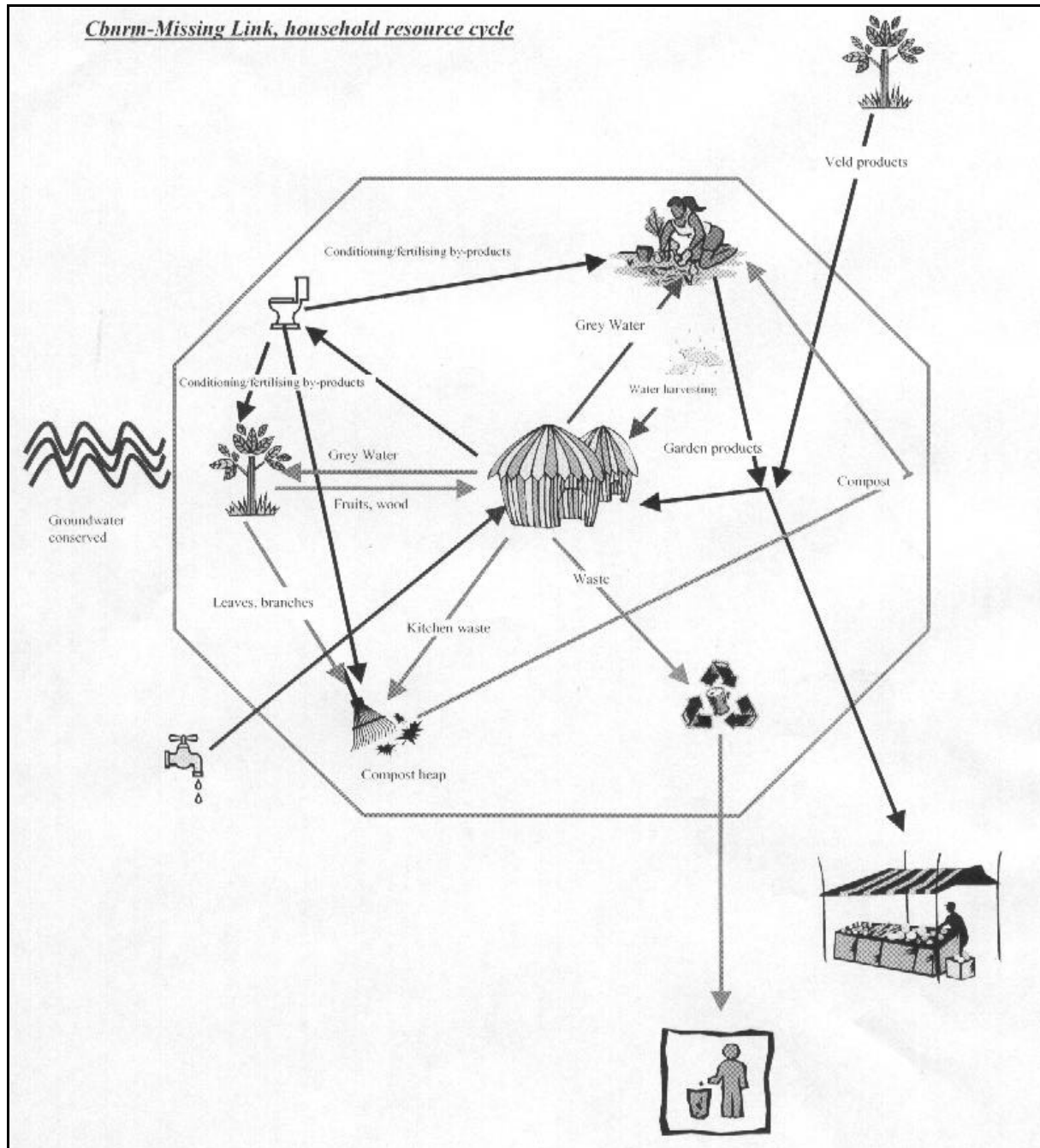


Experiencing Ecological Sanitation in Paje, Botswana

CBNRM Missing Link project

11.09-31.12.2003



by Tobias Hanke

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Abbreviations

BDF	Botswana Defence Force
BWP	Botswana Pula (5 BWP \cong 1 Euro)
CBNRM	Community Based Natural Resources Management
CLO	Community Liaison Officer
cm	Centimetre
d	day
DED	German Development Service
Ecosan	Ecological sanitation
GTZ	German Technical Advisory Service
ha	Hectare
HH(s)	Household(s)
IUCN	The World Conservation Union
kg	Kilogram
l	litres
m ²	Square meter
P	Person
PTB	Permaculture Trust Botswana
TOR	Terms of Reference
UD	Urine diversion
VIP	Ventilated Improved Pit Latrine

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Experiencing Ecological Sanitation in Paje, Botswana

**Internship Report
CBNRM Missing Link project**

11.09-31.12.2003

1. Introduction

The Ecosan approach, tested by the IUCN-PTB “Missing Link” project (funded by GTZ) in Botswana consists of small-scale integrated natural resources management activities around the households and within the communities. The concept includes a so-called single-vault, urine-diverting, dry toilet combined with the collection of kitchen organics and organics from traditional/animal refuse along with the construction of small-scale rainwater harvesting systems and recycling of non-organic waste - all to achieve the zero-emission town. The greywater component is for time being rather applied on garden and tree irrigation, but will be a larger part of the peri-urban Ecosan concept, which is under development by different organisations in/for Botswana. The project aimed to start small so to allow for proper piloting and at a later stage (once considered a viable option) expand to a national level.

Properly sanitised human excreta can be used as an effective fertiliser and soil conditioner. The concept of using human excreta as well as using other natural resources around the house for agricultural purposes is called “closing the loop”, and is a fundamental aspect of ecological sanitation. By collecting the nutrients found in urine and faeces through ecological sanitation and returning them to the environment through agricultural use, an environmentally beneficial and holistic cycle is created. Ecosan stresses the link between people, soil and food production, and attempts to sustainably link sanitation to the water cycle.

