

# Promoting Source Separation – A Pilot Project for Rural Chinese Communities

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## 1. Background

As an important economic centre in China, Tianjin plays an important role in the nation's sustainable social and economic development. With the rapid increase of rural urbanization, modernistic agriculture has become the powerful driving force of the local social and economic development. Meanwhile, environmental problems within rural areas are the limiting factors that restrict this development and they cannot be ignored. What's worse, the relatively underdeveloped rural waste management system leads to a situation in which the potential resources of garbage and sewage have become the main pollution in the Beijing-Tianjin region. This has not only severely impacted the agricultural product security it has also affected the health of the local people, and poses a serious threat to the environment quality and ecological security of the Bohai Sea region.

Tianjin is populated by 11.76 million people, of which the rural population is 2.41 million. Every year, about 0.7~0.88 million tons of waste is generated, and the domestic sewage generated in rural areas reaches as much as 7.0~10.6 million m<sup>3</sup>. However, the waste disposals designed for urban areas such as filling, burning and sewage treatment have not spread to rural areas, where the waste is mostly piled naturally and filled personally by the people. As a result, huge land resources are occupied, while the sewage treatment rate is less than 20%. The clean rural area is now filling with all kinds of agricultural wastes. Therefore, it is of great ecologic, economic and social profit to build and classify harmless treatment technology for rural wastes, make innovations in domestic sewage treatment technology suitable to the rural area, and form mature treatment technologies for rural wastes and sewage. Then it is expected that the goal of resource saving and pollution minimization will be achieved, and that a win-win situation between agricultural economy and the environment shall finally be realized.

Facing the increasingly severe rural environmental problem, the National Long-and Medium-term Program of Sci-Tech Development Planning clearly specified that "the ecologic and environmental situation in our country is still serious, which restricts the sustainable development of agriculture, while the food security and ecologic safety problems are serious", and lists integrated treatment and the recycling utilization of wastes, the ecologic safety of agriculture and forests, the promotion of recycling agriculture developments and improving the ecologic and environmental quality of agriculture and forests as the primary research subjects of agricultural sci-tech research. Therefore, the implementation of this project is also in conformity

with Tianjin's urban planning goal of building an ecological city.

## **2. Material and Method**

### **2.1 Village information**

Shuigao Zhuang village lies in Xinkou town, Xiqing district. There are 1772 households. The resident population is 4500 with a 1500 floating population. Its total population is 6000. The average temperature is 11.6℃. The temperature is -5.1℃ in January and 26℃ in July. There are 184 non-frost days in one year. The rainfall quantity is 584.6mm and is mostly concentrated during the summer. This village belongs to the plain zone. The altitude is only 5 meters. The soil type is Alluvial Soil. The groundwater level is 2 meters.

### **2.2 Current status for fresh garbage and wastewater**

The average garbage generation rate is about 1.5kg/day per capita. The total of the village is about 10 tons/day. The local industries are mainly vegetable planting and agricultural tourism. There are 30 cleaners and about 10 tricycles working towards the collection of the garbage and its transportation.

The farmers put the fresh garbage into the plastic bags and barrels and then bring it to the storage containers in the street. Every day, the cleaners gather the garbage from these containers according to their route and then carry it to the "landfill". The "landfill" doesn't have any seepage control measures.

The wastewater output is about 600 tons every day. The water body has the characteristics of dispersion, small capacity and a high total content of nitrogen and phosphorus. The wastewaters gather in the pipe net, and then drain to the Ziya River. The wastewater is a major pollution source.

### **2.3 Composition investigation and compost experiments**

The physical, chemistry and microbial parameters of the feedstocks different seasons were investigated. After separation, different experiments on the organic parts of the compost were run in a lab in order to ensure the best fermentation conditions and identify recipes.

### **2.4 Design of experiment**

**2.4.1 The fresh garbage sorting, collection and treatment mode** According to the basic waste data, the first demo zone was established and researched, looking at the system of garbage sorting, collection and treatment. The treatment facility was built up to reduce and reuse the waste material.

