PACE
UGANDA

Promoting
environmental
education and action
in schools

2011

Published by Siren Conservation Education and Tusk Trust

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Acknowledgements

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A catologue record for this book is available from the British Library
ISBN 978-0-9555682-3-7

Compilation and editing by Gaster Kiyingi

Additional illustrations by Sekiranda Moses

Designed and produced by GraphiConsult, www.graphiconsult.com

Printed by GraphiConsult.

Photo Credit: Crested crane (*Balearica regulorum*) by Rafael Ramirez Lee from www.shutterstock.com

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Preface

It has been just two years, but the environmental activity at Ggaba Primary Teachers' College would make one believe that our love affair with the environment has already clinched the much coveted Diamond Jubilee!

The bee hive of activity involving rainwater harvesting, eco-sanitation, fuel efficient stove installation, and permaculture gardening has already had its amazing and welcome impact on the college and surroundings.

It all began with a friendly chat with VSO Janice Mercer who was on assignment at Ggaba PTC for the year 2008. We zeroed down to writing a proposal that would attract the support of other environmentalists worldwide, to try out new cost effective and environmentally friendly technologies for our East African region, and Uganda in particular.

Janice took up the challenge and spear headed the search for partners. We eventually were lucky enough to get the partnership hand of TUSK-TRUST/SIREN/PACE of the United Kingdom. We hit more luck as the Desk Officer for our partnership, Ms. Nancy Gladstone turned out to be a real great person with vision, zeal, mission and warm friendship.

Today we have gone quite far. Over 56 primary schools are on the way to implementing the Ggaba PACE vision. About 1002 primary teachers are already an advance cadre group of Trainers of Trainers in PACE pro-environment initiatives. Really the sky is the limit for the PACE Uganda Vision!

I wish to extend thanks to the Honourable Charlie Mayhew for his great support, to Dr. Robert Mercer for availing his expertise, Ms. Sarah Watson for her timely technical support, to Michael Keigwin (founder and executive trustee of Uganda Conservation Foundation), Patrick Agaba and Enid Kakooko (Uganda Conservation Foundation) for their untiring guidance with regard to accounts' figures, and to Charlotte Beauvoisin for her innovative ideas. I am grateful for the support from Mr. Muhenda David that he accorded to the PACE Project and Environmental Club at Ggaba PTC. Finally I'm very grateful to Gaster Kiyingi who has kindly offered to edit this Manual, and Moses Sekiranda whose art-genius lightens up the pages of the Uganda PACE Manual. We at Ggaba PTC wish that you enjoy reading this manual and that you will be strengthened in the love and care of our environment.

For to love nature is indeed the greatest and truest love of our own selves!

Aloysius Kironde PATRON
GGABA PTC ENVIRONMENTAL CLUB

Overture

Welcome to the **PACE Uganda Manual 2010.** It is the most recent addition to the PACE resources, which include among others:

- **Africa Our Home**, a beautiful book written by Sasha Norris with Nancy Gladstone
- **A DVD** of environmental education films (Uganda Edition now available)
- **CD ROM** of PACE Action Sheets covering a wide range of information and activities.

These can also be downloaded from the internet: www.paceproject.net.

This addition, the **PACE Uganda Manual** has relevant action sheets, articles and information based on environmental projects at St. John the Baptist, Ggaba Primary Teachers College and selected examples from other schools.

It is a requirement that Teacher Training Colleges undertake environmental projects. It is for this reason that Ggaba Primary Teachers College started ecologically friendly projects on the college compound and that the college has encouraged its students to start similar projects at schools where they teach.

This manual, we hope, will provide knowledge and practical information to help spread the word about the need for environmental conservation. The projects can be used to demonstrate how simple solutions can not only improve the quality of our environment, but also educate, create viable enterprises and save money. The ideas in this manual can be adapted and used in many different situations and institutions and it is hoped that the knowledge herein will also find its way into the wider communities served by schools and colleges. The lessons plans provided in the annexes provide a guide on how teachers can make good use of the content in this manual for lesson planning.

The PACE Uganda manual only contains action sheets that are relevant to the Ugandan situation. Should there be a need for further information, we recommend that users of this manual refer to the detailed Action Sheets available from the Internet at www.paceproject.net or on the CD-ROM. Email pace@siren.org.uk to request further copies or contact Uganda Conservation Foundation at www.ugandacf.org

One tutor at St. John Baptist Ggaba Primary Teachers College writes:-

> '... human creativity and the desire to exploit the surroundings to make money alters and transforms the environment. During this process of transformation we suffer the consequences. We never realise until it is too late!' Betty Odido.