Human urine and faeces contain valuable nutrients including nitrogen, phosphorus and potassium. Urine possesses the majority of nutrients, as compared to faeces, containing approximately 60-80% of the nitrogen, 45-55% of the phosphorus and 50-60% of the potassium found in human excreta and available for reuse. Although a few diseases can be transmitted through unsanitised urine, it is a relatively safe fertiliser product, especially when compared to unsanitised faeces. Faeces do not always contain pathogens or parasites, but pose a high risk if they are not sanitised properly.

This report is a summary and analysis of field activities undertaken by an intern from the supra-regional GTZ-Ecosan-Project in the period between September and December 2003 in Paje (Central District). As Ecological Sanitation is still a very new concept for Botswana, this field experience – prepared by IUCN/PTB and the supra-regional Ecosan-Team - will contribute to a better understanding and lessons learnt on how to introduce/change attitudes towards household and neighbourhood centred ecological sanitation and resources conservation.

2. TOR and achieved milestones

The CBNRM Missing Link Project takes place in three villages of Botswana: East and West Hanahai (Ghanzi District) and Paje (Central District). The intern was placed in Paje from the 11.09.03 till the 18.12.03. Activities started with a visit to all participating households together with the Community Liaison Officer (CLO) Moetelela Pelokgosi. During the first week the intern had an overview on the situation of project-members from the community of Paje. Based on this information a more detailed work-plan was developed together with the Supervisor and the Co-ordinator (Appendix I). The following table shows the specific Terms Of Reference and the achieved milestones.

TOR for the household based activities	Results achieved
<p>Participate in the monitoring, evaluation and reporting on the maintenance of the Ecosan systems and their acceptance in daily social life, mainly the hygienic aspects and the reuse of the by-products in agriculture will be looked at.</p>	<ul style="list-style-type: none"> - Use of urine in the gardens (trials in 16 locations: agricultural demonstrator, PTB demonstration garden, school garden and participants). - Monitoring and sampling, awareness-raising among farmers living nearby on the use of human fertilisers. - Workshops and presentations on agricultural use of by-products. - Building of new toilets, building of composting units, filling with toilet content. - Teaching video for maintenance of compost
<p>Observation of the behaviour of neighbours not involved in the project: Investigation of their attitude towards the project and the systems, and their motivation / lack of motivation to participate. Benchmarking the neighbour-to-neighbour implementation facilities and investigating whether Ecosan is considered as an intermediate stage towards regular water closets or seen rather as a sustainable element of a holistic improvement in the quality of life.</p>	<ul style="list-style-type: none"> - Interview of neighbours and steady exchange of information in the day-to-day life in the village. <p><i>The water closet is unknown to a large degree, so there is no incentive to implement it.</i></p> <p><i>The Ecosan concept and its benefits (hygiene, comfort and fertilisers) is understandable for people in the project region, and the neighbour-to-neighbour implementation would require long-term monitoring to ensure a high standard of success</i></p>
<p>Assisting when requested in the development from locally available material of low-cost superstructures and collection, storage, treatment and handling systems for urine, faeces and greywater.</p>	<ul style="list-style-type: none"> - Capacity-building and training of builders. - Informing participants about facilities, possible solutions and strategies. - Creation of a demonstration site for rain water harvesting with shade construction out of local

	materials.
Monitoring the ongoing re-use of greywater.	Postponed by co-ordinator
Working on the improvement of community/garden design and selecting suitable plants for better erosion control (wind/water).	<ul style="list-style-type: none"> - Implementation of erosion control methods (wind/water), including terracing of landscape and single object protection in central village sites. - Training and capacity-building, design proposal and construction at HH level
Reporting on the implementation of natural rainwater harvesting, conservation and reuse-systems and on wind barriers and their implementation at the household and community level. If the water is planned for human consumption, weak spots in the system with regard to chemical (material) and environmental (e.g. contamination by birds) pollution should be identified.	<ul style="list-style-type: none"> - Building a demonstration structure for rain water harvesting for gardening purposes and presenting it in a workshop environment. - Protection of several erosion-affected trees at the <i>Kgotla</i> (place of the village chief). <p><i>Rain water for human consumption is mainly harvested using pots, pans and buckets placed under the roof runoff. HHs have been informed that they can be assisted in building water tanks if they wish to</i></p>
Improvement of the backyard gardening usage of the by-products (urine, faeces, greywater and solid biodegradable waste) of Ecosan systems; follow-up treatment, system application, hygiene monitoring, balancing of substance flow (water and nutrients)	<ul style="list-style-type: none"> - Urine trials at 16 locations: agricultural demonstrator's garden, PTB demonstration garden, school garden and participating HHs. - Monitoring the trials, sampling and evaluating laboratory analysis data towards improved understanding of the effects of the use of by-products on soil quality. - Building 'easy to maintain' composting units and initiation of faecal composting process. - Filming an instructional video on maintenance of compost. Workshop and presentations on agricultural use of by-products.
Identifying through field-piloting the first "rules of thumb" concerning how much of the by-products and how often they should be used in the gardens (depending on plot size, soil type, climate, etc), and reporting on alternative usage (trees, soil improvement, etc.) and application rates if the production of Ecosan products exceeds the locations' requirements.	<ul style="list-style-type: none"> - Conception of a measuring program, sampling and monitoring of trials in four different locations. Temporal and quantitative variation of urine application. Each trial consists of three plots, one fertilised with urine only, the second with a mix of urine and compost and the third serves as a control plot for comparison. - Evaluation of potential application areas - Interpretation of laboratory analysis towards improved understanding of the effects of the use of

	by-products on soil quality (possibly different effects on different types of soil).
Reporting back on research results and options and contributing to publications related to the research undertaken.	Regular reporting back has been undertaken during the internship in Paje so to allow for adaptations when and if necessary. Reporting is still ongoing
Monitoring and reporting back on ongoing activities outside the project and on the extension process (e.g. identifying and interviewing Ecosan systems users outside the program, e.g.: Mmatshumo- Lekhubu Island, Serowe, Shoshong).	<ul style="list-style-type: none"> - Interview with Stefan Ille Mmatshumo (DED, chief instructor of the community trust managing and campsite in the tourist area of Lekhubu Island). The campsite has installed UD toilets mainly because of rocky ground. The <i>UD systems divert the urine into soakaways, the reuse of urine was recommended.</i> - Excursions to different sites in Serowe, Shoshong (with Johannes Selke-Orbit pumps, Vaccum system) and Lesotho (Christopher Kellner, DED, HH level Biogas-plants).

