

# Straw Incineration Odor Hazard & Disposal Mechanism in Economic Perspective

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Crop straw is the most valuable resource in the agriculture, but people have never made the most of it with the economic development so that it still has a low yield to this day. There are phenomena that crop straw becomes waste or directly incinerates everywhere. Improper straw disposal will allow it to produce pungent odor and seriously endanger the humans and environment. This paper first describes the odor emitted by straw incineration and where it derives from on earth. Next, it is discussed what's the hazard of such odor. This is also an exploration on the cause why the crop straw incineration will produce the pollution from economic perspective. Based on the negative externality of odor pollution produced when farmers incinerate crop straw, it is analyzed in the economic sense how to prevent against and abate the odor pollution.

## 1. Introduction

Crop straw is not only one of the chief by-products in the agricultural production process but also a valuable type of agricultural resource. Crop yield continues to increase with the development of modern agriculture so that more crop straw heaps up in bulk. However unfortunately, only a handful of the straw is directly used as domestic fuel and forage. In many areas, crop straw has become wastes. Farmers often take measures to burn straw to save trouble in order to rush to farm and sow seeds, which will produce a pungent odor that harms the humans and seriously ruins the environment (Estrellan and Lino, 2010). This just attributes to agricultural pollution. Nowadays, the environmental pollution sources transform from industrial pollution to agricultural pollution that seems increasingly prominent. Straw incineration will not only cause great waste of resources, but also produces pungent odor that pertains to air pollution, and now the increased greenhouse emissions have become a staggering problem in society (Mazzoli-Rocha et al., 2008). How to effectively control and reduce the pollution caused by crop straw incineration is more challenging. This paper first describes the odor and its source of straw incineration, and then discusses the hazard of this odor, and last attempts to analyze what is the best counterplan for straw incineration from the economic perspective.

## 2. Odor and harm of straw incineration

### 2.1 Staple sources of odors from straw incineration

The odor mainly derives from the hazardous substances released during the open incineration process. Open incineration refers to the substance combustion process in which the burned products are directly discharged into the ambient air, but not via the chimney or flue (Haleh and Ashbaugh, 2007; Kulkarni et al., 2008). Open-air incineration sources mainly cover farmland straw, fuelwood in rural residents' stoves, municipal solid waste and industrial refuses (Lemieux et al., 2004). Unlike other combustion processes, these kinds of sources will release a series of harmful odors and substances during incomplete combustion under hypoxic and low temperature conditions (Shih et al., 2016). Multiple studies have shown that open incineration is the staple source that gives off harmful odor, but thanks to its simplicity and economy, it still dominates other disposal modes for farmland wastes (Gullett and Touati, 2003; Regalado et al., 2006).

## 2.2 Hazard of straw incineration odor

When the straw is burned, a huge mass of harmful substances such as sulfur dioxide (Agarwal et al., 2012), nitrogen dioxide, carbon monoxide and nitrogen chloride will be directly released into the atmosphere, giving off a pungent odor which, with the widespread burning for straw over a period of time, will get more intense, more irritating to the human eyes, nose and throat mucus membrane, thus causing cough, chest tightness, tearing, and inducing diseases of, for example, the respiratory and cardiovascular systems, even resulting in sudden bronchitis, aggravation of pneumonia, accompanied by cough, dyspnea and asthma symptoms, and severely attacking lung function (Awasthi et al., 2010). Sometimes it may even induce cancer in some people; while for children, some impairments caused by it may not even recover.

## 3. Economic analysis of repeated straw incineration

Although the government has strengthened their efforts to disseminate how hazardous the burning straw seem by means of various media such as newspapers, television and radio, everyone knows that the odor generated by straw incineration will do a great harm to human health and environment, in many areas there is still the phenomenon of burning straw in the open air (Park, 2013). Based on the principle of economics, this paper analyzes the causes about why straw incineration still happens despite of repeated prohibition in the case of farmer's knowing that odors generated by this behavior is more hazardous.

### 3.1 Technical and economic analysis of crop straw utilization

Straw as an important biomass resource can generate burning value equivalent to about 50% of standard coal, contain about 5% protein content, about 30% cellulose content (Satyendra et al., 2013), and also a certain amount of minerals such as calcium and phosphorus used as fertilizers. The nutritive value of 1 ton of ordinary straw is equivalent to that of 0.25 tons of grain (Gulsonv, 2008). According to the straw utilization value, if the straw gets comprehensively utilized, the economic benefit can be improved by 4 to 5 times (Yang et al., 2008). Assume that nearly 700 million tons of straw will be produced per year, if they are all used for combustion, the calorific value produced by them will be converted into that from more than 300 million tons of standard coal; if they are used as fodders, it is equivalent to 1.5 billion tons of grain. After scientific treatment, the nutritive value of straw will be far more than these.

