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## Community led Water and Environmental Sanitation Programme

Shaanxi Province, China

ECOSAN SYSTEM	SOLID BIOWASTE	FAECES	URINE	GREYWATER	RAINWATER
APPLIED COMPONENTS					
COLLECTION		Twin vault alternating dehydration toilets	Separate urine collection in bucket or container		
TREATMENT		Storage and drying	Storage		
UTILISATION		Soil conditioner in own land	Liquid fertilizer in kitchen garden/ own land		

### 1 General Data

#### Type of Project:

Community led water and environmental sanitation improvement in rural area.

#### Project Period:

Start of planning: 01/2005  
Start of construction: 07/2005  
(ongoing till June 2009)  
Start of operation: 01/2006

#### Project Scale:

196,123 beneficiaries up to June 2007  
Total investment: 2.4 million USD  
(up to June 2007)

#### Address:

Villages in Pucheng, Chunhua, Xixiang, Chenggu, Jia Xian and Yulin Counties of Shaanxi province

#### Planning Institution:

Plan China

#### Executing Institution:

Respective Village Development Committees facilitated by Plan China Programme Units

#### Supporting Agency:

Government Township Project Offices



Figure 1: Domestic urine diverting toilet in Shaanxi Province (source: Plan China)



Figure 2: A urine diverting toilet and its proud owners (source: Plan China)

### 2 Objective of the project

- Deliver sustainable health & hygiene benefits to the children and their families through improvement in water supply and environmental sanitation.
- Promote eco-sanitation methods to reduce water consumption and recycle nutrients and organics.
- Improve household income through time savings and income earning opportunities particularly for women.
- Support processes that can nurture self-empowerment of individuals or groups. The ultimate aim is the em-

powerment of the community, giving it the decision-making power and access to resources.

- Develop operation and maintenance and cost recovery systems to ensure sustainability of service delivery.
- Promotion of ecological sanitation integrated with hygiene education and promotion is the major component of this programme.

### 3 Location and general conditions

Despite China's remarkable growth and development, significant pockets of poverty remain in many regions. The development of poor communities is constrained by lack of access to services, unsustainable use of natural resources and poor environmental conditions. Rural and western China is particularly affected by this inequality. In rural China 68% of the population has ac-

cess to safe drinking water and 29% to adequate sanitation. The absence of safe water supply systems and adequate sanitation is one of the most important problems for people in western China.

In the project area, lack of safe water supply and basic sanitation is closely associated with livelihoods and other social issues. Poor economic conditions and lack of participation has impeded the initiation of developmental work. Annual income per capita is in the range of 150-200 USD. Cultivation and fruit orchards are the primary source of income in the programme area. Human excreta are used as fertilizer for crops and vegetables. This is an old practice in China. In many houses toilets are made in such a way that the excreta of all members of the family are collected in buckets, which are taken to field periodically and are diluted with water and applied raw on the crops. When one bucket is filled up another one is placed in its place. Furthermore, water is not

used for anal cleaning as the habit is wiping. The availability of water resources per capita in Shaanxi province is only half of the country's average. Droughts and low rainfall level, 400 – 600 mm per year, are faced by all rural communities in Shaanxi.

Shaanxi province is among the most under-developed regions in China and a survey conducted by Plan China in 2004 highlights this disparity. 25% of children under-three years old suffer from diarrhoea, due to poor access to water supply and sanitation. A second Plan China baseline survey reveals that only 2.2% of families have access to potable water and 7.8% of families dispose excreta in a sanitary manner.

Communities in the programme area are affected by a very high incidence of water borne diseases, particularly diarrhoea and viral hepatitis. After conducting initial health and hygiene awareness raising activities in Shaanxi province and through participatory planning and discussion sessions with the target communities, the inhabitants identified three main needs:

**a) The lack of safe drinking water** forces families to use contaminated water sources that expose them to a range of water borne pathogens. These water sources are often located far from homes leaving women and children with the duty of collecting water.

**b) The lack of access to basic sanitation** increases the contamination of local water sources, degrades the local environment and promotes the spread of disease.