**2.4.2 Wastewater treatment** Two patents of the Tianjin Institute of Agricultural Resources and Environmental Engineering for building up the anaerobic and aerobic integrative treatment facility were applied.

### 3. Conclusion and Discussion

#### 3.1 The garbage characteristic

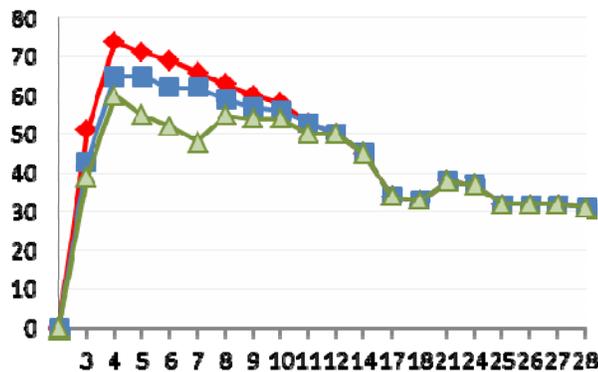
**3.1.1 Analysis of the composing and particle size** The survey showed that compostable material accounts for more than 80% of the waste. Other garbage is mainly plastic bags, which account for more than 8%. 60~80% of the compost is organic matter after passing through 2~5” screen, and 95% when passing through a screen has opening less than 2”.

**Table 1. Garbage constitution in Dec.2010.**

	Plastic bag	paper	Toilet waste	glass	foam	rubber	fabric	Stone, coal ash	Recyclable plastic	metal	Harmful waste	Compost and others
content%	8.33	3.02	2.03	1.92	0.09	0.97	0.81	1.94	0.06	0.13	0.06	80.64

#### 3.1.2 Fermentation experiments

Many experiments showed that in different seasons, according to the material moisture and nutrient content, adjusting the C/N ratio 30:1, the straw length, temperature and other parameters is good for the compost process. The compost system is successfully ready to go to the high temperature phase. During this phase, many kinds of bad microbes are killed. The data table is listed below.



**Fig. 1. Temperature change during composting**

#### 3.2 Project of separation and treatment

##### 3.2.1 Building up the separation demo zone

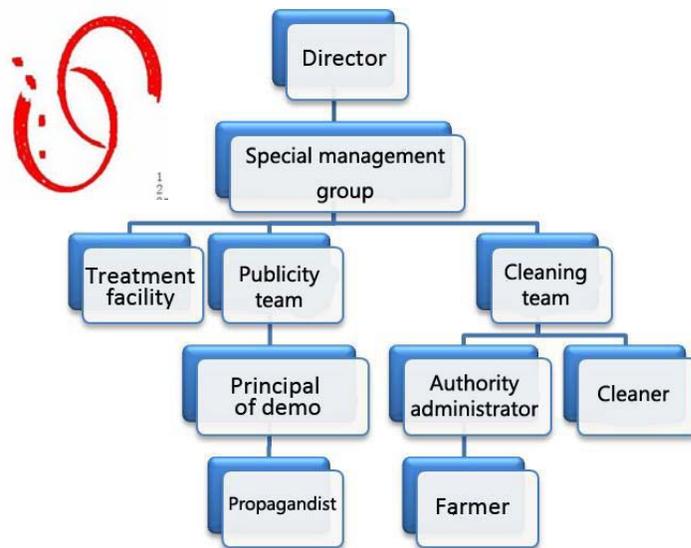
The first demonstration area involved about 180 households, with demonstration areas of 45,000 square meters (about 68 acres). The architectural layout can be described as “four vertical streets and two horizontal avenues”. This area is divided into three blocks, as shown below.



**Fig.2. Distribution of the demonstration households**  
 (Black points are the original location of garbage collection pool )

### 3.2.2 Mode of separation and collection

**3.2.2.1 Systemic organization chart of garbage sorting** To ensure the orderly conduct of the project, the research group and the village committee set up a special management team to further clarify the responsibilities of various departments, they did this through convening the meeting periodically to establish coordination and cooperation amongst the organizations.



