The Policy about Turning Straw into Biomass Energy in Beijing-Tianjin-Hebei Region and Research on the Contribution of Energy Saving and Emission Reduction

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Abstract. This paper systematically introduced straw utilization in China and abroad and relevant policies and regulations in China. It also analyzes straw biomass makes the contribution on air pollution prevention and energy-saving and emission-reduction through case analysis of the typical areas in Beijing-Tianjin-Hebei. Finally we presented the relevant countermeasures and suggestions, short-term method: Enhancing the incentive effects of subsidy policy, long-term method: Creating long-term voluntary emission reduction of carbon trading market, changing the straw burning into comprehensive utilization of industrialization development, forming a large-scale, commercial and sustainable industry cluster and so on.

Introduction

Production of 7 main agricultural products in China ranked first in the world in 2014[1]. The annual grain yield was approximately 607 million tons in 2014, with a crop straw production of 720 million tons. However, the national utilization rate of straw in China is considered low, 80% in 2015[2]. According to the Ministry of Agriculture China, straw burning accounted for approximately 30% of annual production in 2013. Air pollution is one of the environmental impacts of straw burning. In autumn of 2015, northern China suffered severer air pollution episodes with a wide spread of haze. In addition to weak atmospheric mixing due to weather conditions, large-scale straw burning occurred in many regions.

After decades of research and development, straw utilization techniques are becoming more practical and economical with increasing technical content. The economic values and environmental benefits of straw utilization are well known. Nonetheless, efforts in many fields are needed to realize such potential, including technical advancement, improvement in education programs, as well as development and implementation of financial and environmental policies. The purpose of this paper is to 1) review straw utilization technologies worldwide, 2) provide the status of straw production and utilization in China in the past decade, 3) summarize major regulations put into effect since 1999, and major events in 2015 in the field of straw burning in China, 4) make recommendations leading to improvement in straw utilization.
Straw Utilization in China and Abroad

Global Straw Utilization

Straw utilization technology is mature in many developed countries. Comprehensive straw utilization is becoming an attractive alternative to burning, to reap economic benefits and to levitate air pollution.

In the United States, annual straw production was approximately 45 million tons in 2006. Majority of the straw (68%) was crushed and buried in situ after the harvest [3]. The benefits include enriching the soil organic matter and aiding water-conservation production [4]. The biofuels from straw has also reached the stage of industrial production. Straw fired power generation as an approach of straw utilization was first established in Denmark, with the world's first straw power plant in operation in 1988. Avido Power Plan, well known for its high efficiency and environmental protection efforts, consumes 150,000 tons of straw and provides electric heating for hundreds of thousands of users every year. In addition, Denmark also used straw in small gasifiers for home heating in winter [5].

In Japan, 75% of straw was used as fertilizer, another 15% of straw is used as livestock roughage. Only a fraction of the straw production is burned at specified time and place [6]. In addition, the Japanese earth environment industry technology research institution (RITE) and Honda Technology Research Institute have developed a technology of extracting alcohol from straw[6]. A Kip, an Italian company, developed a machine which can produce shaped solid molding fuel in the field. The infield processing includes: harvest → chop→ juice extraction → drying→ forming [8]. Swedish use bagasse for power generation [8].

Straw Utilization in China

By the end of 2015, straw comprehensive utilization rate is more than 80% in China [9]. However, the rates of utilization differ greatly among regions owning to different levels of policy and financial support, consciousness of farmers, as well as economical and industrial development. In recent years, there have been continuously innovation in and application of straw utilization technology in China.

Some provinces turned straw into resource. Although in its early stage, there are brokers in the straw market, more than two thousand in Anhui in 2015[10]. More people are expected to enter the industry. On December 13, 2015, it was reported that "cell factories" can turn straw, cassava, algae biomass into pentanediamine, succinic acid, adipic acid, methane, ethanol and other chemical products, providing abundant raw materials for the modern chemical industry [10].