So what can we do? One of the pioneers of the St John the Baptist PTC Environmental Club, now a qualified teacher, writes:-

> '...we can always improve…… encourage everyone to plant at least fifty trees in their lifetime. Avoid careless littering. Use mostly renewable materials. Sensitise the young and old about the environment, form environmental clubs in school and villages. Don't dispose of poisonous waste thoughtlessly; even pouring away soapy water can dry up grass. Avoid wastage, encourage saving. It is man's responsibility to care for the environment and all its contents right from the beginning and so let it be an obligation that man fulfils' Asimire Jovelyn Mwesigwa.

It is recommended that you use the lesson plans in the annexes in this book as a guide to planning lessons. The Jane Goodall Institute has also published useful material entitled "Integrated Environmental Education Lessons within the Ugandan Primary School Curriculum for Primary Five, Six and Seven". They also have published an Environmental Education Teachers Guide for Primary Five. Please download them, if you can from www.janegoodall.org or email info@jgiuganda.org.

What is the PACE project and how did it come to Ggaba Primary Teachers College in Uganda?

By Janice Mercer and Dr. Robert Mercer

PACE stands for Pan African Conservation Education. Somebody somewhere has found a solution! The idea behind the PACE project is to help spread simple solutions to environmental problems between communities in Africa. From fuel-saving stoves to rainwater-harvesting, compost making to forest product certification, the PACE project aims to share vital information about practical ways in which people are addressing environmental problems.

The PACE project is a partnership between Tusk Trust and Siren Conservation Education. The PACE resources for schools, environmental education centres and community-based organizations include a series of films and written materials and cover 7 topics: Living with Wildlife, Water, Soil, Forests, Energy, Living by the Ocean and Urban Living. Since the project's launch in 2006, PACE packs have been sent to over 260 organisations in 26 countries, ranging from large non-governmental organisations such as the World Wildlife Fund, Jane Goodall Institute and Wildlife Conservation Society to environmental education centres such as Mokolodi in Botswana to small rural schools like the Ntugi Primary School in Kenya.

Ggaba Primary Teachers College received the PACE packs via the Uganda Conservation Foundation, a long-standing partner with Tusk Trust on various conservation initiatives in Uganda. Through this connection, a report on environmental problems at the college by the College Environmental Club reached the PACE Project in the UK, sparking off the idea to use the solutions outlined in the PACE resources to address the problems listed by the club, and to use the college grounds to introduce environmental issues and practical solutions to teachers at the start of their careers.

Based at Ggaba Primary Teachers College, and conducted in partnership with the Ggaba College Environmental Club, VSO Uganda, and the Uganda Conservation Foundation, the PACE Uganda project aims to create opportunities for trainee teachers to learn about and participate in the development of cost-effective solutions to common environmental problems.

The project has three main objectives:-

1. To develop projects in the college grounds that demonstrate solutions to common environmental problems.

The projects include constructing composting toilets and washing areas (to address waste and sanitation issues), creating permaculture gardens integrating livestock/poultry and vegetable growing (to deal with soil erosion and improve food availability), rainwater harvesting (addressing water shortages and expense) and building fuel efficient stoves (to demonstrate energy efficiency and to reduce fuel costs when cooking food for staff and students). These demonstration projects at the college were designed to illustrate how similar projects could work in schools and surrounding communities.

2. To train new Primary School Teachers to be able to teach environmental awareness and practical skills for sustainable development.

This training includes exposing them to the practical projects described above, to enable the students to learn by "doing". It has also involved field trips to places of interest such as a National Park to increase awareness of Uganda's heritage and the threats it faces. Through this project, the college has also procured resources to enhance the teaching and learning experience. For example, the project purchased a DVD player and television screen enabling PACE and other teaching materials to be used for training.

3. To share knowledge and experience developed through the project via the creation of a Uganda specific training manual of techniques for teaching practical skills for sustainable development, poverty alleviation, wildlife and the environment.

This manual, the result of objective 3, was prepared by people involved in developing and delivering the project at Ggaba with reference to the original PACE resource pack. It aims to share the techniques and knowledge now integrated into teacher training at Ggaba with as wide an audience as possible. We hope that teachers, students and other users will find it inspiring and exciting.

