

Appendix A. Supplementary data

**Beyond Technology: A Program for Promoting Urine-diverting Dry
Toilets in Rural Areas to Support Sustainability**

Xianquan Zhuang ^a, Dexin Fang ^{a, b}, Fangying Ji ^{a, b, *}

^a College of Environment and Ecology, Chongqing University, Chongqing 400045,
China.

^b Key Laboratory of Three Gorges Reservoir Region's Eco-Environment, Ministry of
Education, Chongqing University, Chongqing 400045, China.

*** Corresponding author:** Fangying Ji

Tel: 86-23-65127537

E-mail: jfy@cqu.edu.cn

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S1: The specific implementation measures of the promotion program

S2: Questionnaire

S3: Experience obtained from project implementation

S1: The specific implementation measures of the promotion program

1.1 Social incentive system

Trigger meeting: The facilitator should encourage as many people as possible to attend the meeting. During the trigger meeting, the facilitator presents the villagers with a comprehensive village map that is drawn following a preliminary on-site survey. The map is marked with improved ventilated pit latrines, septic tank outlets, and the location of groundwater which is the village's source of drinking water. As indicated on the map, the groundwater is surrounded by numerous pit latrines and septic tank outlets, which is emphasized to motivate the villagers to re-examine and reform the existing sanitation system. At this point, the facilitator explains to the villagers how UDDTs can prevent this type of contamination, then briefs them on various environmental issues, as well as the environmental benefits associated with UDDT use. The idea is to stimulate their environmental protection instincts and bring about the realization that using UDDTs is a way of contributing to the local environmental protection. At the end of the meeting, under the guidance of the facilitator, a commitment through a communal pledge or promise was made by all households to build UDDTs by a certain date. It's worth noting that a lot of other factors also can play a role in the trigger meeting to motivate people to build UDDTs — such as pipe network-free and water-free configuration, the stricter discharge regulations proposed by local authorities, demand for fertilizers, environmental awareness, and low cost (1-3). Which factors can be used in the trigger meeting depends on the local situation.

Operation demonstration: The facilitator selects some influential households among local villagers to construct well-functioning UDDTs and then invites villagers to visit.

Media campaign: UDDTs are publicized through broadcasting, brochures, and banners. In particular, popular new media, such as social networking platforms, mobile apps of major web portals, and video-streaming sites, are taken advantage of for short publicity cycles and diversification. In this way, the younger generation shares their experience with others by posting creative clips and short essays about UDDTs on the new media. Such publicity infuses the UDDT system with some fashionable elements and changes people's negative impression, thus making the use of UDDTs a trendy phenomenon.

In-school education: In-school education enables students to understand the significance of UDDTs to the environment. They can then transmit the information to their parents, and hopefully incite change. What's more, schools encourage students to participate in the daily maintenance of UDDTs so the students are trained and accustomed to maintaining and using UDDTs from a young age.

Dissemination of toilet paper: The facilitator distributes free toilet paper to the villagers that is printed on with the UDDT slogan and the techniques associated with its usage and maintenance. This ensures that the message printed on the toilet paper reaches everyone using UDDTs as people will read it to alleviate boredom when using the toilet.

Brand ambassador: Local influencers and celebrities, such as local officials, well-known stars, and religious leaders, are invited as UDDT ambassadors to serve as an example of UDDT users and encourage the villagers to do so as well. If possible, they will be invited to demonstrate emptying decomposed fecal manure from the UDDT. The UDDT brochure cover features the village head emptying the feces vault.

Personal choice of UDDT products: Unlike the centralized government procurement and supply associated with previous UDDT promotion projects, people are allowed to personally select and buy suitable UDDT types from the market (4).

1.2 Social maintenance system

Commendation conference: A UDDT commendation conference is essentially a celebration that is held on a regular basis, where households with good UDDT operation performance are rewarded and invited to share their experience and skills.

Follow-up visits: After the trigger meeting, the facilitator makes regular visits to the rural households in order to resolve UDDT related problems and mobilize the households who do not yet own UDDTs to start construction.