Xingan league (Inner Mongolia) Administrative Committee allocated 50 million yuan in its 2015 budget to support straw conversion. The construction of straw processing factory in 200 villages was set to complete by the end of October, 2015 [10]. Heilongjiang is the number one grain production base in China and the biggest production base of organic grain. In September 2015, in order to boost the enthusiasm of farmers toward green agriculture, the Farm incased the subsidies in purchasing of straw processing machine/unit. Incentives are accompanied by punishment. Inspection groups were setup to monitor illegal burning. Furthermore, individual farmers signed liability assurance. These measures were effective in implementing a 100% in situ straw utilization plan [10].
The Policies for Straw Converses Biomass Energy in China and Discussion

Obstacles in wide spread and commercialized straw utilization include availability and accessibility of the straw market to regular farmers, feasibility of straw utilization technology in the field, implementation of policies, and enforcement of regulations.

In 1997 and 1998, the Ministry of Agriculture issued three notices about stalk burning; in 1999-2012, the Ministry of Environmental Protection issued nine notices about stalk burning, from the keywords of documents, such as the "forbidden", "strengthen", "emergency", which can feel the urgency of the stalk burning work. In 1999-2004, the state constraints and controls the burning behavior of straw from the legal level, the utilization of straw has been encouraged and supported by the policy. Due to the beginning of migrant workers in cities, leading to the shortage of rural labor, and a large number of straw can’t be collected. Owing to lack of supervision, straw burning phenomenon is still serious and many farmers are the lack of awareness of straw utilization. In 2005-2009, the ways of straw utilization are broadening, technology level obviously improved and comprehensive benefit significantly increased. But policy support is insufficient, lack of funding, such as: high efficiency, clean and wide application of special straw briquette stove without purchase subsidy, the industrialization degree is low, insufficient supporting ability of science and technology. From 2010 to 2015, under the related policies, straw burning has fallen nationally and chinese straw energy industry has rapidly developed, straw gasification, straw curing molding, straw power generation have reached a certain scale. At present, some problems are still existing, such as: there are small and scattered the project of comprehensive utilization of straw which has not been supported, lack of effective economic policies that will enable the vast number of farmers and enterprises "win-win", we can see that Chinese policy encourages the straw market need to be improved.

Cases Analysis

Crop Presentation in Beijing-Tianjin-Hebei

We counted the output of main grain and straw in B-T-H region from 1986 to 2014[11,12]. We combine with crop stubble height to calculate available collection and utilization coefficient, including: rice, wheat, corn, beans coefficient were 0.78, 0.76, 0.95, 0.56 [13]. Eq. 1 is as follows:

\[ Ti = Ai \times Ji \]  

Ti: the number of straw can be collected and utilized, unit: million tons  
Ai: the straw can be collected and utilized coefficient, dimensionless  
Ji: This kind of crop straw yield, unit: million tons.

In 1986-2014, the yield of straw in Hebei shows a rising trend, and Beijing and Tianjin presents small fluctuations. The total yield of straw shows a downward trend in 1999-2004, because China started to implement the strategic adjustment of agricultural structure after 1998. In 2005-2014, the yield of straw to resume rising trend in Hebei and Tianjin. The production of straw has declined year by year in Beijing, which is due to the Beijing local agricultural structure adjustment. But from the overall perspective, nearly ten years, the total production of straw in Tianjin and Beijing is only about 8% of Hebei. In order to improve the B-T-H straw
utilization situation, we can take advantage of technology and financing in Beijing and Tianjin to improve the straw utilization in Hebei. (See Fig. 1, B-T-H straw yield in 1986-2014).

![Figure 1. B-T-H straw yield trend figure in 1986-2014 unit: million tons.](image)

**Utilization of Straw in Biomass Energy**

With the accelerated process of integration of Beijing, Tianjin, Hebei, the problems of environmental pollution and energy shortage need to be resolved. Straw as an important renewable energy should be fully utilized. Many farmers are accustomed to using straw as feed and fertilizer, but if the straw is converted into biomass energy, which not only improves the utilization rate of straw, but also saves non-renewable energy and reduces carbon dioxide and other gas emissions.