Part of the compound at Ggaba PTC where the PACE project planted flowers using permaculture approaches

A traditional African poet is anonymously quoted in an ancient folk song as saying: 'We are our surroundings, and those surroundings reflect and support our very life'.

Let us begin with the person sitting or standing next to us: that person forms part of our environment. The place where we are, indoors or outdoors, is also part of our environment. We can try to list items present in our environment such as our neighbour, our classroom, our school lawn, the trees that sway with the breeze, the butterflies and the host of other insects, birds and animals we encounter from day to day. We could not possibly forget the clouds, the sun, moon and stars in the sky, and obviously the air that caresses us, and the water that quenches our thirst. In short our environment is the extension of ourselves into all that nature has made our endowment; hence there is an inseparable link between us and all those various items of creation. Our well-being is inextricably linked to that of all that exists in nature.

We know that nature is made of matter and energy. Matter is the substance occupying space and having volume and weight, energy is that which can carry out work, for example moving matter to alter its location. Matter can be touched, seen or otherwise sensed, and has form, whilst most components of energy cannot be touched. They are invisible although their presence may be felt (for example, the heating of water or an electric shock). Energy is also very much a part of nature, creation and thus our environment. Examples of energy include: heat, light, kinetic energy, and potential energy (that energy stored in, for example, a static rock at the top of a hill).

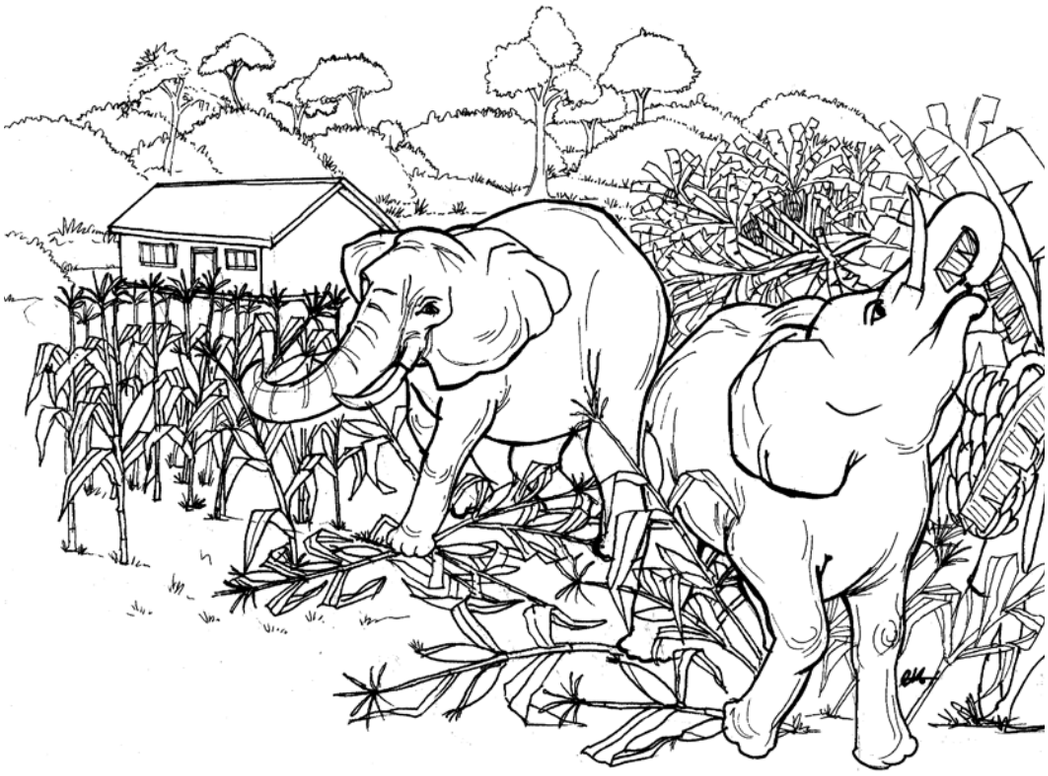
Through the ages human kind has sought to harness the endowment of nature, for example, through domesticating plants and animals. Some plants and animals have remained in the wild where they carry on their natural modes of life. Both wild and domesticated plants and animals are essential to our lives.

Conflicts which occur between us and those plants or animals have usually arisen due to human exploitation of wild nature, and must be resolved creatively and amicably for the sustainable benefit of all nature, so that ecosystems can continue to function and sustain both people and wildlife.