3. Internship Project Location and general aspects

The village of Paje (Central District, Botswana) is situated 20km north of Serowe along the road from Serowe to Orapa. It stretches from north to south. The southern part of the village is situated around a limestone hill approx. 40 meters high. The northern part of the village spreads into the neighbouring hills, so parts of the settlement are situated in the higher regions, but the greater part is in the valley. In the so-called "Highlands", the soil is rather sandy, while the soil in the lower regions is generally more loamy in the lower regions.

The settlement structure is typical for the southern region of Africa. People live in yards ranging from 1200-3000 m². Each yard contains several houses/huts (2-8) and an outside kitchen, pit latrine (when available), garden (when available) and a fenced area for livestock (goats, sheep, donkeys, etc.). In some cases, three generations live together in the same yard. Each yard is usually bordered by its own fence (artificial or natural fence) and in the centre of the village the yards are situated closer to each other. Usually several narrow pathways run between them. Further away from the village centre, the yards are more spaced out (up to several hundred meters apart). The lay-out of the yards within the village looks rather random and unstructured, so that from a bird's eye perspective the settlement resembles a patchwork carpet. This lack of structure has resulted in a complex system of branching roads and pathways. All the pathways except the main road are unsealed lanes or footpaths. Only a small percentage of the population owns or uses a car. Some of the people use donkey carts but most of them do their daily business on foot. Livestock, such as goats, donkeys and cattle owned by the village people graze between the yards making the need for fences for the protection of private property against these smart and hungry thieves!

Several of the yards along the main Serowe-Orapa road are used for commercial purposes (laundry, clothing shops, bars, tuckshops etc.). East of the road is the BDF military camp whose military zone stretches over 20 km down south towards Serowe along the road and is not accessible.

Observation shows that the whole village is affected by the region's strong winds and water erosion, which, in turn, causes extensive soil degradation. The yards situated downhill are most affected. Dongas (eroded channels in the landscape) some 5-10 meters wide, 3-5 meters deep and up to 50 meter length can be observed close to the river which crosses the village in the centre (only in the rainy season). In some cases, small dongas cut right through the yards. One of the most affected public places is the primary school where dongas cross right through the schoolyard and cause the school building to be flooded during the rains.

4. Household assessments and findings of the questionnaire (incl. social and cultural background)

The Project group consisted of 18 participating families (Households, HH). The project started with 11 families and a second recruitment led to 7 new families being admitted. The following table shows the project members, their status and the existing structures:

Name	Status	Garden	Toilet	Compost	Fence	Tap connection	Trials
Dipotso Seaye	First call	X	Ground structure	-	X	-	-
Dipuo Radithoa	First call	X	Ground structure	X	X	-	-
Diteko Mathoka	First call	X	Ground structure	-	X	-	-
Gaanaope Nanatshane (Maseti)	First call	X	Ecosan in use	X	-	X	X
Goitsewang Letia	First call	X	Ground structure	X	-	X	X
Kelebtse Sesemi	First call	X	Ground structure	X	X	-	-
Lelemopedung Masephe	First call	X	Ecosan in use	X	-	X	X
Moetelela Pelokgosi	First call	X	Ecosan in use	X	X	-	X
Nagano Samonana Martin	First call	X	Ground structure	X	-	-	X
Rosinah Kenaope	First call	X	Ground structure	X	X	-	X
Tetelelo Samonnana	First call	X	Ecosan in use	X	-	X	X
Atzenje Kabelo	Second call	X	-	-	-	-	X
Mogomotsi Kebabonje	Second call	X	-	-	X	-	X
Mokanoki Monthontana	Second call	X	-	-	X	-	X
Moruagomo Kealeke	Second call	X	-	-	X	-	X
Onkamile Molodi	Second call	X	-	X	X	-	-
Thebeame Letia	Second call	X	Ground structure	X	X	-	X
Twaelo Boithatelo	Second call	X	-	X	X	-	X

Table 4.1: Project members, their status and the existing structures

Interviews were conducted in the time from the 10th to the 28th of November with a representative group of 24 families, 16 of which are project members and the rest neighbours or relatives of project members or candidates. The interviews were carried out with two objectives: the detailed recapitulation with the participants of project targets (teaching aspect) and secondly the investigation of project related data. The most important results are as follows:

The average number of family members is 6 (ranking from individuals to households of up to nine people) and the average age is 26 years. 17 of the 24 families do not have a male as head of their family and in these cases the families are led by the eldest female member (mother or grandmother). Three of the families are led by the father and four jointly by couples. The family income of 12 of the families ranges between 100 and 300 BWP per month (20-60€). 5 families have 300 to 500 BWP per month (60-100€), four 500 to 1000 BWP (100-200€), one 1000 to 1500 BWP (200-300€), one 3000 BWP (headman) and another 3500 BWP (teacher, non project participant). The source of income differs; in some cases people have regular work, others own a small business, e.g. bakery. In most cases people live from odd jobs (hair dressing, building, little kiosk, etc.), governmental subsidies or cattle.

30% of the families indicated social or health problems and 65% financial problems. The response to the question: “What are your expectations from the project?” varied. The most important tasks are:

- income generation with gardening, preservation of natural resources
- improvement of hygiene situation
- water connection
- extension of the garden, selling of vegetables
- shade-net and support for seedling business
- seeds and seedlings for ploughing; collect-a-can together with community
- use of by-products by community, food supply and income generation
- to learn more about new things from the project
- project can help with a tank for rain water harvesting
- to start own garden for selling vegetables
- better future due to gardening and learning from project
- toilet for generating fertiliser, making “big business” with farming, selling flowers and vegetables
- improvement of living standards
- help for nutrient recycling
- Providing a variety of seeds and farming techniques
- better harvests is possible since fertiliser is readily available
- products should be safe for children; safe implementation requires skilled man power and effective measurement systems

The question: “What do your neighbours think about the “Missing Link Project”?” was answered more or less the same way by all the families: “Neighbours were sceptical in the

beginning but now they have become interested, partly because they expect to benefit. They are nevertheless still sceptical about the use of human manure in the garden”. Perile Mmolai, the teacher who was in charge of the trials in the school garden, summarised this reaction with the words: “Misunderstandings are normal. With new concepts or ideas it takes time to change peoples behaviour.”

