Lessons learnt on Ecosan in Morocco: case of the urine-diversion dehydration toilets

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ABSTRACT

‘Lessons learnt on Ecosan in Morocco’ is a short analysis of experience gained in Morocco especially in rural areas where people do not have adequate systems of evacuation of their wastewater. The rural population cannot afford conventional sanitation systems. In response to this, we have thought to promote ecological sanitation that recognises wastewater not as a waste but as a resource. The first Urine-Diversion Dehydration Toilets (UDDTs) were introduced in a rural village called ‘Dayet Ifrah’ in Morocco in December 2009. Since then, households are starting to see the advantages of UDDTs and the systems are becoming more and more accepted. The UDDT systems implemented in the village could be used as a model for Moroccan rural areas. This paper sets out how the Ecosan approach was successfully introduced in Morocco where people are motivated by reasons to improve this approach such as no smell, safety, comfort, privacy and water reuse. Results reveal that the users are satisfied with the Ecosan approach to cleanse their wastewater. Although Ecosan is relatively new to Morocco, it seems that it can succeed in very poor populations. The paper contains information on general experiences in the different countries and also lessons learnt on Ecosan in each country.

Key words | agriculture, Ecosan pilot project, marketing, Morocco, rural areas, urine diversion

INTRODUCTION

Ecological sanitation, or ‘Ecosan’ for short, is different from conventional approaches in the way people think about and act upon human excreta. First, those promoting and using Ecosan take an ecosystem approach to the problem of human excreta. Urine and faeces are considered valuable resources to restore soil fertility and increase food production. Thus, sanitation systems should be designed to consider the human wastes as a resource for microorganisms that help produce plants and food. Second, Ecosan is an approach that destroys pathogens near where people excrete them. This makes reuse of excreta safer and easier. Third, Ecosan uses little or no water and is therefore a viable alternative in water-scarce areas. Fourth, Ecosan can provide hygienic and convenient services at a much lower cost than conventional sanitation and, therefore, should be considered both in developing and developed countries.

The nutrients contained in urine are not lost during the process of collection and storage and the urine fertilising effects are as good as those of chemical fertilisers (Jönsson 1997). Nutrients included were nitrogen (N), phosphorus (P), and kalium (K). The characteristics (N, P, K contents) of faeces and urine were based on former studies (Tchobanoglous et al. 2000; Lens et al. 2001; Wang & Nie 2001).

The first Ecosan system promoted in 2009 in Morocco, in Dayet Ifrah near Ifrane (latitude: 33°34’N, longitude: 4°55’W and altitude: 1,665 m) city, was the Urine-Diversion Dehydration Toilet (UDDT) (Figure 1). It is composed of two pits functioning alternately (Figure 2); a wash-hand basin as well as an urinal and shower (Figure 3).
The privacy of the users is ensured by a superstructure built using bricks and equipped with stairs serving as access to the cabin (Gonidanga 2004) (Figure 4). The pits have a depth of 1 m and are covered by a flagstone measuring 2.5 m². The pit still to be put into service is protected by a wooden lid. The walls are built of bricks. The fresh excrement will be covered with a mixture of ash as a better additive at destruction of Escherichia coli and Enterococcus spp. (Niwagaba et al. 2009). When the pit is full after approximately a year of use, it will be covered by the wooden lid in order that its contents mineralise.

The second pit is then used until it, in turn, is full, at which point the contents of the first pit are prepared for re-use: Its contents are removed so that they continue their decomposition or are used immediately as manure. Since this experiment in the use of a UDDT in December 2009, the population of Dayet Ifrah locality have asked for it to be used in their homes. Thus, three other UDDTs were built in June 2010 (Figure 5).

A third pit was also built to be used as shelter for piping collecting the various liquids such as: water of anal cleaning, and the urine and grey water coming from the wash-hand basin and shower (Figure 6).
Currently, pilot projects, similar to that of Dayet Ifrah, have been applied in more than 40 countries worldwide, including Afghanistan, El Salvador, Eritrea and Nepal (Mang et al. 2004).