Human Wildlife Conflict

What do we understand by the Human Wildlife Conflict?

Human Wildlife Conflict (HWC) describes any situation where wild animals cause problems for people. They may damage people's crops (see illustration of elephants destroying banana and maize crops), destroy people's houses and property, and they may even endanger people's lives. There are many different forms of conflict, but they are all similar in that they have a negative effect upon the people involved.



Who is affected by Human Wildlife Conservation?

In Uganda, the people that are most likely to be affected are those living in remote villages surrounded by forests, woodlands and National Parks, where many animals live. In these circumstances, farmers suffer from conflict with wildlife because they share the landscape with wild animals.

So why does conflict occur?

People have settled on the land that wild animals once used and this is one reason why animals like elephants, baboons, chimps and buffaloes come into conflict with humans. In other cases people have settled around sources of permanent water and in the dry season the animals are forced to enter the villages in order to drink.

Which animals cause conflict with people?

In Uganda, a wide range of animals cause problems for people. Many animals raid crops: elephants, chimps, monkeys, baboons, antelopes, bush pigs, birds and buffaloes eat almost all food crops. Large animals such as hippos, lions and elephants have often injured or killed people in these conflicts. When these animals are at the water wells, human beings fear to go there. Lions and hyenas may eat people's cattle and goats, and may also occasionally attack people.

What effect does conflict have upon people?

Human Wildlife Conflict makes it more difficult for a farmer to survive. When wild animals damage crops or eat livestock, they are making it harder for a farmer to feed his or her family. Subsistence farmers will rely upon the food they grow to see them through the rest of the year, and if there is not enough they will face serious problems. The same applies when livestock are killed by wild animals. But the most serious form of conflict is when someone is killed by a wild animal. In Bushenyi, near a forest called Kashyoha Kitomi, for example, a chimpanzee hijacked a baby from its mother and vanished into the forest. In Kyambura, near Queen Elizabeth National Park, elephants keep destroying banana and other crops belonging to communities.

Who is responsible for controlling conflict?

It is the responsibility of the Government of Uganda to control problem animals. This responsibility has been delegated to the Uganda Wildlife Authority. Local governments or local environment committees are supposed to guide the population on managing problem animals.

The most common way of dealing with problem animals is either to scare them away using gun shots or to build fences to protect crops and livestock. In some cases thorny fences have been used to cage off the problem animals. However, these methods are not always very effective. Animals stop being scared of gun shots and may find ways to break through fences.

Why not kill all the animals?

Wild animals are part of the beauty, gifted by nature, of Uganda. Some wild animals have cultural importance. Among the Baganda, all clans have totems; animals that have a symbolic representation of a particular clan. Each clan attaches a lot of value to their totem animal. Wild animals are also a tourist attraction; in some places people pay money to view wildlife or undertake wildlife hunting for game. Perhaps most fundamentally, wild animals are part of the ecosystem - a web of interactions which makes the natural world work as it does. Without wild animals, the landscape would change and some of these changes could also hurt people.

Predators, for example, often play a critical role. If man killed off all predators such as lions and leopards, plant-eating animals would grow in number, grazing and browsing until the vegetation was totally altered - trees would no longer be able to grow where they grow now, and there could be even more pressure on people's crops. Indeed, ecologists call many predators "keystone species". If you remove the keystone of a building, the building will collapse. If you remove the predators, the ecosystem will collapse.

So how do we reduce conflict?

The best way to reduce conflict with wildlife is to use combinations of different methods. Conflict reduction methods are known as deterrents, because they aim to deter (stop) the animal from causing the problem. For example, if elephants are damaging your crops then you can dig trenches and form groups to guard against them. In Bukorwe, Rukungiri District, the Uganda Conservation Foundation has supported communities to dig trenches to guard against elephants. You could also try new methods such as burning chilli-dung bricks and bangers. You should also seek assistance from Uganda Wildlife Authority officials if they are available in your area.

Monitoring Human Wildlife Conflict

In order to control conflict effectively, we first need to know where and when the conflict is happening. This is important because it tells us the location and the type of conflict that occurs. This can help us to direct our deterrent efforts where they are most needed. In addition, monitoring can tell us whether our deterrent methods are working or not.