Although gardening is not common in Botswana, those that do have a garden in the project area usually fence off a portion of their yard to be used for the purpose. Although in many cases the yard has a fence, special fencing of the garden is needed to protect against goats, chicken, etc.. In the garden several plots are laid out for ploughing. The size of the plot usually varies between one and two square meters. The evaluation of the yard and garden sizes of the interviewed families led to the following results:

	Average	Minimum	Maximum
Size of yard [m ²]	1800	400	3600
Size of garden [m ²]	121	20	820
Space used for agriculture (excluding spaces between plots) [m ²]	68	6,4	430
Number of trees (> 1m treetop-radius)	5,8	1	23
Treetop-surface area [m ²]	120	21	280

Table 4.2: Evaluation of the yard and garden sizes

The preferred vegetables for backyard gardening are Chemolia, Rape, Spinach (Swisschard), onions, tomatoes, beetroot, carrots, beans, pumpkins and green pepper. The average income of the backyard gardening varies between 50 and 70 BWP (10 –15 Euro) per month. The amount of vegetables used for the family food supply and the amount of vegetables sold at the market differ with the actual personal situation.

According to the tswana lifestyle people normally move to their lands outside the village during the wet season to plough and sow them. However, all the families who were interviewed claimed that in the past three to five years they haven't planted anything on their lands because of the unreliable rainfall. In these cases backyard gardening provides an alternative/option to traditional food production strategies. A strategy of mixed seeding is used whereby all the seeds are mixed together and then sown. According to the information gathered during the interview, the average yield from sorghum and maize fields is 550 kg/ha. The size of land owned by a family varies from two to ten hectares.

The interview also concentrated on water consumption. Those interviewed were asked to estimate his/her family's water consumption. The minimum self-estimated water consumption of the families interviewed is 12 litres per person per day. The maximum is 340 litres per person per day. Water meter data was taken from seven participants with tap connections over a period of one month. According to these measurements, the average water consumption is 105 litres per person per day (max.: 167 l/P*d, min.: 37 l/P*d). The participant with the largest garden is not included in the calculation. In this case the average water consumption is 536 litres per person and day. According to the data gathered for self estimated water consumption, 60% of the total water consumption is used for gardening. Almost all of the families interviewed collect rain water for household and drinking purposes. In all cases collection is limited to the placement of pots, buckets or bowls under the roof runoff. For rain water harvesting for gardening purposes most of the participants use special techniques for surface runoff infiltration since they are part of the PTB (Permaculture Trust Botswana) teaching program.

The following questions were asked to evaluate the attitude towards the usage of toilet by-products:

Do you think that excrement and urine are valuable fertilisers?

23 yes 1 No 0 maybe

Do you believe that they can be risk free after treatment?

17 yes 5 no 2 maybe

Does your household use a toilet?

17 yes 7 no

Do you have a toilet in your household?

16 yes 8 no

Eleven of the families interviewed use a pit latrine, four the Ecosan urine diversion toilet, seven the bush, one the neighbours toilet and one owns a water toilet. The question: "If you had to use a toilet, what would you think is a fair price for a public toilet?" results in an average price of 70 Thebe (14 Eurocent). Prices mentioned were in general higher in the group of bush users. The minimum price was 10 Thebe and the maximum 2,5 BWP. If a person uses the toilet 0,7 times a day on average, a 6-person household would pay 3 BWP a

day to use a toilet. According to these statistics, a toilet would pay for itself in less than one year.

The average price of the existing toilets is 455 BWP. The question: “If you had to buy a new toilet, what would be an adequate price nowadays?” led to an average acceptable toilet price of 800 BWP. The market price of a pit latrine, according to information from local builders, is 1500 BWP. In relation to the toilet prices the average price of a tswana house (round grass thatched loam house) of approx. 20m² is 2250 BWP. A brick house (iron sheet thatched cement brick house) of around 15-25m² costs on average 6800 BWP. The following table gives an overview of the numbers given (The fact that prices strongly depend on the type of material and on the part of hired labour should be taken into consideration, so the prices shown are just a rough average):

Acceptable price for use of public toilet	0,7 BWP
Average price of existing toilet	455 BWP
Toilet price acceptable nowadays	800 BWP
Market price of pit latrine	1500 BWP
Setswana house (20 m ²)	2250 BWP
Brick house (15-25 m ²)	6800 BWP

Table 4.3: Prices for toilets and housing

In response to the question: “Which type of toilet do you prefer?” 20 families answered the urine diversion toilet, 2 the water toilet and 2 the pit latrine. In 4 cases the Ecosan urine diversion toilet is in use. The evaluation of questions concerning people’s experience with the urine diversion toilet is as follows:

The average filling time of a 20 litre urine container is three to five months for one person, while a family with six members (two adults, four children) needs three weeks to fill a container. The filling time depends on the particular behaviour of the users. In many cases, trees, fences or the bush are used for urinating, especially by men. In some cases, the urine passed overnight into smaller containers is transferred to the toilet, but it is also used in the compost or on trees and fences (hedges). Two families preferred to use a bucket for the collection of the faecal matter, while the two others use a heap. A 30-litre bucket for faeces is filled by one adult person in three to five months. A family of six members needs two to three months to fill a 50-litre bucket. The particular experience with the urine diversion toilet is in all cases very positive. The minimal odour was emphasised, furthermore people asked for protective clothing for their hands and mouth for use when emptying out the faecal matter from the container (ash flies around).

18 of the 24 families use urine for fertilising purposes; some as trials to learn the new concept while others use the fresh overnight urine on trees and flowers. The Question: “What are your future plans for your garden?” was answered in most cases with a strong interest in extending the garden and the willingness to increase vegetable production and generate income. The responses to the question: “What are the major obstacles to improving your garden?” varied as follows:

- Goats, pests, termites
- Not being owner of yard
- Fencing problems and poor soil
- No money for seeds
- No tap connection
- Misunderstandings in the family as to who earns the income of the vegetables sold
- No hosepipe
- No fence/corner poles

70% of the families interviewed own livestock such as small groups of goats (3-12) or chickens. 50% have a compost. In general the compostable material generated daily in the households is very little. In many cases it doesn't reach the compost because it is fed to the animals. Five families add overnight urine to the compost (from one litre per week to three litres per day), 7 add grey water to the compost (from six litres per week to 2 litres per day).