**c) The lack of knowledge about safe health and hygiene** and the relationship between good health, water quality and sanitation practices increases the vulnerability of families, especially young children, to preventable diseases.

The project area is most suitable for the promotion of ecological sanitation based on following:

- The sanitation practice is not new to China. Chinese people have a long history of using this type of sanitation in which urine was diverted from faeces.
- The same is true for the reuse concept: Since ancient times, Chinese are using human excreta as fertilizer in agriculture, thus the attitude is positive.
- Cleaning habit in China is wiping thus facilitating the dry separation of urine and faeces.

- Climate and shortage of water supports the project's aims.

The project has targeted children, their families and community. The target area covers 247 communities in the counties of Chunhua, Xixiang, Chenggu, Pucheng, Jia Xian and Yulin in Shaanxi province.

#### 4 Technologies applied

Three types of latrines have been presented to the community to choose from in the programme area, these are:

- Urine diverting dehydration toilets
- Biogas toilets
- Twin pit series latrines (double urn toilets)

The communities were informed about the benefits and cost of all three types of latrines as well as the financial support available from Plan China.

##### a) Urine diverting dehydration toilets.

The major difference between urine diverting toilets and other sanitation systems is that it has two outlets and two collection systems. One is used for urine and one for the faeces, in order to keep these excreta fractions separate (see Figure 1 and 2). There is a cover for the faeces outlet to protect the latrine from flies and other insects as well as to reduce potential bad odour. The latrine used in the programme area is based on the modification of Vietnamese double vault latrines to enhance the dehydration of faeces and allow the use of urine as fertilizer.

The urine collection pipe is normally a plastic pliable pipe with the diameter of 40 mm. It connects between the urine hole in the front of the squatting pan and the urine storage tank. The length of pipe should have sufficient reserve to facilitate the chamber exchange. The length of the pipe depends on the toilet structure. In colder climates, however, the pipe should be not too long to avoid freezing and blockage. The urine storage tank can be bought locally, and comes in various forms, such as barrel, kettle etc. with lids (see Figure 3).

The vault is normally built above the ground. The vaults with the volume of 0.30 m<sup>3</sup> can meet the demand of a family of 5. There are normally two vaults to be used alternatively. The dimensions of the opening for emptying are about 25cmx25cm. It can be sealed with a wooden slab, metal slab or bricks because the emptying takes place only once or twice a year. The best way to seal the opening is with a black metal sheet which can effectively absorb solar energy to dry the waste. When the first

vault is full the squatting pan is reversed and the other vault comes into use. The filled up vault is sealed for minimum 6-8 months for primary composting. The retention time due to high pH-levels allows for die off of pathogens and for safe handling for use as fertilizer.



Figure 3: Access to the urine pipe and urine storage tank (source: Plan China)

When the second vault is full the first vault is emptied from the opening provided in the structure and comes into use.

The ventilation pipe is a plastic pipe with the diameter of 110 mm. It should be installed vertically and should be 50~100cm higher than the roof equipped with lids to protect from entering of rain water.

After each defecation the faeces are covered by ash to enhance the drying process and to eliminate pathogens. Paper used for anal cleaning is not thrown into the vault. It is collected separately in a basket and burnt regularly outside the house and the remains are added to the faeces.

**b) Biogas toilet.** This kind of latrine mainly consists of a squatting pan, faeces inlet, faeces pipe and a biogas reactor (including fermentation chamber and biogas tank), faeces storage chamber etc. In order to avoid the escape of biogas, sealing in the inside layer of fermentation chamber should be done carefully. A squatting pan is normally installed. Under the toilet the faeces pipe is connected. The faeces pipe can be bifurcated to have another inlet which is used for adding animal excrements. The waste outlet chamber is mainly designated for treated excrement sludge. The structures of the

chamber can vary such as pipe, cascade, flat-bottomed etc. It can be designed based on the users' demand and availability of livestock.

**c) Twin pit series latrines (double urn toilet).** This latrine has two urns built underground, which are constructed of brick or pottery. There is a concrete squatting slab with an inlet hole for the waste and with foot rests and a superstructure for privacy and protection from the weather.