Because different crops contain different biochar content, in order to accurately estimate biological carbon sequestration, this paper calculates the number of the straw can be collected and utilized in B-T-H. In order to quantify the benefits of the comprehensive utilization of straw, this paper calculates the number of biological carbon sequestration (abbreviation: BCS), the total amount of transforming standard coal (abbreviation: TSC) and the total amount of reducing soot particles (abbreviation: RSP). (See Table 1 in 2005 -2014 the contribution of transforming biomass energy in B-T-H).

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<td>2005</td>
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<td>3068</td>
<td>577</td>
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<td>2006</td>
<td>232</td>
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<td>3328</td>
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<td>2007</td>
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<td>2008</td>
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<td>2010</td>
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Carbon sequestration rate of rice, wheat, corn, beans is 18.38%, 19.94%, 18.13%, 18.53%[14]. Conversion rate of standard coal: 0.5, emission rate of soot particle: 0.0021.
In recent ten years, the total production of straw was increased year by year in B-T-H, and the yield of wheat and corn is much higher than the others. We combine with the characteristics of wheat and corn, so improve the rate of wheat and corn straw utilization is the key to improve straw utilization rate of three provinces, if turn straw into biomass energy, it can not only save a lot of energy and increase the amount of carbon sequestration ,but also reduce soot particles significantly. Beijing did not find out straw burning point in 2014. The comprehensive utilization rate could achieve 95% in Beijing, and the rate in Tianjin is 90%. The total amount of straw output in both Beijing and Tianjin can take 8% of Hebei output. We need to improve the Hebei comprehensive utilization of straw, which is the key method to control the current situation of air pollution in Beijing, Tianjin, Hebei. In recent years, the utilization rate of straw in Hebei remained over 70% [15], however the utilization rate was 84.4% in 2014.

Suggestions

In order to improve the utilization rate of straw and reduce air pollution from straw burning, there are several suggestions analyzed from four aspects including, government support in infrastructure for straw storage and processing, as well as in promoting biomass stoves, trading market, rewards and punishment system.

Finical support. Farmers are more likely to purchase biomass stoves with a lower price tag. The lost revenue for the manufacture should be subject to government subsides. Transportation of straw is costly due to high volume and high density. Therefore government subsidies in fuel and toll costs could entice enterprises to buy straw from farmers, which will in turn speed up the industrialization of straw utilization [16]. Government fund should help in construction of large and medium-sized straw storage stations, with modem technology to ensure continuous supply with decent quality. Another area the government shall support is the establishment and operation of quality and price control system.

Long-term voluntary carbon trading. The use of biomass stove reduces emission of greenhouse gas and other air pollutants. Therefore, rural household biomass stove could be developed as a carbon sequestration project, and trade on the voluntary carbon market. Companies, governmental sector, non-governmental organizations and individuals should be encourage to carry out various forms of compensation for their emission of greenhouse gases [17]. The resultant carbon credits could be used to continuously subsidize the manufactories and users of the biomass stove. We recommend a pilot project being carried out in the BTH region, to set a quota for the voluntary carbon trade, and to give priority to clean stoves and biofuels including straw briquette.

Establishing an effective education, incentive and punishment framework. No program would work well if it puts the government against the farmers. The goal is to make famers realize that the government is helping them in the transformation to clean energy in rural areas and a healthy and environmentally friendly life style. Education programs alone are not enough to achieve a radical reduction in straw burning. A reporting system of burning ban violation should be improved and each case should be investigated. Furthermore, enforcement of laws and regulations should be monitored. In addition to effective incentive mechanism, some voluntary agreements are also likely to be endorsed by farmers [18].
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References

[1] Information on http://www.360.li/zixun/xk2dr1x51102n425003489.html