So, we need to share experiences with others around the world including some countries from the Southern African region (mainly South Africa, Zimbabwe and Mozambique). In those countries, the priority of most Ecosan projects that were initiated was to address sanitation and health problems. Only very few were directly linked to the idea of closed-loop sanitation. Why? Which processes are driving these projects? What are the aspects of a successful implementation of Ecosan projects in the region? Is Ecosan a solution? Will the loops close? These are only some of the questions we have asked ourselves in analysing country case studies and compiling lessons learnt and developed by Wirbelauer et al. (2003).

**EXPERIENCES IN MOZAMBIQUE**

In Mozambique, the introduction of Ecosan started after the collapse of the country’s centralised slab-construction programme that had left the sanitation sector uncertain about the way forward. The Sanitation policy is unclear, particularly at Provincial level.

The concepts that underpin Ecosan were surprisingly well received and interest in Ecosan grew following the installation of demonstration models at leaders’ houses. Households with UDDT, spoke with their neighbours about these healthier and cleaner systems, that are odourless, fly-less, easy to build (shallow and stable), aesthetically pleasant and that can be combined with the washing area (often a tradition in the country). Aspects related to the re-use of by-products were also positively received and people were looking forward to using the compost to transform their yard. The enthusiasm increased especially after the first pits had been excavated, when users and authorities could see that the compost was of extremely high quality, thus assisting in the acceptance of a possible closed-loop use of the systems. A further advantage of Ecosan systems was that people perceived them as permanent solutions in contrast with pit latrines that once filled were relocated. In addition a few Arbour Loos were also constructed and fruit trees were tested including guava, mango, orange, avocado, as well as a range of local fruit trees. The latter system did not prove very popular in the villages because of lack of space around the houses, but was more popular and affordable at the fields where the systems could be built with local materials. Nevertheless, reasons for the acceptance of Ecosan can be very different and families were not only interested in sanitation for...
health reasons, but also for reasons of status and convenience. Many users referred to Ecosan systems as ‘modern toilets’, given their recent introduction in the province.

In Mozambique Ecosan seems to be a viable option both in peri-urban and rural areas, and evidence suggests that many people will invest in Ecosan systems over better promoted alternatives even if they already have a conventional pit latrine.

Looking at closed-loop Ecosan, Mozambicans recognise that the systems can have an added economic value. The closed-loop concept seems to be culturally acceptable as in the past many people in the province planted trees and vegetables in disused latrines. The acceptance of Ecosan has been overwhelmingly positive in the Niassa Province and the use of the compost from the toilets for vegetable gardens has proven to be a considerable incentive for people who depend on farming. However, most of the new pits haven’t filled-up yet and some questions still remain open: will people really excavate their pits once the faeces and urine have been converted to compost, and once the second pit is full? Will they really use the compost and fertilisers from the toilets for agricultural purposes and in their gardens? Those who have started applying the by-products to fields or home gardens have had positive results especially with maize and many are now testing on tobacco.

LESSONS LEARNT IN MOZAMBIQUE

- Initiatives that allow families to choose between ‘Improved Latrines’ and Ecosan systems proved to be more successful and people consistently prefer ecological sanitation over other choices.
- The acceptance of Ecosan systems is easier when people understand their problems and identify solutions by themselves.
- Interest in Ecosan and a closed-loop approach has subsequently grown as people have seen the contents of the pit and fears about excavating unprocessed faeces have diminished. People understand the concepts behind ecological sanitation, as they are simple, especially with demonstration models in place (learning by seeing).
- Awareness raising and outreach programmes play an important role when introducing Ecosan (combination of participatory work and social marketing principles).
- The desire to build a ‘new’, aesthetically pleasant and permanent latrine that eliminates problems of smell, flies and mosquito habitats while protecting groundwater is proving to be powerful enough to overcome cost considerations.

EXPERIENCES IN ZIMBABWE

The main reason for introducing Ecosan in Zimbabwe in 1997 was to address problems related to sanitation and health in peri-urban areas and soil impoverishment in rural areas.

Ecosan started with the experimentation of Compost Pit latrines and at a later stage (since 1999) the Arbour Loo, the UDDT and the Fossa Alterna. In the peri-urban context, mainly sanitation and health problems had to be addressed as in some cases one toilet squat was used by more than 100 people. In these very needy areas, Ecosan was positively appreciated mainly because of its private use, and being user-friendly and easy to maintain. As Ecosan had the added value of providing compost, the systems were quickly considered to be a household asset. An evaluation study based on a 20% sample of the people with Ecosan toilets in the informal peri-urban areas near Harare was undertaken to assess the acceptance of these systems.

