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The utilization of straw resources in China

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ABSTRACT

The increased energy requirements coupled with seriously environmental pollution have turned the attention of people towards renewable energy. The utilization of straw has received great attention in recent years due to its regeneration and environmentally friendliness. This paper introduces the current utilization of straw in China, analyses the problems and gives the suggestions about effectively using straw.

KEYWORDS

Straw resources;
China;
Utilization.

INTRODUCTION

With the sharply increasing of population and growth of economy, the environment problems in China are becoming increasingly acute. Since January 9, 2013, the central and eastern regions have a serious air pollution problem, and Beijing firstly issuesa haze "Code Orange" alert warning on January 13th in history. Currently, the problems of energy and environment are large obstacles to thedevelopment of economy and society in China. Many studiesindicate that the coal-dominated energy consumption structure in China is mainly responsible for environmental degradation. The production and utilization of conventional energy sources, predominantly oil and coal, have a negative impact on environment. Energy is essential to both economy and society. However, the increased demands for energy coupled with the deterioration of the environment have turned the attention of people towards renewable energy. Therefore, to develop and use new energy sources have become the focus of attention.

Among various new energy resources, biomass energy is a renewable carbon source and can replace fossil fuels directly. It can also serve as a feedstock to be converted to various liquid or gas fuels. Currently, China faces the problems of energy shortages, environmental pollution and the slow increase of peasants' income; however, the bioenergy industry can solve these problems simultaneously. Based on its regeneration, cleaning and environmentally friendliness, biomass energy has recognized as a vital source of renewable energy in many countries. The development of bioenergy industry is heavy reliance on a stable feedstock supply. However, the traditional feedstock for production is the first-generation feedstock derived from starch crops and sugar, which invariably poses a significant threat to food security. Therefore, the utilization of non-edible feedstockis theonly way to develop the bioenergy industry.

The crops strawis the byproduct in the process of agricultural production, but it is a valuableresource with various uses. Except for returned to the field, feed, base material for edible mushrooms in the process of agricultural production, the crops straw is the feedstock of handicrafts, biofuels and so on. The comprehensive uti-

lization of straw can reduce the use of fossil energy and promote farmers'income. Moreover, the straw industrycan also create employment opportunities in rural areas. China is a country with the most abundant straw resources in the world. According to the report of straw resource of the Chinese Ministry of Agriculture[1], the theoretical amount of straw resource in China is 0.82 billion ton. However, the utilization of straw in China is relative backwardness, which causes a vast waste of straw resource and serious air pollution. The effective use of straw is related to soil fertility, soil conservation, environmental safety and efficient utilization of renewable resources of the whole agricultural[3]. This paper presents the utilization of straw in China.

THE CURRENT SITUATION OF THE UTILIZATION OF STRAW RESOURCES IN CHINA

The economic growth coupled with increased demands for energy led to energy security of China. Straw is the fourth biggest energy, only next to coal, petroleum and natural gas. It can substitute coal for generating power and also be converted to bioethanol and biodiesel by thermochemical, physical or microbial conversion. The traditional way there to utilize straw is through direct combustion in the kitchens, which not only result in low combustionefficiency (10%), but involves strenuous labor and insalubrities[5]. However, the utilization of straw energy with high efficiency and rationality not only meets the demands for energy as the economy grows, but also provide a basis for environmental protection and sustainable development of society China.

The effective utilization of straw resources can reduce pollution, which is useful to solve the problem of straw as waste to be burned. In comparison with fossil fuels, using straw resources can reduce the quantity of carbon dioxide and sulfur dioxide in energy consumption and mitigate atmosphere pollution. Though the dominant position of fossil fuels is not likely to be changed in a short term, the utilization of straw resources is expected to effect a sharp reduction in the emission of pollutants.

The straw used for field restoration, which is beneficial for improving organic matter, nutrients structure and moisture content of soil, can raise the productivity of agriculture. Currently, the crop straw output of China is more than 0.82 billion ton, which contains more that 4.6 million ton nitrogen, about 11 million ton calcium, other organic matter and microelement. Thus, returned straw to field is a vital measure to improve agricultural production level.