At the end of the interview general aspects were investigated. The question: “Do you have any special remarks or questions to complete our interview?” was answered in the following ways:

- “Ecosan is very good for controlling the smell and protecting groundwater!”
- “Little children don't like to go to pit latrines because they are very old. Is it OK to let them defecate in the dust and drop the faeces on the compost?”¹
- “I am grateful to be a participant in the project!”
- “How are you going to improve my yard?”

The question: “Thinking about the above topics as a résumé, what are your personal wishes to improve your actual situation? What are the special needs of the household (the village)?” was answered with the following statements:

¹ Advice given: For better control, faeces should be collected in a covered bucket and then filled in compost and covered well.

- Extension of the garden (fence)
- Having an office or project garden for all the members
- Tap connection
- Finishing or building a toilet
- Willing to do some production of tree seedlings if project helps with shade-net
- Assistance from the project and more information for the people
- Improvement of the lands
- Planting of trees, beekeeping
- Yard partly unfenced
- "People of the village can buy vegetables from me; demand is higher than the supply"
- Exchange of soil
- Water connection, toilet for collection of composting material
- I want to join the project
- To bring more skilled man power, to continue learning

The last question concerned the special interest of the interviewed. The main points are:

- Gardening with human manure
- Gardening, Ecosan, composting
- Water harvesting, erosion control, gardening
- Keeping pigs/bees
- Manuring and using urine, gardening
- Water harvesting, ploughing methods, use of HH-waste
- Use of toilet by-products
- How much could I earn per month?

5. Approach and methodologies of field activities

According to the TOR the specific tasks can be divided into four main areas:

- Practical tasks with community members
- Workshops and meetings
- Training of builders and on-the-job capacity-building of project staff (CLO)
- Research on the potentials of the agricultural use of by-products from the toilets

Practical work has been done with project participants on community sites as well as on sites of individual members. All the participants volunteered for the work. Transport was provided by PTB. The work was accompanied by project meetings and/or workshops for training purposes and to define the needs of the group as well as for reflection on progress made within the project. System builders and constructors are in a key position to promote Ecosan systems as they are the ones who have to build the hardware components in line with economic considerations. As there are different toilet systems on the market competing with Ecosan (e.g. flush toilets and VIPs), Ecosan's promotion depends on a high standard of construction and an affordable price for the structures.

For the closed loop approach toilet by-products should be used as soil conditioners and fertilisers. One way to do this is to use them in the family garden. To raise knowledge about the fertilising capacity of the toilet by-products and their appropriate garden use (amount, hygiene aspects, etc.) under the specific conditions of the project area (type of soil, vegetation, climate, attitude of the participants, etc.) trials were recommended. Besides the development of useful data, trials were also instrumental for the practical demonstration of the fertilising value of urine (learning-by-seeing experience for project staff, participating HHs as well as other community members and visitors). The results of these and further trials will contribute to the development of a field manual that will be developed through the Missing Link project. The guidelines aim to inform ecological sanitation users on how to handle the urine and faeces in a safe and beneficial manner and thus promote the use of human excreta in agriculture.

6. Specific Tasks carried out

Specific tasks carried out during the internship are reported in the following section (also see Appendix I-VI).

6.1 Erosion control and rainwater harvesting

The topics erosion control and rainwater harvesting were benchmarked during the project and participants learned in workshops about them. In most of cases erosion control and rainwater harvesting measures derive from similar constructions that have the purpose to control the water flow and/or to reduce surface runoff velocity towards improved local infiltration.

The first activities undertaken with some of the participants and the CLO were linked to team preparation at the intern's yard. The aim was to get an impression of the working attitude so to be able to work out an appropriate detailed plan. The work object was a plastic sealed pit 5 meters in diameter and 1,2 m deep (see pictures Appendix V). Due to the major interest in erosion control matters, it was also decided to undertake erosion control measures in strategic central places, that could serve as good example and demonstration for the entire village. Household based activities in both erosion control and rainwater harvesting were carried out simultaneously during regular visits and in workshops.

The Kgotla (location of the village chief) and the school were selected as work places, where trees badly affected by erosion were reinforced in a collaborative effort. Simple walls of natural stones found in the surroundings of the Paje village were erected around two big trees at the Kgotla. The space between the trees and the walls was filled with earth to protect the exposed roots, and flowers and climbing trees were finally planted over them (see also Appendix V). The Kgotla is used for official meetings and as a waiting area in the case of official requests, so benches were incorporated in the walls for public use. During the entire exercise transport was provided by PTB and labour was provided by volunteering project participants/community members (participants were informed when the work started and it was possible to recruit a group of eight to ten volunteers. Furthermore, protection around an erosion -affected tree in the schoolyard was constructed together with pupils. The work was finalised on October the 16th after one and a half week. A spreading effect was observed as similar structures could soon be found in some private yards of participating and non-participating families.

6.2 Toilets

From the 18 participating families in Paje shown in table 3.2.1, 4 have their urine diversion dry toilet in full use. Two of them use a bucket while the others use a heap for the collection of faecal matter. In all cases urine is collected in a 20-litre container. Particular experiences with the maintenance and acceptance of the urine diversion toilet are reported in the findings of the questionnaire. As with all other project components participants are encouraged to follow the self-help approach, thus the project usually only contributes parts of the cash/kind (often 50:50 agreements) to each activity. In the case of the UD-toilets the project finances the ground structure and the pedestal, but the superstructure has to be finalised by the participants. A particular aspect is that in many cases people delay in finishing the toilet, some possible reasons for this are:

- Financial constraints (Scarcity of money in the family)
- A usable pit latrine exists in the same yard, so the need for Ecosan is not urgent
- The holistic approach hasn't been internalised by the participants
- The seat of a pit latrine (e.g. bench with a hole in the middle) provides a different level of comfort compared to the plastic or cement UD pedestals
- A UD pedestal has to be cleaned, while cleaning is hardly necessary in some pit latrine designs

The Paje participants started by choosing a toilet design seen in South Africa during a 'study-visit' in April 2002. The toilet chamber of the UD toilet is built half or totally underground (substructure approx. 1-1.5m deep). It is covered with concrete, which supports the superstructure and covers two-thirds of the ground structure. For maintenance purposes the last third is covered with a special movable slab which in most cases can be lifted from outside. The experience showed that because of the slab's heavy weight, the families – especially those without male support – have difficulties moving it. Another weak point in this toilet design, which makes handling uncomfortable, is the depth of the substructure forcing people to step down into it to carry out even routine maintenance. In addition the joint between the slab and the back wall is in some cases not watertight, so rainwater enters from the outside toilet walls into the toilet chamber, increasing the moist of the faecal matter and intensifying the odour.