Generally, Fossa Alterna systems were preferred to UDD-bucket (Urine-Diversion system where faeces are collected in buckets in order to keep this excreta fraction separate from urine as shown in Figure 7) systems (people did not want to carry the buckets with the faecal matter and they did have some problems with pipe blockages and the smell of the toilets). Only 30% of the households did not use the by-products, mainly due to the lack of knowledge on how to use them safely. People did not know whether compost from others could be used or only own compost, whether urine would burn plants (although this only happens when directly poured onto the leaves) and whether it was generally safe to use the untreated by-products. Results also showed that whereas the majority of families used the compost (80%) most of the households did not want to
use the urine alone (61%). The use of faecal matter seemed to be acceptable on high-standing crops (maize, sunflowers, trees, flowers, etc.) but not on vegetables. There were fears that, because of lack of space for gardening, very quickly problems related to the disposal of the compost within the settlements would arise (the supply being greater than the demand for use).

In the rural areas of Zimbabwe the introduction of Ecosan systems was of a different nature. In fact, following the price increase of fertilisers and the poor over-cultivated soils some Ecosan projects started-off straight away with the major purpose of introducing cost-effective ways to restore/improve soil fertility in poor rural areas. In these areas UDDTs and Arbour Loos were tested.

After initial resistance to use the by-products, households finally started using urine for the production of a number of crops like rape, beans, peas, tomatoes, onions, maize, cotton and fruit trees. Observations showed very quickly that results differed a lot depending on which crops urine was used on and many technical questions on the proper use of it were raised (concentration, application distance, timing, frequency and volumes of application). Further research on the improved use of urine and faecal matter for agricultural purposes had to be undertaken. Some rural communities that had seen the added value of using Ecosan systems in a closed-loop approach were prepared to start trials on the use of urine as fertiliser, provided they were given sufficient information and health safety assurance. In these rural areas both systems met with success: the Arbour Loo being easy and cheap to build and mobile (ideal for the fields and for planting fruit trees), the UDDT being also easy to maintain, cheaper to build and permanent.

Finally, through the generation of income at household level, Ecosan together with a closed-loop approach had an important economic impact that also contributed to the acceptance of these systems in Zimbabwe. The use of faecal matter and urine in crop production improved crop yields from backyards and fields, thereby improving household food security and increasing household income opportunities. It was quickly understood that a closed-loop approach could allow for an improved crop production with reduced inputs (especially on fertilisers) and thereby improve livelihoods in both rural and peri-urban areas.

LESSONS LEARNT IN ZIMBABWE

- In very difficult situations (e.g. overpopulated poor peri-urban settlements; poor over-cultivated rural areas depending on agriculture) where people are desperate for solutions, the introduction of new systems such as Ecosan can be easier.
- The acceptance of a closed-loop approach is higher in rural areas where people depend on farming and easily recognise the added value of using the by-products.
- Proper training on Ecosan and a closed-loop approach needs to be guaranteed but also a bigger involvement of all the family members pursued (too often only women carry the burden of sanitation, health and gardening, this should be avoided).
- Technical problems on the re-use of by-products can create confusion and jeopardise a process that is already difficult. This can be overcome with proper awareness raising and adequate research.
The introduction of Ecosan and a closed-loop approach seem easier in countries where the culture of re-use has existed for a long time. In Zimbabwe most households traditionally already have composts for example.

EXPERIENCES IN SOUTH AFRICA

In South Africa Ecosan was first piloted in 1997 through the CSIR (Council for Scientific and Industrial Research) and the ECATU (Eastern Cape Appropriate Technology Unit) in the Umtata area (Transkei). Since its very start it was directly associated with the UDDT, which was introduced as the only Ecosan option and was piloted as a new and better technology. Shortly after the start of the pilot project, the ‘National Sanitation Programme’ that aimed to ensure that everyone had access to adequate sanitation systems, experienced problems of difficult geological conditions, precluding the construction of VIPs (Ventilated Improved Pits). Ecosan was then introduced as an alternative solution to VIPs for areas with these difficult conditions (e.g. rocky, sandy, high water table).