**Fig. 3 Organization system**

**3.2.2.2 Mode of garbage separation** According to the former survey and experimental conclusion, and combined with the treatment's technology, household garbage is divided into four categories:

**Compostable:** mainly from the kitchen. Includes food, plants, leaves, coal ash, bumf, animal dejecta, soil, etc.

**Recyclable:** plastics, paper boxes, metal, glass, fabric, maternal and infant supplies, etc.

**Toxic and hazardous compounds:** batteries, light bulbs, pesticides, paints, cosmetic and others.

**Construction waste:** brick, concrete, and others.

### 3.2.2.3 Mode of household garbage collection and transportation

#### (1) Collection : “Two cans, one box”

Each family is allotted two garbage cans :a green one for “compostable” materials and a blue one for the “recyclables”. The streets are allotted two large garbage bins, i.e., “compostable” and “recyclable”, which collect compost and recycled waste separately. A “box” is placed in a street, which is used for poisonous and harmful garbage.

Farmers use “two bags”: one is for packing women and baby garbage, and another one is for poisonous and harmful garbage.



**Fig. 4 Household cans**



**Fig. 5 The box and location**



**Fig. 6 Main street garbage can and location**

**(2) Transportation : “Farmer collection – transportation by villages”**

**① Collection by different kinds.**

**Compostable:** farmers should put their daily compostable waste into the green can, no need to pack it. They should empty them into the green garbage cans that are on the main streets every morning before 8:30.

**Recyclable:** the recyclable garbage is small in quantity and light, so farmers could put them into the blue garbage cans until the garbage can is full. The dumping time is the same as with the compost. In addition, the women and babies’ garbage should be packed separately and put into the recyclable garbage can.

**Toxic and hazardous compounds :** put this kind of garbage into a separate bag. When it has accumulated to the household’s standard, put them into the designated box.

**Construction waste:** when the quantity is large, contact the cleaning team, because this kind of garbage does not often exist.

#### ☑ **Cleaning team**

Two cleaners are responsible for the collection part. One is in charge of transportation. Another one is the driver. At 8:30 every morning, they should put the garbage from six groups, 24 cans, into their tricycle, drive it to the station and clean the surrounding area.

Each Wednesday, at 1:00 PM, they should collect the recyclable garbage, if the quantity is small, they could delay it to Sunday. That is to say, this kind of garbage is only transported one or two times every week.

#### ☑ **Administrator**

We need 3 responsible women, to be in charge of monitoring, management, education, and cleaning the surrounding area.

Management includes: pour out time, separation, dumping place, garbage cans and sanitation.

Implement pay for performance. Reward the higher salary to the woman who is more responsible. The village garbage management team has the right to evaluate the management people, if one can't finish the job, or meet the requests, the team could appoint another.

#### **3.2.2.4 Treatment mode**

After separation, the garbage will be transmitted to the facility to further “compost and compression”.

**Compostable:** transport it to the station, and separate it a second time, then the garbage can be used as compost.

**Recyclable:** as the Xiqing district's “clean project” plan, put the garbage compress truck in the station, when the truck is full go to the nearest landfill.

**Toxic and hazardous compounds:** the town will gather and transport these to the designated companies for disposal.



**Fig. 7. Treatment facility**

### 3.2.3 Popularization and training for garbage sorting

#### (1) Forms of garbage propaganda

Various forms of publicity are used to promote knowledge of universal waste sorting such as drumbeating boards, words and others.



Fig.8 Materials

#### (2) Training

##### ☑ Training for farmers

The training meeting was held in the media room, with the target audience being the leaders, garbage management team members, the clean team, women administrators, farmers, and project team members. They were given brochures and the questionnaire. The training includes how important it is to sort the garbage, how to identify waste types and different implementation methods of waste separation. A Q&A session followed to further promote the understanding of sorting. Have them return the questionnaire when they go out of the room. If some farmers did not participate in the training meeting, the personnel in charge of publicity will make every effort to explain these things to them.



**Fig. 9 Training meeting for farmers**

**② Training for students**

The training meeting for students was held in the school media room. These students are about 10-12 years old. The trainee group of teachers and students made up a total of 100 people. The training content is basically the same as that told to the farmers. The difference is that after training, classes need to implement waste separation, and allow students to start small, developing good habits of waste separation.