In the Hanahais – the other project area– the start-off was similar and the toilet design was gradually changed upon request/ideas from the Households themselves. The ground structure was built-above the ground with a door at the back for better handling and toilet maintenance (see photo documentation Appendix V). This design was transferred to Paje

using local builders. Two new toilets were built in Paje (see Appendix III and V). One at the site of Thebeyame Letia, who is a project participant and builder of the toilets, and another one at the site of Mr. Nagano Samonana Martin, the village headman. A third toilet is planned for Atzenye Kabelo who first wanted to build a new pit latrine but has now decided to use the UD toilet.

For the construction of the new toilets all necessary materials were purchased for the different sites. Quotations for the material were requested through PTB. Construction plans were drafted and builders trained on the new structure. A major problem during the building phase was the sensitisation of the participating workers to ensure an adequate standard of quality.

The experience after the first two toilets showed that a builder with one assistant needs two and a half to three days to build the toilet ground structure. The following table shows the material, prices and labour for the ground structure. Based on this calculation, the price for the ground structure is estimated at 700 BWP (140 €) for Paje.

	Amount	Price per piece [BWP]	Total [BWP]
Bricks (big 44*22.5*11)	35	2,6	91
Bricks (small)	35	0,6	21
Cement (slabs, brickwork and plastering)	5	25	125
Riversand (wheelbarrow)	15	4	60
Plaster-sand	5	4	20
Mashwire	2	25	50
Brickreinforce	1	25	25
Timber for frame (10% of total price)	0,1	70	7
Timber for the door	1	36	36
Joints, nails, screws, etc		30	30
Labour [h]	20	8	160
Labour [h]	20	4	80
			705

Table 6.2.1: Material, prices and labour for the toilet ground structure

The ground and the top slab were built with the help of a wooden frame, and a frame of concrete was made in a wooden mould for the opening in the toilet. Some difficulties arose as the door of the toilet chamber had to be connected to the frame. The plan was to drill some holes and to use plugs and screws. Unfortunately there wasn't a drill available at either PTB or in the Paje village – and even electricity is only available in certain places. Finally the concrete frame for the opening was built with small wooden inlays so that the door could be easily connected with screws. For safety reasons (playing children, etc.) it was recommended to install a lock at the door.

6.2.1 Toilet Pedestals

Plastic pedestals for the first UD toilets were purchased from South Africa. Once the use of UD-systems confirmed a mould was acquired from South Africa so to allow communities to mould their UD-pedestals directly. Several pedestals were made of cement together with the CLO and Thebeame who had been to a moulding workshop organised by the project a few months earlier. Moulding trials showed that the pedestal should be removed from the mould after three to four days drying time. If done later the pedestal sticks to the mould and eventually breaks. Accelerator was not needed. Even if the mould is filled very carefully some air pockets/pores remain in the fresh pedestal, and these have to be filled with crackfiller afterwards. Due to hygienic aspects and for maintenance purposes (e.g. proper cleaning, so to minimise the risk of bacteria surviving in a rough surface), the pedestal has to be painted before use. After crack filling and painting, the pedestal is ready for use. A special resistant floor paint was ordered for this purpose and should have been delivered at the end of December. The following table shows the calculated price for one pedestal (as moulded and finished in Paje):

	Amount	Price per piece [BWP]	Total [BWP]
Cement (slabs, brickwork and plastering)	0,5	25	12,5
River-sand (wheelbarrows)	0,25	4	1
Plaster-sand (wheelbarrows)	0,25	4	1
Chicken-mash	-	4	4
Oil	0,5	8	4
Rope	0,5	16	8
Sandpaper+crackfiller	-	6	6
Paint	-	12	12
Rental of mould	-	1	1
Labour [h]	6	4	24
			73,5

Table 6.2.1.1: Calculated pedestal price in Paje

73,5 BWP or 15 Euro is the price/unit for a pedestal under the specific circumstances of the project area (Paje). A standard ceramic pedestal could be bought in the local shops for around 100 BWP.

6.3 Composting

For hygienic reasons it is necessary to compost faecal matter for further use after it has dried in the urine diversion toilet. The recommended composting time is one to two years or longer to achieve advanced hygienisation. The maintenance and use of compost is culturally unknown in the project area as well as generally in Botswana. Only in a few cases it was possible to compost successfully, since the dry climate means that compost has to be watered or overnight urine has to be added to it regularly. PTB shows good results producing and using chicken manure compost. Most of the participants use cow dung or chicken manure without composting in their garden, which obviously doesn't lead to the desired results (leaf-burn from excess nitrogen, weeds from seeds in cow dung, etc.).

In September the buckets of one project toilet were almost filled so they needed to be emptied. The participant was already using compost in a pit close to the kitchen. For safety reasons (children playing nearby, etc.), it was decided to build a "Composter" as they were seen during the 'study-tour' in South Africa. A simple brick structure with aeration openings was built in the participant's yard (see Appendix V). The same structure was also built at two other sites where the UD toilet was in use. After finishing and drying the structure, the buckets were emptied into the Composter. In order to ensure a successful composting process, the faecal matter was mixed with some earth (bacteria inoculation), garden waste and other organic materials (smaller twigs for aeration) and with parts of the already existing compost for better activation of the biological process. Samples of the faecal matter were taken to monitor hygiene. The participant was told to keep the compost humid (but not too wet!) using greywater and/or overnight urine. This is absolutely necessary in Botswana's climatic conditions, since biological activity is considerably reduced in a dry medium. It was recommended not to use the suds. The amount of greywater needed to keep the compost humid won't harm the biological process and it is an effective way to reuse it.