As the UDDT was introduced following the Central American example, the ‘main research objectives’ of the pilot project in the Transkei were ‘to test the basic acceptability of the technology and to determine the potential for resource reuse’ in the Southern African context.

During the same pilot, issues related to the use and maintenance of UDDTs as well as cultural taboos and beliefs were also addressed. Community and household involvement were immediately considered to be crucial and consultation processes were undertaken. Initial worries on how to store cleaning material or on the collection and re-use of urine for example were integrated into project implementation, thus not hindering the use of these new systems.

Whilst introducing UDDTs some further cultural and technical aspects had to be covered: ‘men must sit down when urinating unless a separate urinal is provided; toilet paper does not decompose in the vault (because it is a dehydration and not a composting process); what do you do with the urine and with the faecal matter’, the system would only be appropriate if households were prepared to handle the by-products, etc.

These questions were promptly addressed and the acceptance of UDDTs was relatively positive.

During the implementation of the National Sanitation programme, it was noticed that Ecosan was accepted mainly because the system met people’s expectations around privacy, dignity, safety and convenience rather than health. Although the UDDT required more input in terms of maintenance, families appreciated the fact that the structure was permanent and could be built inside the house; that it required lower building, operation and maintenance costs, and that it was odourless. These perceived benefits meant for many households that the inconvenience of handling dry excreta was less disturbing than the inconvenience of moving a toilet or of using the bucket system.

Although the added value of high fertilisation and conditioning potential of the by-products had been recognised, the questions related to the re-use of these and a closed-loop approach were only promoted during the pilot project in the Transkei and not during the National Sanitation programme. In fact in South Africa there is not a culture of re-use and the UDDT was introduced solely to solve sanitation problems. The by-products of the toilets were not reused directly, the urine was led to a soak pit (and possibly taken up by adjacent trees) and the dehydrated faeces was simply thrown into the mealie fields, burned, in some cases buried or composted. The strategy of introducing Ecosan by emphasising the social aspects rather than the added value of a closed-loop approach has been one of the success factors for the introduction of the systems in South Africa.

In South Africa the importance to adopt a holistic and multi-sectoral sanitation programme where successful implementation is linked to a ‘step-by-step’ approach has been recognised and pursued. Toilet construction is seen as part of a bigger programme that includes: change of personal behaviour, improved water supply and storage, safe disposal of domestic waste and proper handling of food towards improved health and quality of life.

Although research on the safe use of urine and faecal matter for agricultural purposes has been undertaken, projects implemented have mainly been looking at improved sanitation, health and safe disposal of faeces. In South Africa there isn’t a culture of re-use and some taboos are still alive. However, people are slowly becoming more
receptive to re-using the by-products. Some pits are now being emptied and some people have thrown the faecal matter on the mealie fields and are now starting to realise that mealies now grow better.

**LESSONS LEARNT IN SOUTH AFRICA**

- Sharing experiences with others around the world is crucial (the introduction of the Urine-Diversion ‘technology’ was based on experiences from various countries including Central America, Mexico, Sweden and Vietnam).
- Political will and tensions within communities/areas can influence Ecosan.
- When introducing Ecosan, social and cultural considerations are of utmost importance.
- Cash-subsidy stifles self-initiatives and continuous access to funding is required to maintain momentum on highly subsidised projects. A subsidy in kind (e.g. pedestal, some building material) could motivate households/communities to get on with improvements by themselves.
- In order to be successful and to increase rates of coverage a wide selection of methods and materials must be made available so as to meet the needs and aspirations of different households/communities.
- Social interventions and health and hygiene awareness programmes should always accompany sanitation programmes, not only during the planning and implementation stage but also for a period of monitoring and follow-up.
- Sustainability is only achieved when the community wants and accepts the level of service provided, is able to pay for it and the skills are available locally to service the systems.

**EXPERIENCES IN MOROCCO**

Experiences from projects dealing with the implementation of four Ecosan toilets are presented. The projects took place in Dayet Ifrah in Morocco. In the following paragraphs, we will discuss how the experience gained in the four projects can be used as pilot Ecosan projects. In general, the main priority for end-users was to have an affordable and comfortable sanitation facility. In all places, recycling of nutrients is already a priority. Demand must be created through information and mutual engagement in order to achieve a successful result. It is equally important to ensure involvement of the users in all aspects of the implementation and running of the toilet system. Communication, both before and after implementation, is paramount.