The two urn storage tanks are named according to their form. The front urn is smaller and is normally constructed under the ground. It is mainly used to accommodate and store faeces. The retention time is generally over 40 days. The excrements can be completely digested to eliminate the pathogen bacteria and parasite eggs. After the digestion in the front urn, effluent of this urn flows into the rear urn via a connection pipe. The rear urn is mainly used for storage of the effluent. A concrete slab is used on the outlet of the rear urn which can prevent odour from escaping and rainwater from flowing into the urn.

67% of the constructed systems in the project area up to June 2007 are urine diverting dehydration toilets (UDDTs), as can be seen in Table 1. The promotion of UDDTs is quite successful in the Plan China programme area particularly in the central plain and south. There is still an operational problem in the North where harsh winter conditions cause frequent freezing of urine pipes.

**Table 1: No. of Sanitary latrines constructed until June 2007**

Period	UDDTs	Biogas	Twin Pit
July 2005-June 2006	8,457	1,214	1,650
July 2006-June 2007	6,410	1,369	3,072
Total	14,867	2,583	4,722

## 5 Type of reuse

Since ancient times human excreta has been used in China for crop fertilization. However, the safety aspect has been often overlooked and mostly the fresh excreta have been taken to the field depending on the crop need while neglecting the health concerns.

By promotion of ecosan systems the hygienic concern has been highlighted

and excreta can be safely utilised for crop fertilization.

The composted faeces are removed from the vault once or twice a year depending upon the filling rate. They are applied to the field before plantation or sometimes in mid between two planting periods. However the amount produced from one household is small compared to the need of the household.

Urine is applied once or twice a week mostly to the nearby fields. Often it is applied with a dilution of 1:2 with water but sometimes also raw followed by plain watering.

The users are generally small farmers owning in average an area of 3-5 mu (15 mu = 1 hectare). Most of the farmers have some land near their household used mostly for vegetable farming and some fruit orchards (apples, dates, pears, plum, apricot etc.). The land away from the house is generally used for grain farming such as rice, wheat and maize.

## 6 Further project components

This programme aims for comprehensive development in the field of water and environmental sanitation in the respective communities. The sanitation programme is integrated with the hygiene promotion and education activities in the communities to raise their awareness about the linkage between health, sanitation and livelihood. The project emphasises on behaviour change through communication. The approach of this program is software precedes hardware, demand based, child centred development, gender awareness, sanitation precedes water supply and other infrastructure. The other project components include water supply, solid waste management, grey-water management, rain water harvesting and water source protection.

Midterm evaluation of the programme was due in September 2007. The project is regularly monitored at three levels -community, programme units and country office(s). The country offices are planning to conduct action research on community participation, use of urine and faeces in agriculture and the programme's impacts on community and children health in coming years.

Similar programmes will be implemented outside of Shaanxi province and also in other counties in Shaanxi in association with government departments.

Apart from this urine separating systems have been introduced in school

programmes and the initial results are encouraging. In the future more schools will be covered under this programme for constructing urine diverting toilets.

Plan China is lending support to other organizations for promotion of ecosan toilets in their respective areas.

## 7 Project History

The WES (Water and Environment Sanitation) programme of Plan China started in year 2005 to cover 500 communities and 200 schools in Shaanxi province with a grant from Plan Netherlands and supported with a matching amount from child sponsorship. Prior to this the WES programme was implemented with sponsorship money and the project interventions were limited. The WES programme integrates the water supply, sanitation with hygiene promotion and education (3 in 1) with further linkage to health and livelihood.

The first urine diverting toilets of the project were piloted and demonstrated in Sanyong village in Pucheng County during May/June 2005 and later it was piloted in other programme counties. After the successful pilot of urine diverting toilets in all counties, the construction of these systems have been taken up in fiscal year 2006 (FY 06) starting from July 2005. The number of latrines constructed in FY 06 was impressive, confirming that the community accepted this new technology in large numbers.