The filling and preparation of the compost was recorded on video. The film was presented to a number of participants at a workshop the following weekend. One participant who uses a heap (instead of a bucket) started to fill the Composter by himself as was shown on the video, which is a good example of the value of instructional videos in extension work. The calculated rates and demand of material and labour for the composting unit are given in the following table:

	Amount	Price per piece [BWP]	Total [BWP]
Bricks (small)	114	0,6	68,4
Cement (slabs, brickwork and plastering)	2	25	50
River-sand (wheelbarrows)	6	4	24
Plaster-sand (wheelbarrows)	2	4	8
Brickreinforce	1	25	25
Timber for the frame (10% of total price)	0,1	70	7
Joints, nails, screws, etc		6	6
Labour [h]	10	8	80
Labour [h]	10	4	40
			308

Table 6.3.1: Material and labour for the composting unit

6.4 Use of Ecosan by-products in gardening

Experience in the village showed that people in general react unfavourably to the use of urine and treated faecal matter as fertilizers and soil conditioners. An example is the case of Mr. Ganaope Nanatshane's yard. During the first visit on 12.09.2003 both urine-containers (40 litres) were full, the urine pipe was found aside, leading to the sand near the toilet. An intensive smell of urine could be discerned around the toilet (the same situation had been found by the co-ordinator 2 months previous). During the presentation to the village chief on 15.09.2003, it was announced that some trials for garden use of urine would be made. In the following visit to Ganaope Nanatshane's yard on Thursday 16.10.2003 both containers were found empty and the toilet surrounding cleaned up. Mrs. Nanatshane told us that she had put the urine (40 litres!) on the compost, but no intensive odour was subsequently found there. A reason of the rejection might be found in education and tradition. In the project region for example the yard fence serves as a urinal. Urine is therefore something to keep out of one's own terrain. There is also the strong belief that urine and faecal matter is something very dirty. The consideration that it could be something very valuable after treatment is quite erroneous in tswana understanding. On the other hand there are some superstitious reasons for the negative attitude, for example widespread belief in witchcraft (urine as a substance which could be harmful). Even the fear of spreading HIV through the use of urine in the garden was mentioned.

6.4.1 Trials

Soils in Paje are degraded. Fertilizer and soil conditioner are needed to improve backyard gardening. Normally in Botswana – cow manure from old “crawls” (congregation point for cows) is used for these purposes. Because of the central role of cattle farming in Botswana, cow manure is available in many places, and it is even a basic material used in house construction. Urine and faecal matter are another source of valuable fertilizers, and are readily available. Pilot trials for the agricultural use of urine were identified as the most important follow-up step towards encouraging responsibility for one’s own toilet products and for demonstrating their fertilizing potential. Learning by seeing is a chance to convince people of the benefits and fertility of urine and thus close the loop. Several participants (see above list) were interested in the trials. Furthermore it was possible to convince the chief of the agricultural demonstrator of the village to facilitate trials on the demonstrator’s plot. Additional urine trials in the school garden and in the PTB demonstration garden were also possible. In order to test the facilities for Ecosan recycles reuse in the village-related farming areas, additional trials are planned and contact has been made with interested farmers.

Three plots were prepared in each of the 16 locations. One was fertilized with urine, one with urine and compost, and the third one without any kind of fertilization for comparison purposes. A sampling schedule was drawn up for four of the sites. The selected sites are spread over the village, they differed in the soil quality and gave an overview of the variety of conditions that can be found in Paje.

Samples were taken four times in a vegetation period of 8 weeks (mixed sample from each plot in 5 and 20 cm depth). After the first preparation with urine and compost, fertilizer (urine) was reapplied twice. The first sample was taken before preparation, the second one week after preparation at the time of ploughing and planting. The other two samples were taken after reapplication. Urine was reapplied after four and after six weeks after ploughing.

According to general fertilizing strategies reapplication could take place earlier (e.g. after 14 days). As it was not clear how the plants would react to urine and how sensible the system is under local conditions (soil, climate, watering, etc.) a decision was made to delay reapplication until the plant reached a stable growth-stadium in order to avoid growth repression. In the plot only fertilized with urine we added 1l/m² the first time and 0,5l/m² the second and the third time, so that this plot had finally been fertilized with two litres of urine per square meter and growth period. Drawing from the PTB’s experience, three shovels of compost were used to fertilise one square meter. The same amount was used in the plot

fertilized with a mix of compost and urine, with an additional 0,5l/m² the first time and then 0,25l/m² of urine added twice more.

In all cases half of each plot was prepared with spinach (Swisschard) for reasons of comparison. The participant was free to choose the plants for the second half. The full responsibility for the trials (seeding, watering, etc.) lay with the owners of the garden. In most cases it was possible to attain the expected results for demonstration purposes:

- The biomass production in the urine fertilized plot was on average 30-40% higher than in the unprepared plot
- Best results could be achieved with the use of compost and urine. In this case growth was on average 40-50% higher than in the unprepared plot
- In general growth repression due to over fertilisation was not recognised
- By-product fertilized plants were strong and healthy and more resistant against pests
- By-product fertilized plants seems to be rich in taste
- Participants started to use urine after demonstration and even those without a toilet started to collect urine for further use

More than 50 factors affect crop growth and yield potential. These include the climate, soil characteristics and plant nutrients. With a minimum of one or more nutrients plant growth is limited. Urine is rich in nitrogen, phosphorus and potassium, and compost contains a wide spectrum of all macro and micro-nutrients. With the use of urine and compost the nutrient supply is more balanced than in the use of only urine, resulting in a higher yield. In the location with the sandiest soil the urine fertilised plot showed significantly less growth in the first four weeks than in the unprepared plot. However this hints to the importance of soil organic matter and to the toxic effect of free NH₃ on germinating seedlings in dependency on soil moisture and soil texture.

Project related research on the use of Ecosan products is ongoing. A detailed report on the results of Laboratory Analysis of field trials/samples will be prepared later (mid-2004).

