Photo: Bo Ling

Safe use of treated night soil

Human excreta, or night soil, has been used in China to fertilise crops and feed fish for thousands of years. Presently, some 164.25 million tonnes of night soil are produced every year by 300 million people in 479 cities. After a period of disinterest, night soil again gets the attention it deserves, being a valuable resource rather than a contaminant. However, to make safe handling possible, treatment of the raw night soil is necessary.

Bo Ling

Before 1979, urban night soil was cleared away jointly by farmers and environmental sanitation bodies. It was fermented in small-scale storage tanks in the rural areas. It could be applied to the farmland directly when needed. Sometimes, night soil was used together with urban domestic waste, which was transported to the rural areas too. After mixing both materials simple piles were made for composting.

In 1979 a drastic change of the rural economic system took place. The community system was replaced by the family responsibility system. This made it difficult for individuals to collect and transport night soil from cities. At a certain time, farmers also did not like to use night soil to fertilise their land. Especially the young generation preferred to use newly introduced chemical fertilisers to improve their living standard and working conditions. Hence, in some cities night soil had to be disposed of through sewers and this caused to environmental pollution. In recent years, as prices for vegetables and commercial fertiliser rose and the market remained stable, farmers became motivated to use night soil again. Also, farmers recognise more and more the advantages of using treated night soil in farm lands or fish ponds. But for sanitary reasons, the State now demands that night soil is treated before application.

Economic effects

Roughly estimated, at least 800 million kg nitrogen, 400 million kg phosphate and 500 million kg potash can be annually acquired from night soil produced in urban areas. This is equivalent to some 4 million tonnes of commercial fertiliser, which is about 4% of all commercial fertiliser used throughout the country. Some 30% of urban night soil and 2.6% of city waste are presently utilized. This means that still some 3 million tonnes of chemical fertiliser could be replaced if all night soil and urban waste were used. The reuse of night soil is officially stimulated by extension. Sanitation departments of local governments are responsible to collect and transport night soil from toilets to storage tanks located in the suburbs. All fees, 1.8 yuan per tonne-km, including labour, and costs of vehicle and gasoline are paid by local governments. Farmers pay 12 yuan per tonne and transport from storage tanks to farmland at an average cost of 0.2 yuan per tonne-km (1 US$ = 8.6 yuan). The price of commercial fertiliser is much higher (urea 1,400 yuan/tonne; Ammonia phosphate 2,500 yuan/tonne). Collecting, transporting and processing night soil is not very convenient and it takes much time as compared to handling commercial fertiliser. Statistics show that if 200-500 kg/mu (1 ha = 15 mu) night soil and 80 kg/mu commercial fertiliser (20-20-20) were used instead of 100 kg/mu commercial fertiliser, rice production could increase with 15 kg/mu, wheat with 30 kg/mu, high-quality onions by 20% and grape can reach 2000-2500 kg/mu. This will be profitable as long as transport distances are not too long.

Health effects

Night soil contains various kinds of pathogenetic bacteria, virus and parasitic ova, such as the pathogen of typhoid, dysentery, hepatitis A, poliomyelitis, schistosomiasis, anchylostomiasis and ascariasis. Therefore, a potential health risk exists in the practice of reusing excreta. In fact, excreta-related diseases, such as intestinal infectious diseases and parasitosis are very common in the countryside. For example, in the spring of 1988, hepatitis A struck approximately 2 million people in Shanghai, who had eaten shellfish con-

The construction site of a family size biogas digester in villages.

taminated by night soil. At present, diarrhoeic infectious disease accounts for over 70% of all kinds of infectious diseases. The number of typhoid cases surpasses 100,000 per year. About 490 million people have caught ascariasis, and 200 million have anchylostomiasis. Schistosomiasis is now reappearing in areas previously under control, especially in Hubei and Hunan provinces and a total of 1.5 million people have been affected.

Treatment of night soil

In order to prevent diseases, raise fertilising efficiency and protect the environment, night soil management and treatment are particularly important. In the past 20 years, several night soil treatment facilities have been built. Since the launching of the national campaign to become "Sanitary City", which means that a city has facilities such as running water, toilets, septic tanks, sewer systems as well as collection, transportation and treatment/disposal of night soil and city waste, this work has developed considerably. However, on the whole, urban night soil treatment is still in the primary stage and treatment coverage is very low. A sound system has not yet been developed and treatment processes has not been standardised. Treatment processes include mixed composting, ferment fertiliser manufacturing, storage tanks and biogas digesters.