Food supply safety is an important issue for china. Therefore, the development of animal agriculture, dominated byherbivorous livestock, is a good choice. There is not much likelihood that the carrying capacity of natural grassland will furtherincreased based on the condition we are in. Using straw to raise the livestock can handle this problem.

The effective utilization of straw resources is the ecological project to achieve sustainable development of agriculture which can ease the press of overgrazing and decrease tree consumption. It also helpful to protect vegetation and play an important role in consolidating the outcome of biological environmental construction.

In many rural an area of China, straw is considered to be a valuable resource, which can be used as household fuel, feed for livestock, fertilizer and base material for edible mushrooms. However, with the change of the mode of agricultural production and increase of peasants' Income, the structure of rural energy consumption has also changed. Since the diversification of development on rural energy consumption, enormous straw resources were burned or discarded. Although burning in fields is prohibited byenvironmental protection restrictions, the straw burned directly in the field accounted for 31.1% of the total collectable volume.

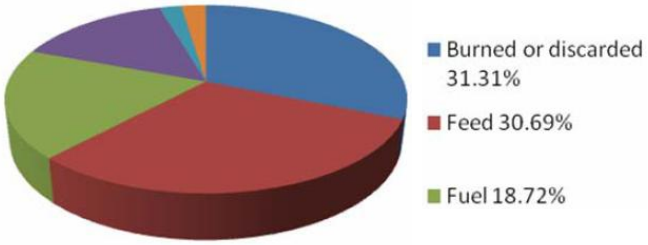

Figure 1 : The proportion different usage in total collectable volume

As a valuableresources and primary byproduct in agricultural production, the effective utilization of straw resources involves energy circulation in the agricultural production system. Meanwhile, it also relates to soil fertility, soil conservation, and environmental safety of the whole agricultural ecosystem. Thus, the utilization

of straw resources is necessary for the sustainable development of agriculture and rural economy.

The crop straw, with abundant organic matter, nitrogen,phosphorous, potassium and microelement, is an important organic fertilizer in agricultural production. Straw returned to the field shows remarkable water, fertility and yield-increasing efficiencies: mulching can add water use efficiencies by 10%, 50% ~ 60%straw returned to the field of wheat-maize double cropping system can keep soil nutrient balance; straw returnedto the field can lead to crop yield increase by 10% and fruit yield increase by 20%[4]. Straw organic fertilizer can raise the productivity of the soil and sustainable development of agriculture. TABLE 1 show the organic matter of different crop straw[2].

TABLE 1 : The organic component of different straws (Mass fraction, %)

Organic ingredient	N	P	K	Ca	Mg	Na	Si
Rice straw	0.60	0.12	1.00	0.14	0.12	0.02	7.99
Wheat straw	0.50	0.20	0.73	0.14	0.02	0.003	3.95
Corn stalk	0.60	1.40	0.90	0.39	0.26	-	-
Soybean straw	1.93	0.26	1.55	-	-	-	-
Rape straw	0.56	0.50	0.50	0.42	0.05	0.004	0.18

The straw could be used for field restoration in two ways, one is direct field restoration which shattered directly and restored in the soil or in an original way without cultivation, the other way is through animal excreta and its byproducts[3]. Nowadays the direct field restoration is the most popular way in China. The area of field restoration of residual was 3.58 billionhectare, which account for 15.3% of total sown area in China during 2009. The field restoration quantity of straw was 0.12 billion ton, and Henan, Hebe and Shandong provinces are of the most direct restoration quantity.

The straw contains various nutrient sources for cultivate livestock, which nutritive value is equal toonequarter of crops. The nutritive value of 6kg silage straw or 4kg ammoniated strawis tantamount to 1kg crop. For instance, there contains more than 30% carbohydrate, 2%-4% protein and 0.5%-1% fat in corn stalk. The straw for feeding was more than 0.21 billion ton in China during 2009. The utilization ratio of straw by ensiling and ammoniating is 44%. Since 1992, Chinese Ministry of Agriculture launched strategies for the project in popularizing the technologyof ensiling and ammoniating straw. The project had built 6.67 million cubic metersammonition silo,purchased forty-nine thousand straw treatment orsmall feed-processing machines[1]. Some kind of straw is unsuitable for direct feeding due to bad palatability and lower digestibility, such as rice hull and corn cob. However, most crops straw can be converting to high quality feed after processing.