**METHODS**

The analysis required a logistic and scientific organisation to achieve its goals. The main steps achieved can be summarised as follows:

- Preparation of the questionnaire to be answered by surveyed households.
- Determination of the criteria required to select the 24 households to be examined, thanks to the local authority and also to Jmâa (group of the oldest people in Dayet Ifrah who are decision makers about the community affairs). Thus, four households per tribe were chosen by Jmâa for socio-cultural reasons of acceptance (six tribes exist in Dayet Ifrah).
- Interviews with the Cheikh (local representative of Moroccan authority) to collect general information about the village.
- Visit to schools and mosques and interviews with the individuals responsible for public establishments (teachers, directors).
- Visits to 24 families and interviews with household head or his representative (Figure 8).
- Localisation of the concerned houses with Global Positioning System (GPS).

This investigation was also used to draw up an inventory of the situation of water and wastewater and to select the beneficiaries of the Ecosan pilot project in Dayet Ifrah.

The criteria to select UDDT beneficiary people are:

- Interest of the beneficiary household to take part in an Ecosan project.
- Participation of beneficiary household in the building work (masonry, earthworks).
- The degree of willingness to take responsibility for maintaining the toilet.
• Beneficiaries’ willingness to accept future visits from researchers, students.
• Without toilet.
• Need for chemical manure.
• Weak supply water.
• Availability of site for a toilet.

According to the criteria mentioned above, 12 families were selected and the choice was presented initially to Jmâa, which approved the proposed list and subsequently to the whole population of the locality. Initially, four projects were financially accepted. The others need financial support.

RESULTS

Investigation-household

The average size of the households is eight people in the houses without conventional toilets and six in the houses with toilets. Thirty per cent of the households without a toilet were interested in having a UDDT, compared to 81.8% of those who have a traditional toilet. This is as expected since at the beginning of our investigation the population were not aware of the Ecosan approach.

Females account for 44% of the surveyed population. They account for 13% of illiterate adults. However, only 38% of women benefited from primary education and 3.4% benefited from secondary education. This is explained by the fact that the rural females limit themselves to the first classes of primary school education.

Feder & Slade (1984) affirm that the individuals, in particular the women, who have a higher level of education, interpret correctly the information about the innovation of Ecosan and its adoption.

All the surveyed population have access to electricity via the national network or the photovoltaic panels. Economically, the selected households do not differ significantly. 83% of the surveyed households have a garden or fields for agricultural demonstration within individual or family fields. Research on agricultural practice conducted in Dayet Ifrah showed that 71% of households use chemical fertiliser and are in favour of using human excrement as fertiliser for their ground.

Knowledge, preferences and acceptability

We asked the people if they had ever heard about Ecosan technology and we discovered that they knew nothing about such technology. It was only in April 2009 that the Ecosan approach was introduced for the first time when negotiations with the people and the local authority began.

The future users of the UDDT considered these toilets to be the healthiest way to defecate and hoped to have them in their home ever since hearing about them.

The users reported their satisfaction with the new toilets and announced they would recommend this type of toilet to others. They are happy to be the first people to use this kind of toilet in Morocco.

They confirmed that their family had shown improved comfort since the UDDT was built, previously having defecated outdoors even when it snowed or rained. People said, ‘We do not have to brave the cold. We are sheltered from snow and rain. Our wives and children are very comfortable.’

We asked if beneficiary people could identify the particular aspects of the UDDT that they like having. All the users accepted that which we had proposed to them – UDDT with double pit equipped with shower and wash-hand basins. It is important for the families to reserve an
area in the toilet for anal cleaning to cleanse oneself after defecating and/or urinating.

In conclusion, all the beneficiary people wished to have a UDDT at home as soon as possible. Their motivations are focused on the benefits of ecological sanitation such as: use of human excrement as manure for agriculture, in particular with the urine, rich in nitrogen and in phosphate (Larsen & Gujer 1996; Otterpohl 2002; Vinneräs & Jönsson 2002; Muskolus 2008; Winker et al. 2009); the possibility to increase the agricultural outputs and revenues; and the acquisition of a well-built toilet near home. The adoption of the Ecosan approach in Dayet Ifrah in Morocco is easy to implement.

