The rural areas' livelihoods have improved a lot, and the traditional cooking method is being replaced by electric cookers or items or gas

cylinders. But, in many parts of the country, traditional cooking methods are still employed. Replacing coal with corn stalk reduces the emission of carbon dioxide and other particulates and saves money for the farmers. This attempt will also encourage the farmers to stop burning the stalks.

(6) Shredding and burying the stalk deep to make natural fertilizer instead of burning them. This organic fertilizer fertile the lands and helps farmers not to spend too much money on purchasing fertilizers.

(7) Encouraging the farmers by providing them with rewards or some other recognition instead of quitting stalk burning.

(8) Create mass awareness and improve capacity building for the farmers to successfully deal with stalk disposal rather than burning.

(9) Ensure the strict implementation of the rule of law and enhance monitoring activities during the harvesting.

(10) Use stalks as resources for animal feeding and biomass power generation. Biomass, a renewable source of energy production, can sustainably use agricultural crop residuals to decrease the amount of carbon dioxide in the atmosphere and make extra income for the farmers.

(11) Inspire the farmers to retain agricultural residues in their croplands by strengthening the government's hand to mitigate climate change issues. It requires government's incentives and farmers' friendly policies to retain crop residues instead of burning them.

(12) Commercial use of stalks needs to be increased for carbon manufacturing and compact granule factories that use stalks for industrial purposes.

(13) Reform the rural land tenure system to assure farmers adopt stalk retention. Reforming the land tenure system may help the farmers be inclined to conservation practices rather than burning since many farmers want to invest more money in agricultural production for a long time.

4 Conclusions

Like other counties of Henan province, farmers of Xiayi county also adopt the quick and easy option of burning the stalks. Although our study finds that the scenario of stalks burning in Xiayi has gradually been shrinking due to the government's efforts; nevertheless, still, one-third of people choose the option of burning to prepare their lands for cultivation. Besides implementing legal instruments, local governments mobilize and engage the farmers and other stakeholders to prevent and control stalk incineration. Despite numerous efforts from the government side, the stalk incineration problem is still prevalent in the county. The common reasons behind stalk arson are insufficient labor, the high price of the laborers and stalk collecting machines, no households use of stalks, long-distance of croplands from houses, time-consuming, shortage of industrial production of stalks, farmers' superstitions about stalk burning, weak punishment for stalk burning, insufficient incentives from the government are prominently responsible for open stalk burning in Xiayi county. Our study addresses these issues and finds that stalk incineration causes heavy loss to the environment and the cropland. Therefore, this study suggests that appropriate legal measures need to be ensured and seriously implemented at the county level so that no one can attempt to burn stalk at their own will and a strict monitoring unit needs to be formed to monitor the village areas during the harvesting times.

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