

China is an agricultural country with 5 billion organic waste production. A large amount of untreated agricultural waste performs seriously negative effects on the rural living environment and becoming a major source of pollution in China's agriculture. According to <Environmental Science Dictionary>, agricultural waste is divided into four categories: (1) agricultural production waste, such as crop straw (more than two-thirds of agricultural production waste), residues, weeds, fallen leaves, fruit shells, vines and branches in farmland and orchards, etc.; (2) agro-processing waste; (3) livestock waste, including manure; (4) human excrement and urine as well as domestic waste^[1]. The <Agricultural Dictionary> defines agricultural waste as the general term for waste discharged by agricultural production, agro-processing, livestock and poultry farming, and rural residents' daily life^[2].

According to the survey data, annual agricultural waste output is gradually increasing in China, with obvious regional differences. In terms of planting industry, the comprehensive utilization rate of agricultural waste of major grain-producing areas reached over 90% in eastern China^[3]. Thirteen crop-producing provinces and regions in China, including Heilongjiang, Jilin, Liaoning, Henan, Hebei, Hunan and Hubei, account for about 1/3 of the total amount of agricultural waste (1 billion tons), with a comprehensive utilization rate about 72%. The amount of livestock and poultry waste of the thirteen provinces accounts for about 1/4 of the total amount in China (3.9 billion tons), and the comprehensive utilization rate is around 83%^[4]. On the whole, the annual agricultural waste of straw is nearly 900 million tons, with a utilization rate about 75%^[5,6]. Among them, the proportion of crop straw as feed is about 30%, and most of the rest are utilized by returning to the field and composting of straw^[3]. According to the data of the ministry of agriculture, the annual output of livestock and poultry waste in China is about 3.8 billion tons, but the comprehensive utilization rate is only about 55%^[3,7], which mainly relies on biogas project and fertilizer treatment to realize the local consumption of livestock and poultry waste. Most of the rural domestic waste is not managed, and less than 20% of the garbage is collected, transported, and disposed^[5,8,9].

Agricultural waste is a misplaced resource. If biogas produced by medium-temperature anaerobic fermentation is adopted to realize resource utilization of crop straw and manure, the theoretical gas yield of agricultural waste generated in China in 2009 is about 58.3675 billion m³, equivalent to 414 million tons of standard coal^[10]. Harmless treatment and resource utilization of agricultural wastes can effectively solve the problem of agricultural environmental pollution. And it is conducive to the development of circular economy and the realization of sustainable development of agriculture^[11].

Table 1 Summary of agricultural waste in China

Type	Typical residue	Total amount	Comprehensive utilization rate
Agricultural production waste	Crop straw	900 million tons	75%
Agro-processing waste	Starch manufacturing industry waste	3.3 million tons	—
	Sugar manufacturing industry waste	30 million tons	—
	Grain and oil processing industry waste	60 million tons	—

	Brewing industry waste	35 million tons	—
	Livestock and poultry processing waste	—	—
Livestock breeding waste	Livestock and poultry manure	3800 million tons	55%
Rural domestic waste	Rural domestic waste	300 million tons	30%