THE PRACTICE, PROBLEM, AND STRATEGY OF ECOLOGICAL SANITARY TOILETS WITH URINE DIVERSION IN CHINA

Liu Jiayi, National Patriotic Health Campaign Committee Office, Beijing
Wang Junqi, Institute of Environmental Health and Engineering, Chinese Academy of Preventive Medicine, Beijing

Background

A sanitation system is a basic necessity in modern life and excretion is a normal physiological process. At present, the Chinese Government has given rural sanitation top priority: it requires intensified efforts from government at all levels for the achievement of the National Programme of Action (NPA) goals. The safe disposal of excreta is emphasized.

China is an agricultural county with a rural population 954 million (1999) or 75.7% of the total population. Parts of the country suffer severe water shortages and flush toilets are not suitable.

Safe disposal of human excreta is one of the key measures for the control infectious diseases. In order to improve children's development status, besides the nutritional factor, non-hazardous disposal of human excreta is of utmost importance. About 5 million children in the world and 30,000 children in China under 5 years of age are die from diarrhoeal diseases every year. There are an estimated 1.5 billion people in the world and 500 million in China infected by *Ascarisis lumbricoides*. The rate of ascarisis infection in children in China is 44.9% and it is estimated that about 190 million children under 14 years of age suffered from such parasitosis. The infectious rate of ancylostomiasis in children under 14 is 5.4% or 40 million. The infectious rate of tuichurasis in children is 12.6%, or 70 (a female worm excretes 0.2-3 million zygotes per day). Schistosomiasis is prevalent in 119 counties. There are 660,000 cases of dysentery, many thousand cases of cholera, 190,000 cases of hepatitis A and 2,000 cases of hepatitis E in the county every year. The national baseline survey of 1993 indicates that the ruralcoverage of household toilets is 87.5%, and that only 7.5% of these could be considerd sanitary. According to the statistical data in 2000 the proportion of households with sanitary toilets in rural area increased to 44.8%.

The use of human excreta as a manure in China has a long history. The rate of human excreta utilization is 93.7%. The 1.3 billion people in the country produce 1.95 million tons per day. Each year some 490 million tons of human excreta are applied to the soil without any treatment. In such a situation the complete control of enteric diseases in China is not possible.

At present the types of sanitary toilets used in rural areas of China are the 3 compartment double urn toilet, the biogas toilet and the ventilated improved pit toilet (VIP). These three types cannot meet the requirements of many households. There is a need to develop other types of toilets and sanitation systems.

Practice

The Chinese Ministry of Health, UNICEF’s China office and the Swedish International Development Coopertation Agency (Sida) have jointly carried out a research and development project aimed at testing sanitation systems based on urine-diverting toilets. The project has been directed by the National Patriotic Health

Campaign Committee Office (NPHCCO) and the Institute of Environmental Health and Engineering, Chinese Academy of Preventive Medicine has been in charge of implementation together with related departments of Jilin and Shanxi Provinces and Guangxi Zhuang Autonomous Region. One pilot project was built in each of these three areas. The toilets were built between 1997 and 1999.

In 2000, the project was extended to the provinces of Shandong, Guangdong, Sichuan, Anhui, Guizhou, Qinhai and Shanxi. At each site 300 toilets were built. The project has since been extended to the Inner Mongolia and Xinjiang Uygur Autonomous Regions. In these autonomous regions there are now more than 10 manufacturers of toilet utensils. By now tens of thousands of eco-san toilets have been built in one-third of China's provinces and autonomous regions.

Results

Table 1: The period (days) of attainment of non-hazardous disposal of human excreta by means of various covering materials

Covering material	Faecal coliforms (conform to the National Standard)	Ascaris eggs (conform to the National Standard)	Phages (absent)
Plant ash	33	55	75
Coal ash	214	214	303
Saw dust (or corn husk)	250	250	250
Mud or Soil	250	303	250

The results show that the pH of the faecal material increases after plant ash is added. The requirements of hygienic standard for faecal coliforms, ascaris eggs and phages can be achieved within two and half months. The persistence of faecal microorganism is normally enhanced during cold or temperate environmental conditions. The other covering materials, such as coal ash, sawdust (or corn husks) and soil do not achieve the same effect as plant ash. The data indicate that to achieve the same effect in terms of pathogen destruction, the coal ash, sawdust and soil need 210, 250 and 303 days respectively. Therefore, plant ash is the best covering material for this purpose.

If a certain proportion of quick lime is mixed with coal ash or soil the mixture can be as effective as plant ash. However, the soil of farmlands need only a limited amount of additional lime. For the sanitary treatment of human excreta it is therefore only recommended in disaster conditions.