Feces and urine collection: Most villagers use treated feces and urine as fertilizer. However, when fertilizer is not in demand in some cases, there is a higher risk that the feces and urine will be disposed of improperly (1). To mitigate this problem, the facilitator arranges for local private contractors to collect the unwanted feces and urine for treatment, distribution, and sales. The money incurred from farms who purchase the non-hazardous feces and urine for fertilizer is partially used as subsidiaries for collectors' wages while remaining wages are undertaken by users.

Feces vault emptying: The facilitator arranges for local specialist service providers to empty the feces vaults of certain households for a fee. This task is one of the primary reasons why UDDTs are so unpopular (1). Some of villagers are willing to pay for the emptying service.

Cover materials supply: The facilitator sets up some venues within the village to distribute the cover materials that need to be externally purchased.

Troubleshooting service: The facilitator carries out annual UDDT inspections. In addition, a professionally trained local villager is appointed as the repairman so that a repair service can be promptly offered should the UDDT system encounter difficulties.

On-site training: Upon completing UDDT installation, the facilitator makes an appointment with the user to conduct on-site training with regard to proper UDDT use and maintenance.

S2: Questionnaire

14 Implementation factors

Please indicate whether you have participated in any of the following activities or received any of the following services:

(1=Yes; 0=No)

1. Did you watch the trigger meeting?
2. Did you attend the commendation conference?
3. Does the type of UDDT products used by your family satisfy your needs?
4. Does the facilitator provide on-site training on how to use and maintain UDDTs?

Please indicate how frequently you use the following services or find yourself in the following circumstances:

(5=Always; 4=Often; 3=Sometimes; 2=Rarely; 1=Never)

5. Did well-known figures or social organizations call for you to use UDDTs?
6. Did you pay attention to the relevant UDDT content as publicized by the media?
7. Did you visit a well-functioning UDDT at someone's home?
8. Did you use the cover material that need to be externally purchased?
9. Does the UDDT in your family have a history of malfunctions?
10. Did you ever pay to have the feces vault emptied?
11. Did the facilitator make a follow-up visit to your family?
12. Did you ever find no use for the feces and urine produced by UDDTs?
13. Did your child communicate with you concerning the UDDT-related content?
14. Did you read the promotional UDDT material printed on the toilet paper?

Outcome measure

The UDDT household operation situation level:

(3 = good operation; 2 = poor operation; 1 = non-user)

Choose one

Good operation

Poor operation

No usage

S3: Experience obtained from project implementation

UDDT prevalence requires enhanced coordination and cooperation among all stakeholders—such as end-users, governments, non-governmental organizations (NGOs), research institutions, universities, and the private sectors. If the government provides strong political and firm financial support, the prospect of UDDT prevalence is even higher. In addition, the governments also should improve the relevant laws and regulations, as well as the supervision and enforcement required to standardize UDDT operation. Local and international NGOs are willing to contribute to the UDDT promotion, and they have flexible means to match technologies and methods to user needs. Private sectors can contribute to the UDDT promotion by providing reasonably priced products and offering a wide variety of products catering to the needs of different people. In addition, the prevalence of UDDTs requires technical support and should keep pace with technological progress (5). Universities and research institutions can provide abundant technological options.

Public participation is crucial to the success of UDDT prevalence. The sustainability of using UDDT cannot realize unless people are involved in the planning and selection process. In previous prevalence projects, governments failed to consider the users' stance and forcibly carried out UDDT installation in their homes (4). Needless to say, such action facilitated public resistance to UDDTs from the start and discouraged them from performing proactive maintenance. Furthermore, because there was no way for the public to express their opinion, the products and services offered to the users might not meet their actual needs. Therefore, the public should not only participate in, but also drive the whole project to progress, with the facilitator serving only as a guide. Under this promotional program, the villagers discussed a UDDT

construction completion date at the trigger meeting, made choices on the UDDT products based on their personal needs, made suggestions during operation demonstration and follow-up visit, and finally conducted maintenance on their UDDT under the guidance of professionals. Thus, every aspect of this promotional program involves public participation.