The main reasons of the acceptance of this technology by the community is the effective promotion by Plan programme units, low price in comparison to biogas, flush latrines and twin pit series latrines, simplicity of usage and maintenance and the individual household subsidy provided by Plan China. The respective government department also accepted the fact that this type of latrine can be promoted on a large scale in rural areas since they are hygienic and present a compelling alternative for use by rural households. Subsequently ecosan toilets have been included as the standard type of systems promoted by the Chinese government for on-site treatment, disposal or reuse of human excreta. These are:

- Three compartment latrines
- Double urn latrines
- Biogas toilets
- Urine diversion dehydration toilets
- Elevated dry compost latrine

In this respect the work done by Jiu San Society for promoting ecosan in China and also for advocating at national level

is laudable. Ecological sanitation is high on the agenda of the Jiu San society national action plan.

Apart from this, the international conference on ecological sanitation held in Nanning, China in 2001 further encouraged the promotion of ecosan in China.

## 8 Costs

The standard urine diverting toilet (complete in all respects) in the project costs 750 RMB (93.75 USD). However due to localization and use of several options for superstructure the cost has come down to 500 RMB (62.5 USD). In cases where it has been constructed inside the cost of superstructure was saved and normally it costs 300 RMB (37.5 USD). Following table shows the cost breakdown of a standard UDDT.

**Table 2: Cost breakdown of a standard UDDT**

Item	Quantity	Costs in RMB
Squatting pan (plastic)	1 unit.	61
Concrete squatting slab	1 unit	29
110 mm PVC ventilation pipe	6 m	24
PVC bend 110 mm plus adhesive	1 unit	3
Cement	3 bags	33
Sand	1 m <sup>3</sup>	35
Glazed tiles (20 nos. x0.3x0.3=1.8 m <sup>2</sup> .)	1.8 m <sup>2</sup> .	36
40 mm plastic urine pipe	1.2 m.	3
Urine container	2 unit	5
Ash Container	1 unit	4
Tissue paper basket	1 unit	2
Spade for ash	1 unit	5
Mason (1 for 3 days)	3	120
Labour (2x3 days)	6	168
Bricks	700 pieces	112
GCI sheet for roof	3 pieces	24
Wooden Beam	1 unit	6
Door	1 unit	60
Ventilator	1 unit	20

Total		<b>750 RMB (93.75 USD)</b>
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Rate of materials are for bulk procurement by the community inclusive of transportation. The rates would be higher if procurement of material would be done individually on account of transportation and retail cost. Cost will increase if RCC roof would be provided.

Plan China has a policy of individual household subsidy for the promotion of UDDTs. However gradually it is being reduced and will be phased out in next 2-3 years (Table 3). In the future the focus will shift more towards intensive software with complete discontinuation of hardware subsidy. On the basis of standard cost of a UDDT the community contributed 49.6% in FY 06 and 53.5% in FY 07.

**Table 3: Subsidy for UDDTs**

Fiscal Year	Average Subsidy (USD)
06	48.25 (51.4 %)
07	43.60 (46.5 %)
08	41.50 (44.3 %)

## 9 Operation and Maintenance

The operation and maintenance of urine diverting dehydration toilets is very simple. The must do's for urine diverting latrines are:

- Before the first use, cover the vault floor with a 3 cm thick layer of dry powdered earth to absorb moisture from the faeces and to prevent it from sticking to the floor.
- Always keep two containers/jars on the latrine platform, one full with ashes with a spade/bowl and the other for storing used paper after anal cleaning with a small stick to compress it in the container/jar.
- After each use, sprinkle two bowl/spade of ashes over the faeces and return the cover attached to the pan. The ashes absorb moisture, control bad smell, prevent fly breeding and make faeces less unsightly to next user.
- Paper used for anal cleaning stored in a jar/container should be burnt regularly outside the house.
- Keep a brush/small piece of cloth for cleaning the pan at regular intervals.
- Wash hands with soap after defecation, handling urine container and cleaning pan.