Workshop on realisation of the UDDT in Dayet Ifrah

This workshop was held in Dayet Ifrah from 14 to 27 June 2010. It was an interesting meeting between the representatives of the technical public institutions, municipalities, and universities and researchers. The object was to present the results of the Ecosan project in order to provide the basis for the promotion of the Ecosan approach in Morocco for the first time.

The objectives of the workshop were various. Notably, they included physical achievements, the actions of accompaniment and the sensitising related to the adoption of the Ecosan approach.

Concerning physical achievements, we note constructions by the local masons in four households of the UDDT with double pit and the acquisition of materials. The actions of accompaniment such as the sensitising, communication and reinforcement of the capacities were also carried out. The advantages relating to the adoption of the Ecosan approach in rural areas of Morocco are numerous. They concern the protection of the water resources, the reduction of prevalent diseases related to poor hygienic practices and the valorisation of the nutrients contained in the human excreta. This last advantage would provide Morocco with significant economic gains, if it managed to develop the nutrients contained in the excreta of the whole rural population and this is without taking into account the numerous indirect advantages. In addition, for rural areas that still suffer from inadequate sanitation, sustainable solutions modelled on decentralised systems are required (Wilderer 2001).

Use and maintenance practices

The users of the UDDT followed perfectly the maintenance instructions they had been given during the training workshop from 14 to 27 June, 2010. Indeed, they all announced that they will add ash to their pits to reduce the odours and, consequently, the number of flies normally associated with devices that collect faecal matter (Okalebo et al. 2002). The ash will be collected from burning charcoal or wood on charcoal stoves, a practice usually used during food preparation in Dayet Ifrah and in rural areas in Morocco.

DISCUSSIONS

We noted that the households who defecate outdoors are concerned, at the same time, about having less expensive and simpler wastewater sanitation at home which will encourage the re-use of the hygienised products in agriculture.

User identification

The Dayet Ifrah village located at 20 km from the town of Ifrane has a population of 1,500. In spite of the proximity to Ifrane city, this village remains confronted with the consequences of having little infrastructure, such as insufficient wastewater evacuation infrastructures.

The village has very few toilets; a total of 11 out of the 24 surveyed households do not have toilets at all. Those existing are called ‘lost wells’ and are not made very well (Figure 9).

These traditional toilets are abandoned by their users when they are full and replaced by another one dug beside it. The pathogenic bacteria coming from these toilets constitute a major risk of biological pollution of the ground water and are often used as indicators of faecal pollution. The nutrients and pathogenic germs filtrating from these toilets are the cause of contamination of the ground water and the surface water everywhere in the world. Human faecal excreta are the main source of pathogenic organisms (Esrey et al. 1998).

The present research on Ecosan in Dayet Ifrah consequently met the approval of the population majority and it was necessary to define clear strategies to identify people who could receive the experimental UDDT.
The wisdom of the association members and the collaboration of the head of the local authority helped us to choose the future beneficiaries of the UDDT. Thus, it was allocated to this association and to the local authority head to identify the households that will profit from the first UDDT pilot.

**Characteristics and profile of the users**

The name ‘user’ can be considered as all the members of the profit household of the pilot toilet. ‘Users’ can also be considered as the members of large families including all those who use the toilet during weekly market days.

Our analysis is more concerned with the direct users of the toilet, defined as the permanent members of the beneficiary families. The UDDTs were allotted to four households deprived of wastewater collection and which defecate outdoors.

**User reactions**

The meetings at the beginning of April 2009 aroused a manifest interest from the population in being able to obtain an Ecosan toilet, but in pilot form in order to better appraise the technology, its assets and its strong points, before reaching a conclusion about its generalisation.

The advantages related to the use of the hygienised muds in agriculture were timidly accepted because of the ignorance of the new technology.

The information which we provided was analysed according to the practices and empirical knowledge of the beneficiaries scattered throughout the world in countries such as Sweden (Rhode et al. 2004; Tidäker et al. 2007), China (Jurga et al. 2005), India (Sridevi et al. 2009), and South Africa (Mnkeni et al. 2008).

The Chinese have practised the composting of human and animal excreta for thousands of years and Japan introduced the practice of human urine recycling into agriculture in the 12th century. The use of animal excreta in agriculture in Dayet Ifrah draws on the past in order to support the fertilisation of the fields.