Conflict with wildlife is a common problem but it can vary greatly from place to place. For example, in one village buffaloes may damage crops every night, while in a neighbouring village a few kilometres away there may be no crop damage at all. Conflict also varies over time: a village may suffer only one crop damage incident in one year, but then suffer twenty or thirty incidents the next year. Therefore, to understand the patterns of conflict we first need to know where, and when, and how much crop damage is occurring.

How do we monitor Human Wildlife Conflict?

The easiest way to assess conflict would be to ask those farmers affected. But previous studies have shown that such reports may be exaggerated, and therefore not reliable. In addition, each farmer may report different details, so it would not be possible to compare one report with another. Instead, it is better to train a team of reporters to assess the conflict that occurs.

Each time a wild animal causes problems, a trained reporter must visit the area and make a report based upon what he or she finds. The reporter should use data sheets to ensure that the same information is collected each time. This will allow you to compare incidents from different villages and see which is the worst.

Wildlife conflicts can be separated into two different types:

Direct conflict affects a person's livelihood and includes incidents where crops have been damaged, livestock have been killed, or people have been killed or injured. Direct conflict can be easily recorded by counting or measuring the damage done.

Indirect conflict includes wider issues such as competition for wild fruits and water, which are needed by both people and wildlife, or the fear of walking at night because dangerous animals are nearby. Indirect conflict is much more difficult to measure because it deals with issues like fear and competition rather than actual damage. However, it should still be described in note form.

What information should we collect?

Direct conflict

The two important things to measure for each conflict incident are: first, the location; and second, how much damage occurred in each incident. The location can be taken with a Global Positioning System (GPS) or it can be described using village or place names and directions, for example: "the lion killed three cows 2km north west of Gulu town". In addition the reporter should record the date and the name of the farmer. These details are essential, and MUST be captured accurately, as they allow the report to be followed up in future.

The quantity of damage depends upon the type of incident. It may be either the number of livestock killed, as described in the example above, or the area of crops damaged.
Crop damage can be measured by pacing the damaged area. Usually the farm will not be a neat square, so the average width and lengths should be taken. To calculate the area of the field, multiply the width measurement by the length: 20 x 12 = 240m^2. Do the same for each individual area of damage, and calculate the area separately, e.g. 4 x 5 = 20 m^2.
It is also important to enter the crop that has been damaged. If one field with several crops growing together has been damaged then enter the crops on one line.

You can also estimate the crop age using simple categories: seedling – when the crop is at early stage of growth; intermediate – when the crop is growing but does not yet have fruits; and, mature – when the crop is producing fruits. If possible describe the type and the number of the animals that caused the damage. This can usually be worked out from the footprints and from talking to the farmer.

Indirect conflict

It is difficult to measure indirect conflict, because the problems are more related to people's behaviour or emotions. The best way to record indirect conflict is to interview the person who was affected and then write a description of what they tell you. Write as much detail as possible, and try to describe the location as you would for direct conflict. For example: "I talked to Mr. Mayanja of Kyanamukaaka village in Masaka District, on 24th November 2010.

He told me he could not return home at night for fear of lions that have been reported in the area. He decided to spend a night at nearby friend's home. Unfortunately, hyenas attacked the homestead and the family did not have a fair sleep that night. He estimated the hyenas to have been five". Such information can be added to the 'comments' section of the report.

What do we do with the information we collect?

The information we collect should be analysed so that it can be used to help to identify the areas with the greatest problems. The first thing we should do is plot the positions of all incidents on a map. This can be done using GPS and a computer, or using laminated paper maps, or traditional village maps. From this it will be possible to see where the majority of incidents have occurred. Two measures are used to compare the conflict between villages:

- the frequency or number of incidents; and
- the quantity or amount of damage.

The frequency of incidents in each village tells us how often conflict occurs, and is an easy way to compare conflict between villages. But it does not tell us how much damage has been done. For this, the quantity of damage in each village must also be calculated. The quantity of the damage that has occurred in each village may be the total area of crops that have been damaged, or it may be the number of livestock that have been killed.

How will this information be useful to us?

The information for direct and indirect conflict can then be used to identify the villages worst affected by problem animals. These sites will then become the focus of future wildlife deterrent schemes.
In addition, when you begin using methods to control problem animals, the monitoring information will help you to see whether the methods are working. For example, does the amount of crop damage in a village become less after you start using deterrents? If so this will indicate that your methods are having some effect.