- Always keep two small urine containers and two big urine containers. The big urine containers with tight closing device should be placed in the courtyard in a shed for storing the urine from small container. Two small containers (with a small inlet for inserting urine pipe) should be used alternatively to collect urine by placing it near the latrine. Urine container should be closed at all the time to prevent odours and losses of nitrogen into the air. (Average urine discharge of an adult is 1.25 litres per day).
- When the 1<sup>st</sup> big urine container is full then seal it properly for use as a liquid fertilizer (undiluted) after 30 days and use the 2<sup>nd</sup> container.
- At kitchen garden, urine may be applied directly but the time gap between urine applications and harvesting should be at least one month. Urine contains salt so plain watering would be beneficial after urine application for better plant growth.
- Apply undiluted urine to open soil. For growing plants it can be used diluted or undiluted. If diluted then one part urine to 3 parts of water. It may be applied in one large dose or several small doses. Apply urine in smaller doses for crops with smaller roots. For fertilizing 1 mu land approximately 850 litres of urine would be required i.e. total urine discharge of two adults in a year.
- The big urine container may be partly filled with water or ashes. The diluted urine or the urine soaked ashes should be used as fertilizer.
- When the first vault is 2/3 full, level the content, top it with dry powdered earth and seal it for dehydration for minimum six months and reverse the pan for using the second vault. The process should be repeated when 2<sup>nd</sup> vault is full. Then the first vault is emptied for using it.
- Always wear gloves during emptying vault and wash hands with soap & take a bath afterwards.
- The emptied dried faeces should be put for secondary composting outside the house and will be used as per requirement. The timing for using compost should be planned in advance. (400-500 kg humus per family per year can be formed)
- The ventilation pipe should be as straight as possible and extend above roof (minimum 50 cm).

- In extreme cold conditions, insulate the urine pipe so that it will not freeze. Urine pipes should be attached to the container in such a way that all urine passes to the container and that it is free of any residues after use. This will help urine pipe not to freeze in extreme cold conditions.
- Wash urine pipe at regular interval by passing small quantities of water through it from the squatting pan, where it is attached.

## 10 Design information and technical specifications

Expected average quantity of faeces & urine per adult:

- 400-500 litres urine per year i.e. 33-42 litres per month i.e. 1.10-1.36 litres per day.
- 50 kg faeces per year i.e. 4.16 Kg per month

Urine diverting latrines promoted in the Plan China programme area are urine diverting toilets where urine is collected in a separate container sometimes placed under the stairs for safety and space utilization. The construction of these types of latrines is very simple and it eliminates the risk of floor leaking hence the construction's water proofing is not required. It can be constructed entirely above ground. Due to separation of urine, the volume of potentially hazardous materials becomes smaller and requires less space for construction.

- For a household of 5 persons the unit should consist of two processing chambers, each of a volume of  $0.25 \text{ m}^3$  (50 Kg per person per year  $\times 5$  (No. of adults)  $\times 1$  Year = 250 kg  $\sim 0.25 \text{ m}^3$ ).
- The entire construction is above ground and the vaults are placed on a solid floor. The size of a vault may be  $0.9\text{m} \times 0.7\text{m} \times 0.4\text{m}$  (depth) =  $0.25\text{m}^3$ . 0.2m of free space are provided, i.e. total depth =  $0.4+0.2 = 0.6\text{m}$ . Thus, final vault size is  $0.9\text{m} \times 0.7\text{m} \times 0.6\text{m}$  or  $1.0\text{m} \times 0.6\text{m} \times 0.6\text{m}$ . For a smaller household the size may be reduced.
- Two openings of size  $0.25\text{m} \times 0.25\text{m}$  are provided in each vault for the removal of dehydrated material.
- The first vault can be used for about 6-7 months by a household of 5 persons. Since the additives are also added after defecation and soil is placed on the bottom and also on top for sealing when it is full. Effec-

tive depth would be  $0.6\text{m} - 0.03\text{m}$  (soil on floor) -  $0.05\text{m}$  (top soil for sealing) -  $0.20\text{m}$  (free space) =  $0.32\text{m}$ . When it is roughly full up to  $35\text{cm}$  ( $0.03 + 0.32$ ), level the content by a stick and then fill the vault to the brim with dried powdered earth and seal it for processing. The 2<sup>nd</sup> vault now comes into use. When the 2<sup>nd</sup> vault is nearly full, empty the 1<sup>st</sup> vault.