However, some people asked how the hygienised and developed products will be transported to the fields. Thus, we propose to wait for the results of the first tests after completing the pilot toilets before arriving at a final decision about whether the products of these toilets constitute a good fertilisation option for the fields (Kiba 2005). The manageability of handling the muds and urine, as explained, is a motivating factor and the households are also ready to consume the agricultural and market-gardening produce treated with the products Ecosan.

**Justification of the use**

The need for or curiosity about having stabilised muds motivates ‘users’ to regularly use the toilets. This use will also be justified because of the high cost of the manure which reaches ‘users’ from remote zones. This cost was estimated at 60 Dh per ton of manure.

**The integration of the principles of use**

Defecation is a human act which is not usually the subject of discussion or information exchanges, except if the person is attacked by a disease making this act difficult or painful, as is the case with diarrhoea or haemorrhoids.
The transmission of the information about the separation of urine from the excreta and about the procedure of addition of ash on the fresh faecal matter seemed at the beginning of the project a little silly to the villagers. In Dayet Ifrah and in the majority of the Moroccan rural localities, families are very conservative. A discussion between father and son or between son and brother about human excrement is almost impossible.

The sensitising day of May 2009 bore fruit. Indeed, the processes were communicated using imagery in order to get the message across about the separation of the urine and the adequate use of the toilets Ecosan (Figure 10). These supports facilitated the comprehension of the procedure of use of the toilets and the majority of people affirmed to have all the necessary information about the concept.

Meetings of recommendation and decision making

In this rural area and at the beneficiary households, there were obvious relationships between UDDT adoption and the agricultural factors and attitudes towards wastewater treatment. They are rural families that defecate outdoors. They are thus convinced of the association between the property of the UDDT as a technique of collecting and treating wastewater and the conviction to reuse the human excrement (faeces and urine) in agriculture, which would enable on the one hand the protection of public health and, on the other, the provision of hygienically healthy products for agriculture. For these reasons, the adoption and the promotion of ecological sanitation in the rural world, where the requirement of fertilising is strongly expressed, are very welcomed.

In addition, it should be recognised that the ecological sanitation was introduced into the village of Dayet Ifrah and its inhabitants accepted it as a ‘justified choice’. This apparent choice (because in reality, the choice was guided and justified) of the ‘user’ conforms with our promotion strategy of the ecological sanitation in its pilot phase in Dayet Ifrah, knowing that thereafter the users will make their own decisions about the best method for wastewater sanitation. Indeed, thanks to the public sensitising campaigns during April and May 2009 and the capacity to integrate the various aspects (technique, hygiene, health) in our animation, it was explained that we envisage realising a first phase of the pilot Ecosan toilets for families that defecate outdoors. This will allow us, in a second phase, to evaluate and judge its acceptance by the whole population regarding it replacing existing toilets that are not in conformity with Moroccan law (Decree 2006).

Although the households declared that they had not chosen the UDDT as an alternative solution, the choice was made for them and ratified by the local leaders in order to create the request. According to the survey sample, all the users who did not actively choose the UDDT are in favour of the addition of ash and separation of the urine. Those who have not yet profited, did not stop asking us for them during the survey phase and even during the workshop that took place in June 2010. This is a good sign of the success of the generalisation of the Ecosan approach for the whole population of the village.

Use and maintenance practices

UDDT users were sensitised and educated well on the addition of ash to their pits. For example, 100–500 mL of ash is enough to cover the fresh faeces after each defecation (Esrey et al. 2001). The obviousness of the addition of ash to the pits and the use of the specific sites for hand washing are proof of the conformity with advice given to the ‘users’. The conformity with the instruction to add ash is encouraged by real results: the users perceive the addition of ash as a manner of reducing odours and flies.
LESSONS LEARNT IN MOROCCO

In Dayet Ifrah, Ecosan systems were positively received as appropriate sanitation systems. When people could choose between conventional and Ecosan systems they preferred Ecosan. Generally, the closed-loop approach was more acceptable in rural areas where people depend on farming and recognised the added value of using the by-products for agricultural purposes.

The choice of Ecosan over other systems and eventually the choice of adopting the closed-loop approach were easier when people identified by themselves that sanitation was the main cause of their conditions (poor health and poverty). The use of participatory methods and social marketing tools seems to have provided a good basis of understanding in most of the projects.