Table 2: Retention period for non-hazardous disposal of human excreta based on household sanitary toilet store experiments

Province or Autonomous Region	Retention period (days)	Faecal coliform (decrease of log value)	Ascaris eggs (% of died eggs)	Phages (Salmonella phage 28B decrease of log value)
Guangxi	0	0	5-6	Not available
	20	6-7	18-52	Not available
	74	6-7	66-73	Not available
	150	7-8	95-97	Not available
Shanxi	0	0	5-6	0

	20	2-3	17-37	0
	85	5-6	53-85	1
	147	5-7	78-87	2-3
	195	6-8	96-99	5
Jilin	0	0	5-6	0
	24	1	32	0
	84	1-3	23-32	0-1
	206	6	33-69	5
	262	6-7	69-73	5-6
	322	8	97-99	7

Table 3: Results of laboratory examination on apply 29 household sanitary to practicein three provinces and autonomous regions

Numbers of toilets	Feacal coliforms (cfu/kg)	PH	Moisture(%)	Remarks
6	$N\times10^{7\text{-}10}$	9.0-10.2	51.82-67.15	Too little ash
2	$N\times10^{5}$	8.0-8.3	27.68-28.35	Inadequate covering with crude and coarse ash granules
3	$N\times10^{4\text{-}6}$	8.4-9.1	26.30-51.07	Inadequate covering with crude and coarse ash granules
10	$<N\times10^{3}$	9.1-10.0	15.15-35.35	Enough ash
4	$N\times10^{3}$	8.1-8.4	25.84-27.17	Enough ash 1year in use
4	<900	7.0-7.1	14.59-21.13	Enough ash 1 year in use

In Guangxi most of the eco-san toilets are located indoors. The drop hole for faeces has a tight-fitting cover. This means reduced evaporation water and the need to add more ash to absorb moisture. Measurements Guangxi show that the faecal coliform values are >0.43 in 52.6% the toilets which means that the die-off effect is satisfactory. Insufficient amounts of plant ash were observed in 42.1% of the toilets, and the death rate of ascaris eggs becomes quite slow under humid conditions. We examined 6 toilets during a period of 151 days. The moisture content in the mixture of faeces and plant ash ranged from 42.5% to 49.9%, and the death rate of ascaris eggs were 62.5%, 70.2%, 67,1%, 69.4% and 64.8%, respectively. We also noted that at least one family member of each of four households are suffering from diarrhoea. The 42.1% of toilets with inadequate addition of plant ash will become the focal point of our work, especially the 26.1% of household toilets wher we observed no change.

Where the humidity in the processing chamber is high, not only is there a slow-down of pathogen destruction but also the breeding of tiny winged insects. Such insects disappeared one month later as more ash was added.

The results of our evaluation of this project indicate that eco-san toilets when properly operated can destroy pathogenic organisms , prevent fly breeding, are odourless, do not contaminat the environment, save water and make possible the recovery of urine and faeces as manure.

We call this type of household toilet “the non-flush, ecological and sanitary toilet with

urine diversion", and affirm it possesses the following advantages:

(1) no need to use water flush;
(2) enables us to treat and recycle urine and faeces separately;
(3) provides an effective, non-polluting fertilizer;
(4) suitable under a range of environmental conditions including areas with severe water shortage and high altitude cold.

Problems

Our study of ecological sanitation toilets with urine diversion in more than ten provinces and cities has identified the following problems:
1. The covering of faeces with ash is an essential requirement for this type toilet. Suitable types of ash are not always available.
2. Ecosan systems may be difficult to apply in cities with high buildings..
3. Many households have no need for fertilizer.
4. Many households raise pigs. The amount of faeces excreted by a pig is about 10 times of that of a person. A pigs faeces and urine cannot be collected separately. Under such circumstances there is no point in providing the household with an ecosan toilet.
5. Climatic conditions: extremely humid climate.

Our conclusion is that to introduce ecological sanitation systems three conditions should be fulfilled: ash should be available, there should be a demand for urine-faeces fertilizer, and there should be no raising of livestock.

Strategy

1. Adapt to local conditions
2. Strengthen the technical competence of the implementors.
3. Propagating the significance of ecosan to human health and the environment.
4. Continue and expand scientific research:
- the application of urine diverting household toilets in urban areas
- the relation between storage and usage of urine and diseases
- devices for automatically or semi-automatically adding
- alternatives to plant ash as cover material
5. Improve not only toilets, but also other aspects of the built environment. Examples: “Liang Guan”(two management: management of water and management of human excreta),
“Wu Gai” (five improvement: improving of water supply, toilet, farm animal pens cooking stove and the environment), planting trees and flowers, hardening the road, sanitizing the garbage, etc.