7. Conclusions and recommendations

After three months of intensive work with the project members it was possible to obtain an insight into the specific challenges and problems of the introduction of a closed loop sanitation concept in Botswana, especially in rural areas. The introduction closed loop sanitation concept in Botswana is in its expanding phase. As a result of the work during the internship with IUCN and PTB supported by the supra regional GTZ Ecosan Project, it was possible to improve the linkages between different programs and the sharing of knowledge on ecological sanitation. As ecological sanitation is still a very new concept in Botswana, this field experience contributes to a better understanding and lessons learnt on how to introduce/change attitudes towards household and neighbourhood-centred ecological sanitation and resources conservation.

The interview (the results of which can be found under Point 3) was also conducted with Mr. Nagano Samonana Martin, headman of the village and participant in the project. Several points concerning policies and the way forward for Ecosan in the Paje village were consolidated during the discussion. Mr. Martin, who at the end of the internship gave the strong impression of being convinced, mentioned the importance of passing on the information to all the village members. He said that people are still digging pit latrines and pollute the ground water, and that he won't accept this for the further development of the village. But he also pointed out some doubts. One of his main questions was: "What happens as more and more people use the Ecosan concept? Will all the by-products have to be recycled in the village when the project spreads?" Mr. Martin is owner of a second yard outside the village. He told us that he would treat and use his own toilet by-products there.

In the tswana understanding urine and especially faecal matter are something dirty that you have to get rid of and forget about as soon as possible. That is also the experience made during the work. "The toilet is a place where you just go because of the call of nature" is a quote from one participant. This attitude comes from years of using the existing sanitation systems. The bush-users have the problem that the squatting places are dirty (flies, etc.) and each time they go there they are confronted with other people's faecal matter. The pit latrine-users are used to the "drop and forget" mentality; however most pit latrines are quite smelly, and populated by cockroaches, flies and other small animals (worms, snakes in rocky areas, etc.). Daily experience of this repulsive location is psychologically related to what people do at this place and to what their bodies release. Even if the faecal matter is treated and then used in the garden, for many people it feels as if they defecate in their garden. In this context Mr Martin's doubts are understandable and maybe he has fears that some people might not be responsible enough to conduct adequate follow-up treatment.

As Ecosan is a philosophy with a large variety of system components, the possible closed loop scenarios are wide-ranging. Co-operating with farmers operating near the village is also an option, since the experience showed that in most cases these people are interested and open-minded. In this context it should be taken into account that it is barely possible to expect everybody to account for his or her own toilet products. In every community there will be a certain group of people who is not able or willing to work on this. For this reason, a neighbourhood centred solution should also be conceptualised. As was mentioned by PTB, an example would be to take care of faecal compost in case people rejected it, local farmers could be found to do this job and benefit from the fertilizers in return. Another point is the hygienic product quality control. Even if it was certain that after more than one year composting time the amount of pathogens is reduced to a non-risk level, in some cases composting might not be successful. If, for example, the compost was too dry all the time, a real biodegradation would not take place. In this case the faecal matter is more or less simply dried, instead of being decomposed by bacteria and micro-organisms. Such faecal matter may be considered 'untreated' as it may contribute to recontamination as pathogens would become active again once humidified. The question is on how hygiene standards could be guaranteed for all users in a project which is at an advanced stage? For as long as the number of participants is small, monitoring remains relatively easy, once the concept starts spreading to a larger audience though it might become difficult to guarantee hygiene standards. It definitely needs skilled and motivated personal as well as a minimum of analytic capacity to guarantee sustainability of the project, even when the project is over. This is an opportunity to create local businesses. In Western countries it is a normal thing to call a plumber when something is wrong with the toilet. Why shouldn't a concept like this work together with the Ecosan approach in Botswana? In any case a certain kind of value is created with the fertilizer reuse.

Another point is the central role of builders. Once the financing received through the project is finished, they have to build structures under economical constraints. Capacity building and quality management concerning the construction of toilets is a key role in the expansion process of the Ecosan systems. This has to be linked however to the prices and quality of competing systems on the market.

One part of the Ecosan approach is the construction of the system, another is the treatment of the toilet products and a third is the use of the treated by-products. At the beginning of the internship a slight uncertainty concerning the use and the usage of the by-products was recognised. In the trials the fertilizing potential of the by-products, especially of urine, could be demonstrated. When the results from the trials became significant, people who had been storing urine started to use it in other parts of the garden. Inspired by the results, others started to collect urine. This shows in an impressive way that with time and learning-by-

seeing experiences a change of attitude is possible. Another important aspect recognised during the work was the different levels of acceptance of using urine directly as opposed to pouring it on the compost and then using it in the garden. The indirect use seems to be easier to accept. However this is related to the abstraction between fertilizer and toilet product. It remains to be seen how the composting of faecal matter can create this necessary abstraction and therefore acceptance. The same difference can be observed in verbal understanding. "Faecal matter as fertilizer" is a less acceptable phrase than "a fertilizer for which production faecal matter was used". This is the kind of mental barrier everybody has towards his own toilet products, more noticeable in some than in others. Even the belief in witchcraft (urine/faecal matter as a harmful substance) and the fear of transmission of HIV due to urine should be mentioned here for better understanding of the cultural background.

The maintenance of the dry toilets as monitored was in all cases adequate. In some cases users do not add enough mixture of ash and sand. This could result in the development and increase of flies. One cup after use is recommended. Due to the dry climate in the project area, water scarcity and lack of water connections, people are used to handling their water resources economically. For example it was observed that after washing water is carried out to the trees. These activities vary with the family's attitude and facilities. On the other hand there is a certain risk connected with families getting new water connections. Not being used to the new abundance of water, they might lose interest in resource protection, as was seen in various cases. In the long run, the first water bills people have to pay will regulate this. The real costs of the garden products including water costs should be investigated.

On the 3rd of December a project delegation from East and West-Hanahai visited the Paje project group to exchange experiences. The day was organised by the Paje project group and all the important sites were visited. The composting of faecal matter and the trials as well as the new toilets were demonstrated. After some minimal initial anxiety the understanding and exchange of the two groups was very productive. One of the visitors stated: "This was really educational!".

Appendixes