**Fig.10 Training for students**

**(3) Promotion**

Teams of 10-20 that work together as a group to advocate the project and to develop training and supervision are formed from the 180 households. Volunteers are picked from these groups to act as management and/or supervision of the cleaning team and public education.



**Fig. 11 Training for administrator and women representatives**

#### **(4) Award**

Measures were taken to buy awards for plastic bags. Villagers could collect 1 kg of plastic bags in exchange for a promotional card from the respective manager. A total of 5 as a reward in exchange for the daily necessities of life can be reached. The plastic bags collected by the administrator are brought to the cleaner and then into the garbage compression vehicle for further treatment.

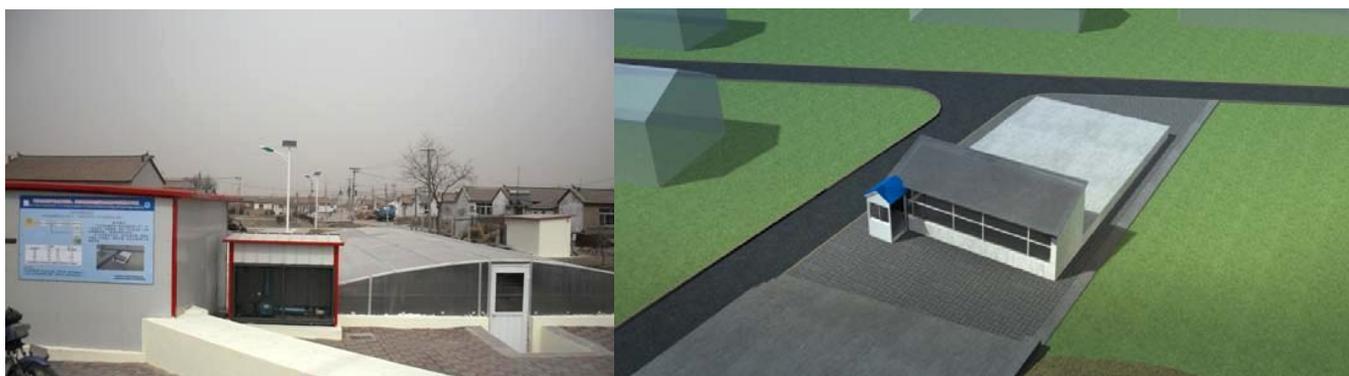
3.2.4 Flow chart for the treatment process



Fig.12 Flow chart

### 3.3 Treatment of the wastewater

The anaerobic and aerobic integrative technology is integrated designing. The investment and cost is very cheap. The facility body is made up of reinforced concrete and has a long life of about 30 years. This facility has many advantages such as stability, less sludge production, easy management, etc. The discharged water meets with the national secondary standard. This facility can treat 100m<sup>3</sup>/d, and occupies an area of 370 m<sup>2</sup>. The building costs only 570,000RMB. The treatment costs only 0.53RMB per ton of wastewater.



**Fig. 13 Wastewater treatment facility**

**Table . The result after the wastewater treated (2011.2.24)**

Unit: mg

L<sup>-1</sup>

Items	Infall	Outfall	National secondary standard
COD <sub>cr</sub>	276.4	44.7	100
BOD <sub>5</sub>	124.4	26.8	30
SS	164.4	23.7	30
NH <sup>4+</sup> --N	34.3	17.5	25 (30)
TP	6.6	2.7	3
pH	7.22	7.79	6-9

Annotate: The datum outside of the bracket is the standard when the water temperature is higher than 12°C. Inside of the bracket is the standard when the temperature is lower than 12°C.

### 3.4 Discussion

The project system supplies a new method for facing the main pollution sources of wastewater and fresh garbage in rural Chinese villages. In the future, along with other relevant developmental works, through adjusting and optimizing the scheme, building up the completed system, and establishing a new recyclable and continual model for solving the environmental problems of many of China's villages.

## **References**

- [1]Tianjin Statistical Yearbook 2009. China Statistics Press. 2010.
- [2]Long-term Scientific and Technological Development Plan. PRC State Council,2006.