The straw composed of carbohydrate compounds, which are determined as the elements of carbon, hydrogen and oxygen and possea high energy content. The calorific value of 2kg straw is equal to 1kg standard coal. Currently, main utilization of straw in energy in China is: direct combustion; biogas; straw power generation; gasification, liquefaction and briquette.

Direct combustion is the traditional way of the utilization of straw. Though the structure of rural energy has changed, straw is still one of the fuels in rural. Currently, straw power generation has achieved prodigious development. For instance, by the end o f 2009, Jiangsu province has 12 grids straw power plants and Henan province has 16. The straw power plants in Henan province consumed 2.92 million ton straw resources during 2009, which accounts for 3.52% of the total volume.

The straw, which contains various nutrient sources, is suitable for the cultivation of edible mushrooms. The total production of Edible fungi is 18 million ton, which consumes 15 million ton straw during 2009 in China.

THE PROBLEMS IN THE UTILIZATION OF STRAW IN CHINA

Currently, there still exists many problems in the utilization of straw resources in China, such as insufficiency of comprehensive utilization and unreasonable of utilization structure. The comprehensive utilization rate of straw is low and technology is immature. For instance, the biofuel production from the straw is not economically feasible because of high cost. The problem of straw waste gas and burning are serious in some rural places which invariably led to a negative impact on atmosphere and the life of people in rural areas. Due to the influence of the traditional management mode, some peasants accustomed to directly burning straw in the field. The lack of propagandaalso led to lower cognitive level.

Thus, straw burning will be a social problem in long term of China. The utilization of straw resources as energy is heavy reliance on direct combustion; however, the quantity of straw for new energy exploiter is very limited. For example, the quantity for straw gasification, carbonization, liquefaction and power generation is rarely in comparison with burning directly. On the other hand, some renewable energy projects have the problems of over-investment and excessive competition. The utilization amount of straw outside the economic system in rural is not high and the development of straw industrialization is still in its infantstage, which led to the lower comprehensive utilization ratio of straw resources.

CONCLUSION AND SUGGESTION

The straw resources should used in high-efficient, which has a positive impact on the development of agriculture and rural economy. The phenomenon of straw as waste to be burned or discarded must be prohibited. The amount of utilization in low-efficient ought togradually reduce, such as directly combustion in kitchen. The principle of the utilization of straw is recycling and environmental friendliness. According to the local condition, local government should make reasonable and comprehensive plan to avoid repeat construction and unnecessary competition.

The sustainable development of agriculture is fundamental of economic growth in China. Therefore, the utilization of straw resources should satisfy the need of agricultural production. Since returning straw to field can add soil nutrient, fertilize land productivity, the amount of straw returned to field, which by mean of scientific evaluation, must be ensure. On the other hand, the peasant' income is highly related to the rural economy and living standard. Livestock breeding and edible fungi can increase the income of peasants. According to the local condition, the animal husbandry and cultivation of edible fungi using straw resources as base material should be supported.

Biogas technology is widely adopted in some places in China. In the future, China government could insist on encouraging farmers to build biogas digester self-fund with a part of collective subsidy. The government should actively support the study of new technologies and new products. Some new pattern, such as "Pig-Biogas-Fruit", or "Pig-Biomass-vegetable" could extend to more places with suitable condition.

In the short term, the traditional way of directly combustion of straw will be still exist in rural places. Currently, the utilization of inefficient stoves causes many environmental problems in rural areas of China. Thus, improving efficiency is an effective way to solve the problem. In comparison with conventional stoves, the efficiency of improved stoves is relatively high. The government should support the farmers to build new improved stoves; meanwhile, foreign advanced technologies could be introduced.

As a valuable resource, the utilization of straw outside economic system in rural society will have a room of development. The utilization of straw in biomass energy has external effects, since straw resources is renewableand environmental friendliness in comparison with fossil fuels. The government should promote the study of key technologies of efficient utilization of straw in biomass energy, such as liquefaction, gasification and power generation to reduce the cost of production. Meanwhile, the plan of new energy should be reasonable programming to avoid waste and necessary competition.

Straw can also be used as industrial raw material, such as building materials, packing material and papermaking. The industry of processing straw with clean technology should be supported by policy.

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