- Provide one vent pipe (diameter 10/15 cm) extending above the roof in the processing vault for ventilation & aeration. To remove odours and drying contents Pipes should be as straight as possible as bends reduce air flow and should be minimum 50 cm above roof. If necessary the vent pipe can be fitted with a small electric fan.

### Setting/location of UDDTs:

- Setting of a UDDT can be done in several different ways depending on the availability of space, its location inside or outside the house, convenient position/space for opening for taking out the dehydrated material and urine collection.
- The vent pipe should be provided in the middle. Where it is not possible to provide a pipe in the middle then two vent pipes, one in each vault, should be provided at the edges especially in warmer/humid area. Generally in the latrines constructed inside the house, it is not possible to provide vent pipes in the middle as it encroaches the leg space. The size of vault can also be suitably modified depending on the space.
- Where the plinth level of house (in dry areas) is substantially higher than ground (around 1-1.5 m higher than ground level) and the location selected for the latrine has access to an external wall in which a opening for collecting dehydrated material can be provided to collect it from outside, the UDDT can be constructed partially/fully underground. In this case urine container can also be placed outside the house. This arrangement will save space needed for stairs but extra precaution should be made about the dampness. Excessive dampness will negatively affect the dehydration.
- The riser for stairs can be 200 mm or 150 mm. For children and elderly the riser should be ideally 150 mm. Number of risers should not be more than 3 in case of 200 mm and 4 in case of 150 mm thus limiting the depth to 0.60 m. Higher depths re-

quire more space for stairs and are not safe for children and elderly.

- The stairs can be constructed in the middle or in the sides depending on the availability of space. Stairs should be in sides for latrine constructed together with bathroom.
- For detached latrines constructed outside the house, again there can be a number of different ways to place the opening for taking out the dehydrated material. It can be placed on the rear wall, on any side walls or even in the front. The most optimal setting of an external latrine is to provide openings in the rear wall and stairs in the front (middle of the vault). The other option is to provide opening in the sides and stair in front of one vault. (Stairs provided from outside).
- Thickness of partition wall should not be more than 60 mm. Since it is non-load bearing wall and the squatting slab rests on peripheral wall (120 mm thick) the thickness can be reduced further by using other materials like thick dark hard glass, stone slate slab and wood with aluminium wrap. If the thickness of the partition wall exceeds 100 mm there is a chance that faeces will stick to it.
- For lighting and ventilation adequate openings in the walls should be provided.

## 11 Practical experience and lessons learned, comments

A community, if properly mobilized and trained, is capable of identifying sanitary problems and their solutions and also ready to plan, design and execute the system which is useful for them. Children and women have eagerness to learn, analyze and solve their problems and manage their time in a most useful manner. Design and target hygiene promotion message with women and children in mind. Hygiene activities should suit to the women family and domestic responsibility.

Demonstration and cross visits are important tools for community capacity building. Urine diverting toilets proved to be a community-friendly technology. Promotion of new technologies should always be supported by demonstration, pilot and cross visits. Community is able to accept the new technology for betterment of their lives and changing their unhygienic behaviours by health and hygiene information conveyed by the ecosan promotion programme and above all willing to embrace the change.



Simple, low cost technology allows independent local level construction.

More community mobilization activities should be planned. Community mobilization and gender awareness is a continuous process and can not be achieved by a single training period.

Specific children activities should be planned in the preparation phase. Women should be encouraged to participate in regular meetings of VDC (Village Development Committees) as well as in community-wide meetings. Some activities should be planned for more active women involvement. Consult women for site selection of household latrine and water tap connection.

Post implementation support is required for permanent behaviour change, consistent use of latrine and safe use of faeces as fertilizer.

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## 13 Institutions, organisations and contact persons:

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