Seen from the comparative benefits of comprehensive straw utilization: First, the straw utilization cost is high. Farmers are rational people. Although there are many ways to use the straw in an integrated manner, such as generate electricity, making straw boards, return to the fields as fodder, and cultivate edible fungi, etc (Tovalin-Ahumada and Whitehead, 2007). However, when these technologies are used in practices, farmers must collect crop straw. As farmers find that the investment costs of harvesting may be higher than the benefits gained from the straw utilization, they make a rational choice, that is, to burn the straw. It is supposed that there is a machinery which can crush the straw to return it to the field in order to increase soil fertility, but the cost per acre in the use of machinery reaches RMB 20 or so, plus other labor charges. Worse, farmers have also found that the improvement of soil fertility in this way is not obvious in the short-term. Second, the opportunity cost of harvesting and utilizing straw is too high. There is phenomenon that rural households' by-business and labor exodus gets very common now. Between the farmers' income and the cost of straw utilization, if the opportunity cost of straw utilization is greater than the income created by farmers when they serve for others or are engaged in other agricultural production, the straw will be fully utilized, otherwise the only way they can choose is no doubt to incinerate the straw. In fact, when a per capita net income the farmers earn is less than RMB 2,000, the crop straw will be incinerated in large quantities as the main means of disposing it. When farmers get the lower returns from straw utilization, they will invest their labors in other economic activities with higher income.

### 3.2 Negative externalities and performance of crop straw incineration pollution

From the perspective of microeconomics, the pollution caused by farmers' incineration on the straw is essentially an external problem. The externality of crop straw incineration pollution is defined such that the environmental pollution caused by agricultural producers' production behaviors spoils the welfare of others, but no incentive mechanism developed for farmers will be vigilant in the farmers' action to consider whether the others are hurt by the environment at the time of implementing production decisions. It is manifested that the private and social costs for straw incineration are not balanced. The reason why farmers' straw incineration behavior occurs repeatedly is that they have no incentive to consider the cost of pollution that would be imposed on others when making production decisions. Their behaviors of burning straw is not punished, but other people in the society bear the damage caused by their behaviors like this, so that the marginal private cost of the polluter is less than its marginal social cost. Without intervention policy (Chen, 2018), polluters who are rational economic men will not automatically take measures against pollution

because, on the one hand, all of external damage caused by their behaviors has been shared by the society, which reduces their costs; on the other hand, measures against pollution usually mean increasing the expenditure on environmental protection or various opportunity costs, which thus increases the expenditure of farmers.

During straw incineration, it becomes soot discharged into the atmosphere. This mode can reduce the cost of farmers to dispose straw, which means the cost consumed for treating waste straw is shifted to the society. Farmers do not need to bear the responsibility for pollution caused by burning straw. Therefore, straw incineration has become the most economical and inevitable choice for farmers. To ban straw incineration is tantamount to preventing farmers from shifting costs, which means that farmers need to pay for the cost incurred by disposing straw, thus naturally encountering farmers' contradiction. Therefore, farmers lack the motivation and awareness to reduce pollution.

#### **4. Control mechanism of straw incineration pollution from the economic perspective**

In order to avoid the harm caused by the odor that derives from straw incineration from the root cause, and eliminate the negative externalities created by farmers in this process, it is required to start from the essential activity of producing this odor, that is, straw incineration. In theory, if the agricultural producer can charge the environmental beneficiary for controlling the pollution-generating activities, or pay the corresponding compensation to the environmental victims for the external uneconomic behaviors, the negative externalities in the economic sense do not exist or are internalized. Therefore, incentives or enforcement mechanisms can be taken to control pollution, eliminate the externalities, and improve environmental levels.

##### **4.1 Incentive mechanisms**

The market is an effective means by which the rational allocation of resources will be achieved. Economic or market-based policy measures have the advantage of improving the flexibility, efficiency, and cost-effectiveness of micro-subjects to control pollution behaviors. Incentives are taken to strengthen the economic interests of polluters to achieve the purpose of controlling pollution (Shang and Wen, 2018), and beneficial for agricultural polluters to adopt pollution control modes applicable to their own situation.