The facilitator plays a role in overall planning and coordination between different parties. They should have sufficient social and political acumen to cope with the resistance to change within communities and implement a robust enforcement mechanism to carry out various measures and policies. In general, the facilitator is responsible for ensuring construction and operation of relevant systems and designing structures that ensure the rational allocation of available resources (6). In this project, the local government and university cooperated as facilitator, who could also be communities, NGOs, and the private sectors.

Establishing UDDT use as a social norm is the ultimate objective of its prevalence. The new social norm of using UDDTs is built or reinforced for public good, and based on common knowledge and cooperative behavior to maintain a clean environment, conserve resources, and limit disease. It ensures that people integrate UDDTs into their local cultures and lifestyle. Thus, UDDT use becomes a society standard that does not require legal constraints and is passed down from generation to generation along with other social norms. Like garbage sorting, UDDT use can create significant social benefits by the propagation of small individual efforts, and ultimately become the next social norm.

The prevalence of UDDTs requires effective spending plans and strategies. In this project, people were not encouraged to build up UDDTs by subsidies, but the social incentive system. The funds were primarily used to support operation of the social

incentive system and the social maintenance system. Subsidies are not provided due to the potential problems that may arise if people construct UDDTs for reasons other than their personal need for them (6). It's worth noting that when funds are sufficient and hundreds or thousands of UDDTs are used, the urine and feces from UDDTs can be collected, further processed, or sold by the specialist service providers which can be either public service agencies or private sectors through the signing of service contracts (7). Then the UDDT service becomes more like waterborne sewer system that most people in the world want primarily because it is comfortable and it means that they do not have to manage their own waste (6, 8).

It is necessary to remove people's prejudice against UDDT. Our project has subconsciously changed villagers' prejudice by inviting prominent people to serve as UDDT ambassadors, setting up demonstration toilets, and launching media campaigns. There are still people in many parts of the world who are influenced by traditional ideas and associate UDDTs with filth and bad odors (4). These ideas can be dispelled through flexible means over time. We should not therefore presuppose how an area will react to UDDTs, but instead conduct a trial before reaching any conclusion.

Financial support is the foundation of UDDT prevalence. A large portion of funding can stem from public financial support previously directed at the construction and maintenance of the vast pipe network, central sewage, and sludge treatment plants (9). Apart from the use of government funds, social capital can also be applied. For the private sectors, once the social norm of using UDDTs is established, massive market demands will develop, which incentivizes them to make their own contribution, including funding, to early promotion. Regardless, innovative multiple-channel financing should be further explored in future projects.

Of course, the prevalence of UDDTs should consider the local conditions —

primarily nature, society, the treatment process, and architecture. The facilitator, in cooperation with the research institution, should assist the users in selecting the technical solution that best suits the local practicalities. Pilots should be conducted for localization of technology that entails: trial → evaluation → improvement → retrieval. The outcome of this phase will determine whether the project as designed will be successful and sustainable in the future (6).

Environmental protection is becoming a major driving force for use of UDDTs across many parts of the world. Currently, global warming, glacier meltdown, and the frequent occurrence of extreme weather events are constantly reminding us that humans are having an observable negative impact on our environment. Though UDDTs do not match the convenience of flushing toilets, the current state of our environment is demanding us to make more environmentally friendly choices at the expense of convenience in order to maintain a habitable living space. Though it appears that UDDT use is a trivial matter, a substantial environmental benefit can be gained if hundreds or thousands of people participate in.

As a decentralized treatment system, UDDT usually conducts treatment on the spot. Furthermore, treating feces and urine so they can be safely used as a resource is significantly more complicated than disposing of it as waste (6). Therefore, social intervention is required to motivate people to use UDDTs and to reduce the burden placed on the users. In general, the prevalence of UDDT requires that all parties in the society jointly create a favorable external environment that includes incorporating UDDT use into the social norms and designing a system that guarantees its proper operation and maintenance.

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