Successful Ecosan projects (whether looking at closed-loop or not) need also to be accompanied by proper awareness raising campaigns, adequate capacity building and intensive social interventions from their initial stage. One of the successful methods to achieve this has been the ‘learning-by-seeing/doing’ approach whereby people accepted Ecosan and the idea of closing the loop when they could see the high quality of the compost, when they were trained on how to safely handle the by-products, and when knowledge had been shared. The closed-loop approach seems to be acceptable (especially in areas depending on farming). Generally, when users are made aware and sensitised about the added value of having an Ecosan system and using the closed-loop approach from the very start they have time to appreciate this advantage slowly. It also became evident that where there is already a culture of re-use of waste, it is easier to introduce the closed-loop approach. The use of by-products (when accepted) was applied mainly to crops and trees and less to vegetables, indicating that although the concept is acceptable, fears are still present and efforts should go towards alleviating these fears by providing tangible results.

As the Ecosan project is still in its initial phase, we would like to point out the following lessons learnt so far:

- We will not conceal the fact that the delimitation of centralised vs. decentralised solutions in city outskirts, slums and scattered settlements can be very difficult. The same holds true for design parameters and for treatment standards. The wishes of our partners as well as suggestions made by consulting engineers sometimes exceed the limits of ecological and economic viability. Frequently, we have to adjust expectations and apply concepts for gradual expansion. Therefore, in most of our projects central sewerage is limited to high-density settlement areas whereas in the remaining areas on-site systems are promoted.
- Solutions for reusing treated wastewater and sewage sludge to close water and nutrient cycles are gaining priority, specifically in very densely populated arid regions. However, based on our first experience this undertaking can be highly complex and challenging from a technical, socio-economic, legal and institutional point of view.
- In our view promoting ‘appropriate technology’ implies that we focus on the very problems to be solved. Thus, depending on local conditions, in principle a wide range of technical solutions from simple latrines to sophisticated treatment facilities may emerge as being ‘appropriate’. In any case, there are no universal solutions.
- Shelter is required for privacy and to protect from cold, rainy and dark conditions.
- There is no need for earthworks to build the UDDT.
- Integration of the ‘anal cleaning’ aspect is achieved in the architecture of the UDDT (Islamic Culture).
- Water and soap are available in the wash-hand basin to wash hands after defecation.
- The population showed a strong adhesion with the project which constitutes the factor of success of the Ecosan concept.
- The sustainable environment management could not succeed without the participation of the population in this management.

CONCLUSION

Since 2009, when the first UDDTs were introduced in the region, some progress towards closed-loop sanitation has been made. Research on safe handling and re-use of by-products has been undertaken and is already informing the projects in Morocco. Although users have to manipulate urine and faecal matter, often considered a taboo and dirty,
households are slowly starting to see the advantages of a closed-loop approach and the systems are becoming more and more accepted. The closed-loop approach seems to be generally more acceptable to poorer populations and farmers, who more easily recognise the added value of using Ecosan systems. In more populated areas people seem rather preoccupied by health and sanitation problems and do not recognise the immediate benefit of using the by-products. Even though Ecosan is still very new to the region it seems to be a suitable option to address sanitation and environmental concerns, but there is still a long way to go before the loops will be closing in Morocco.

In addition, ecological sanitation in Morocco is in its promising infancy: The users are satisfied at the moment with the Ecosan approach to cleanse their wastewater. Our work shows that Ecosan can succeed in very poor populations. It is particularly relevant as locomotors of agricultural economics. It creates a strong link between sanitation and agriculture and contributes to food security as well as employment generation with regard to micro and small enterprises operating and managing the sanitation system. Experiences with regard to the use of the toilets and the use of human excreta products in agriculture to this day are promising and encourage the further dissemination of this technology (Meinzinger et al. 2009).

It can be concluded that Ecosan concepts are a way of moving towards a more ecologically sound sanitation. There are many different Ecosan concepts available that can be appropriate in different socio-economic and geographical situations. Ecosan concepts are also in accordance with the United Nations (UN) Millennium Development Goals due to their accessibility also to the world’s poorest people. There are so many technological options that most social and economic conditions can be met. Creativity is needed to find the appropriate technology and the best way of implementing, operating and financing Ecosan concepts (Langergraber & Muelleger 2005).

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