###### **4.1.1 Subsidies**

Subsidy intends to encourage and guide farmers to adopt environmentally friendly production modes, or to subsidize the users to comprehensively use the straw. The subsidy policies are reflected in two ways: First, subsidies for the use of agricultural environmental protection technologies and production modes. As farmers are generally reluctant to adopt new environmental protection technologies, subsidies should be granted to them in order to guide them to change production modes, adopt new technologies. It will have the effect of improving social environment and personal welfare. Financial subsidies can be given to farmers who use straw for the field. The second is to subsidize the processors of straw, the producers and consumers of straw products, cultivate the industrialized operation mode for straw utilization, increase the demand for straw, and improve the economic benefits of it. In fact, the subsidies for those producers who comprehensive utilize and recycle the straw act as an incentive way for them to increase the price of straw. It has a more significant effect because it can increase the incentives for farmers to recover straw, reduce the probability of straw incineration and improve the environment; and it can also increase the added value of straw crops and increase the income of households.

###### **4.1.2 Education and technology promotion**

The purpose of education and technology promotion is to provide producers with relevant information to encourage them to adopt or employ environmentally friendly production practices, including how to use the existing or new technologies to farm the fields more efficiently. These new technologies produce less pollutants, but generate more profit, so that they are more environmentally friendly. Education and outreach programs usually depend on the volunteers, and the role the government plays is to provide information. The advantage lies that when farmers are not familiar with the effects of protective production practices, or are uncertain about whether and how they should be adopted, education and technology promotion policies can promote the adoption of farmers through the collection and transmission of public information. For the more mature straw comprehensive utilization technology, farmers as small producers on a little scale will cost high in obtaining information, so that they will not invest excessive expenses. Compared with small producers, the government has a lot of information about pollution control or pollution prevention practices. If this knowledge can motivate producers to use environmentally friendly production modes, then the dissemination of this information can contribute to environmental improvements. The dissemination of information on agriculture

and its pollution control depends on policy advisory, technical training and technology promotion provided by the government, so that it can be achieved through education and technology promotion programs.

#### **4.1.3 R&D**

Like application of education resources, R&D is also an important incentive mechanism for crop straw incineration pollution abatement, which provides producers and society with more effective ways to achieve environmental goals. Since not all studies will bring economic benefits to investors, it is obvious that small-scale agricultural producers have insufficient investment in R&D of pollution prevention and abatement. The involvement of the public sector, with government inputs, can not only help to achieve comprehensive utilization of straw, but also encourage producers and the private sector to make more effective R&D inputs (improve investment efficiency) in order to upgrade environmental levels to a greater extent.

### **4.2 Mandatory mechanism**

#### **4.2.1 Taxation**

The taxation policy for controlling agricultural pollution is to implement “discharging right control” for unreasonable production modes and behaviors in the agriculture. According to the principle that “polluter pays the bill” and “user pays the bill”, the agricultural workers who burn straw are charged in accordance with certain standards. The intent is to restrain farmers from adopting environmentally harmful production modes and behaviors, and reduce the occurrence of straw incineration pollution. They are also forced to abandon the traditional concept and choose the “win-win” eco-agriculture mode of economic and environmental benefits. Although the pollution control fees paid by farmers is in line with the “polluter pays the bill” and “user pays the bill” principles, in the context where government hammers at reducing the burden on peasants, and more because of the weak nature of agriculture and policy sensitivity, excessive or inappropriate charges may increase new burdens to them and cause dissatisfaction among them, which is not conducive to agriculture and rural environmental governance. Therefore, it is difficult to implement the existing traditional pollution control measures based on the “polluter pays the bill” principle in the straw pollution control.

Under the existing system and market defects, the mechanisms of “compensation for users”, “management for polluters” and “recovery against destroyers” have not been established at all. Coupled with the imperfect legal means and the relaxed law enforcement, as well as lack of the economic incentives for farmers’ environmental, external costs are unpaid, and external income is shared by everybody, all lead to the accumulation and negative externalities of rural pollution.

#### **4.2.2 Penalty mechanism**

The penalty mechanism is defined as direct regulations plus strict supervision and law enforcement to control agricultural pollution and make waste management. There are many ideas proposed for reducing the pollution from burning straw, for example, the ban burning recently proposed as the main disposal method for many local governments. It is a purely administrative measure. The Environmental develops a target-oriented responsibility system for straw incineration and comprehensive utilization, and implements relevant tasks into the villages, the households, and the fields. A law enforcement team is established to investigate environmental violations. For those who arbitrarily burn crop straw, the Environmental in the local will take the lead, jointly with the Agriculture and the Farm Machinery, to warn them, order them to stop burning it. According to laws and regulations, those duty officers will have to be subject to criminal prosecution; for those who cause air pollution accidents due to burning straw, thus resulting in major losses of public property or life, criminal responsibility shall be investigated by judicial authorities. If there are serious consequences, the judicial organs shall be handed over to investigate the criminal responsibility of the responsible person. These administrative measures seem to be severe, but they only restrain human behaviors to a certain extent, regardless of the fact that they play a great effect in controlling the pollution from burning straw. They fail to fundamentally deal with all problems in the interest of people. In fact, the administrative cost of ban burning is too high, and even there is no new straw utilization technology program which can eliminate economic motives for farmers to burn straw. It eventually ends up with a “boundless effect”.