ACKNOWLEDGEMENTS: The original Action Sheet was written by Guy Parker, with reference to the following sources among others:

Bell, R.H.V. (1984): The man-animal interface: an assessment of crop damage and wildlife control. In: Conservation and wildlife management in Africa. Bell, R.H.V. & Mcshane-Caluzi (eds.), US Peace Corps seminar, Malawi.
Naughton-Treves, L. (1998): Predicting the patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology 12 (1): 156-158.
Parker, G.E. & Osborn, F.V. (2001): Dual season crop damage by elephants in northern Zimbabwe. Pachyderm 30: 49-56.

Can Chilli Pepper help reduce Elephant-Wildlife Conflict?

By Dr. Robert Mercer

According to national statistics, Uganda's human population is currently increasing by over one million people per year (33.5 million with a growth rate of 3.6% per year). Meanwhile, the elephant population in Uganda has generally stabilized, with minimal increases in some parts of the country. Rural farmers and elephants share the same areas as agriculture expands and elephant rangeland is compressed. This is particularly true in areas where the predominant form of agriculture is at a subsistence level and is close to National Park boundaries such as Queen Elizabeth National Park, located in South Western Uganda.

This creates a human wildlife conflict elaborated in the above sections of this manual. For many people living in close proximity to the Park, their crops are the main source of food, and one night of elephant raiding can wipe out the entire year's food supply. With expanding and increasing numbers of human settlements, and increasing pressure of human activities in wildlife corridors, elephant populations are expanding into nearby villages. This has led to elephants losing their fear of people, and coming into close contact with humans.

Research conducted by the Mid Zambezi Elephant Project (MZEP) has revealed that chilli peppers are a natural deterrent to elephants and other wildlife, as the animals find the crop unpalatable. Elephants do not like the smell of chilli, and the smell of the chilli drives the elephants away from the source (in this case the human settlements). The chilli powder and oil has no harmful effects on the elephant. Chilli can also be a good crop in its own right - it does not exhaust soil nutrients and has a far higher price and a more stable market than other crops, such as cotton. It is well documented that elephants have a remarkable memory, the chilli pepper will deter elephants from returning to settlements, and thus assist in avoiding the need for conflict and instead aid in conserving elephants.

Methods of using chilli as a deterrent include:

- planting chilli plants along perimeters as a barrier crop.
- using chilli powder or oil in grease on rags along the boundaries.
- burning low-grade chilli oil (essentially a by-product of the crop) or chilli dungbricks around the boundaries of the farm.

How to make chilli dung bricks?

- Collect 5-6kg of elephant or cattle dung in a bucket.
- Grind 1-2kg of hot dry chilli
- Mix chilli and dung together, using a little water to make a paste.
- Compact the dung mixture into a brick mould, then remove and leave to dry for several days.
- Burn the dung brick at night. It will produce a noxious smoke for 3-4 hours.

Many projects throughout Africa, are trying chilli pepper alongside other forms of deterrent, ranging from bees, thorny bushes, and trenches to discourage elephants from crossing into human-inhabited areas. Most projects find that several approaches need to be used, as it has been established that some elephants are more aggressive than others and that using chilli may not work on its own.

In Uganda, the Uganda Conservation Foundation is involved in using chilli as a deterrent in conjunction with the construction of the trench and fence work in the much troubled Ishasha sector, around Queen Elizabeth National Park. Use of Chilli grease on the valley fencing in the Bukorwe ridge project has served to increase the effectiveness of the barrier and contributed to the decrease in frequency and severity of the animal raids.

Acknowledgements: Uganda Conservation Foundation, Elephants, crops and people project. Ugandacf.org, Mid Zambezi Elephant Project. Wild Horizons Wildlife Trust wild horizontrust.org 06-12-2008 Elephant pepper development trust elephantpepper.org,Voices of Africa Africanews.com/chilli_pepper… elephants/23698 17-03-09, openafrica.org, openafrica.org/participant/elephant-pepper.forum.

Bukorwe Ridge Elephant Trench

Report by the Uganda Conservation Foundation

Too often research projects gather dust on shelves once completed but in Uganda the findings of one such project has now produced very practical action. Uganda Conservation Foundation (UCF) has taken the earlier Elephants, Crops and People (ECP) research programme into elephant, human interaction and turned it into a practical project in conjunction with Uganda Wildlife Authority (UWA). The communities hand-dug a 2m x 2m trench, with fencing in the valleys, along a 20km stretch of ridge which, it is hoped, will keep elephants and other non-jumping animals from raiding community crops and destroying them.