Mixed composting. After pre-treatment, domestic waste is mixed with night soil for co-composting in windrows. Night soil can improve the fertilising quality of domestic waste by adjusting the compost humidity. When the compost temperature rises, most bacteria and worm eggs in the night soil will be killed. However, with this method only small amounts of night soil can be treated. Especially in the rain-ridden areas of the south, this method of treatment is difficult.

Ferment fertiliser-manufacturing. In some cities, after de-watering, night soil is mixed with waste or crop straw. Then, anaerobic fermenting takes place in containers during 20 days. After drying, the product is granulated, packed and sold to farmers. As it is easy to transport, farmers welcome it.

Storage tanks. Large storage tanks, 1,000 m3, have been built in Shanghai, Yantai, Chengde, Hefei, Qingdao, etc. for preliminary treatment of night soil and biogas production. The storage period is usually 2-3 months. Moderate-temperature ferment treatment is used in Qinhdao. It can achieve satisfying sanitary effects in a relatively short time, but costs a lot of energy. Normal-temperature anaerobic ferment treatment is used in Yantai. This saves energy and has good sanitation effects too.

Biogas digesting. The application of biogas technology in China dates back to the early 1950s, when electricity was not available in rural areas. But it did not last very long due to lack of experience in constructing and maintaining biogas digesters. Since the 1970s, the development of biogas digesters has entered a new phase. Numerous biogas digesters have been built throughout the country. Today, there are 6.5 million family-size digesters serving 3.8% of China's population. A preliminary target of some 20 million biogas digesters and 10,000 electricity generating stations based on biogas has been set. This would supply about 5% of total household energy in near future. The family digester is always connected with the latrine and the pigsty. Human excreta, pig dung, cowdung and crop residues are the main raw materials used as feed stock. For methane production, in volume as well as speed, human excreta are the best among various feed stock. The biogas digester, as a separate treatment method, is more suitable to be used in small townships and villages.

Although there are still many technical problems to be solved, appropriate technology of night soil treatment can provide a safe perspective for re-using night soil in agriculture and aquaculture. ■

Photo: Bo Ling.

A pilot plant for treatment of night soil with anaerobic digestion, a biostabilization pond / fish pond.

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Farmers of forty centuries

"One of the most remarkable agricultural practices adopted by any civilized people is the centuries long and wellnigh universal conservation of all human waste in China, Korea and Japan and its utilisation in the maintenance of soil fertility and the production of food. From the analyses of mixed human excreta made by Wolff in Europe and by Kellner in Japan, it appears that, as an average, these carry in every 2,000 pounds 12.7 pounds of nitrogen, 4.4 pounds of potassium and 1.7 pounds of phosphorus. In 1908 the city of Shanghai sold to one Chinese contractor for $31,000, gold, the privilege of collecting 78,000 tons of human waste, and of removing it to the fields. The storage of such [human] waste in China is largely in stoneware receptacles, which are hard-burned, glazed terra-cotta urns, having capacities ranging from 500 to 1,000 pounds.

Nowhere in the Shantung province, nor further north, did we see the large terra-cotta receptacles so extensively used in the south for storing human excreta. In these drier climates some method of dessication is practised. The greatest pains are taken, both in reducing the product to a fine powder and in spreading and incorporating it with the soil, for one of the maxims of soil management is to make each square foot of field or garden the equal of every other in its power to produce. In this manner each little holding is made to yield the highest possible under the conditions the husbandman is able to control.

It was on Honam Island that we saw fields, which had matured two crops of rice during the long summer, had been thrown into strong ridges to permit still a third winter crop of some vegetable to be taken from the land. There was abundant evidence of the most careful attention and laborious effort devoted to plant feeding. We saw a boat which had come from Canton in the early morning with two tons of human manure and men were busy applying it, in diluted form, to beds of leeks at the rate of 16,000 gallons per acre. They have other methods of 'manuring the soil'. Large amounts of canal mud are collected in boats, brought to the fields to be treated and left there to drain and dry before distributing. Both the material used to feed the crop and that used for manuring the land are waste products, hindrances to the industry of the region, but the Chinese make them do essential duty in maintaining its life. Human waste must be disposed of. We turn it into the sea. They return it to the soil.

Professor F.H. King, from University of Wisconsin, USA and chief of the department of Soil Management travelled early this century to China, Japan and Korea and wrote the book "Farmers of forty centuries" with over 200 pictures on the agricultural practices. First published in 1926.