## **5. Policy recommendations for pollution control of crop straw burning**

### **5.1 Build a social participation mechanism to improve farmers' awareness of environmental protection and participation**

Farmers participate in the control of crop straw burning pollution, the effect of protecting the environment is most obvious. Generally, the environmental awareness of farmers can be enhanced through formal education and non-formal education. The former is to set up relevant courses in the period of compulsory education to

cultivate students' environmental awareness; the latter is through cable Television, newspapers, radio, programs, lectures, leaflets, etc., teach the public about the impact of agricultural pollution on the environment and human health.

The government can make full use of newspapers, television, radio and bulletin boards to actively promote the state's laws and policies on "ban burning" straw, publicize outdoor burning straw for the environment, transportation, farmers' own health and soil structure. The harm caused by the increase will increase the farmers' awareness of the dangers of burning straw, enhance the farmers' legal awareness, and enhance their willingness to "burn" straw.

### **5.2 Improve the profit opportunities of straw utilization and realize industrialized operation**

Economic benefits are the most basic economic driving force for the development and utilization of straw and consumer straw products. Increase the industrial management of straw utilization, extend and lengthen the industrial chain of agriculture, and turn straw from waste into valuable economic resources, which can eliminate the material roots of burning straw pollution. At present, the comprehensive utilization of straw mainly reflects several aspects: Industrial use, such as chemical production, paper and fiber sheet manufacturing; feed industry, such as premixed feed; fertilizer industry, such as biological microbial fertilizer; fuel industry, converted into high-efficiency fuel through straw gasifier in the industrial chain, Industrial capacity plays a decisive role in the process of elongation. Only when breakthroughs are made in the industrialization of straw processing, it is possible to realize the industrialization of straw processing and obtain the scaled benefits of straw processing.

### **5.3 Exploring positive incentives**

Incentive policies can be adopted for the treatment of burning straw pollution and the comprehensive utilization of straw. In the case of mature straw utilization technology, farmers should be fully mobilized, the initiative and enthusiasm of enterprises to develop and utilize straw, increase the scale of enterprises, industrial production, and encourage enterprises or consumers to consume straw products. Incentive policies can be implemented in multiple ways, but the effects of policy implementation should be considered. The price subsidy policy is the main measure to implement incentives (Langmann et al., 2009). The object of price subsidy may be the processor of straw, the producer of straw products, the consumer of straw products, or the farmer. From the perspective of the effect of subsidies, the former is more efficient, because from the beginning of the industrialization of straw utilization, the industrial capacity of straw processing is insufficient, and the price subsidy of factors has a greater effect on the initial development of the straw processing industry. Because of the high cost of supervision, farmers' subsidies actually encourage the increase of straw production and encourage the burning of straw.

### **5.4 Increase technical innovation**

Under the existing technical conditions, the utilization cost of straw is relatively high, so that the supply of straw greatly exceeds the demand, and the price of straw is very low, which is the main reason for farmers to burn straw. To fundamentally solve the problem of farmers burning straw, it is necessary to increase farmers' straw income, and an effective bridge connecting resources and increasing farmers' income is technological innovation (Singh et al., 2010). Technological innovation can also enable people to actively and consciously develop and utilize straw. Through technological innovation, we can develop new uses of straw and reduce costs, improve the utilization efficiency of straw, and thus improve its economic benefits.

Technological innovation is an important way to solve the problem of farmers burning straw. High-tech, industrialization, scale, and industrialization are the main technological development directions of straw utilization technology innovation. On the one hand, the existing rotary tillage machinery is technologically innovative, increasing its cockroach function, developing a straw smashing device, and greatly reducing the cost of "stalk returning to the field"; on the other hand, it is a technical guarantee for industrialization and scale of straw processing.

In respect of the choice of the market and the masses, we must resolutely eliminate technologies that have been proven to be inefficient and have no market prospects, focusing on the development and promotion of high-efficiency and high-efficiency technologies to promote the industrialization of straw utilization.

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