People in Bukorwe hand-dig an elephant trench

Where did this happen?

The trench is on the eastern border of the Ishasha Sector of Queen Elizabeth Protected Area (QEPA). This sector hosts the largest elephant population in Uganda. Through the Elephants, Crops and People Project, UCF discovered that the extent of animal raiding in Ishasha was much higher than was being reported. Previously, some elephants were killed and some humans very badly injured as villagers attempted to counter the raids. Competition for land and resources is growing as the human population increases and a number of communities farm for subsistence right up against the edge of the Protected Area.

Meanwhile, the elephant population is growing due to increased and successful security by UWA. The elephants are moving back into community settings, which in itself, could cause an immediate increase in crop raiding and result in collapse of community relations with UWA. On top of this, elephants and other wildlife are being killed at an increasing rate as difficult economic conditions drive more people to take up poaching - hunting illegally - for food and in some cases to make money. Reducing the incidence of human-elephant conflict must not only improve the survival of the wild animals but also assist in the reduction of poverty. The elephant will only have a hope of survival to the benefit of the world's future generations if the people who live near them have an economic benefit from its continued existence.

So, what are the benefits of the trench?

The anticipated benefits and outputs include a reduction in elephant, buffalo and other mammal crop-raiding leading to improved harvests for local communities, a reduction in illegal cattle-grazing in the Protected Area, a reduction in human and elephant deaths associated with crop-raiding and improved park–community relations. The project has also enabled testing/trial of pilot techniques to reduce crop raiding in valleys where a trench cannot be dug.

How was the community involved?

An encouraging aspect of this project has been the enthusiasm of the local communities demonstrated by their digging the first sections of the trench on a voluntary basis once a week. The revenue-sharing scheme established by UWA and now the additional funding sourced by UCF has given t he additional benefit of providing temporary paid employment for these subsistence farmers. All excavations have been carried out by hand and UCF funding includes provision for appropriate local tools for this work.

The communities are anxious to progress the works and this enthusiasm has to be reined in at times. For example in one wetland area the labourers continued excavations despite the trench filling with water at a depth of only 1 metre. It had never been the intention to establish the trench in the wetland areas where alternative strategies will be required and the communities have now realized the rationale behind this advice.

What environmental considerations were required in digging the trench?

In supporting this project UCF is very mindful of environmental considerations and impacts and is taking advice on the most appropriate mitigation of the barrier in the valley and wetland areas. Specific issues will include the best constructions for the valley barriers, appropriate drainage provision to allow free flow of natural water courses, measures for prevention of blocked drainage and for alleviating sediment collection.

The trench is not a permanent solution to wildlife crop raiding and must be used in conjunction with other measures. To be effective, the trench must be maintained by the community farmers, who seem to have enthusiastically embraced the project. Completion of the whole project will take time but, provided the additional funding is sourced, UCF hopes that this work will make a real difference to the lives and livelihoods of these subsistence farmers. In addition, the work of Uganda Wildlife Authority in protecting and conserving Ugandan wildlife should be greatly enhanced. This project is a vital component to the future of the already highly threatened elephant populations of the region.

Acknowledgements: Uganda Conservation Foundation, Elephants, crops and people project. Ugandacf.org. A registered UK charity number 1087295

There is probably no more satisfying a feeling than a drink of water when one's throat is dry. The sensation as the water cascades down quenching the fires of thirst is too beautiful to be described.

In this unit we will find out how to harvest and conserve water by applying affordable rainwater harvesting technology. You will also be introduced to procedures for filtering and making water safe to drink. There is also an article on a plant which although attractive is a great threat to water bodies and aquatic life in Uganda. This is the notorious water hyacinth. Patrick Agaba who is Project Manager for the Uganda Conservation Foundation has an enviable wealth of experience in eco-care and presents us with an article on how dedicated workers, supported by the Ugandan government and international donors waged a successful battle against the killer weed.

Also included in this section is an article by the Principal of Vincent Alex School in Mukono District, where comprehensive rainwater harvesting has reduced water bills by a staggering 96%.

Roof water harvesting

Rainwater harvesting is an easy way to improve security in water supplies. People have been doing it for a long, long time. For many generations in Uganda, rain that falls on trees has been collected using folded banana leaves as gutters. Now, people all over Uganda are collecting and storing the rain that falls on their roofs to use at home. This section will help you decide whether it's worth collecting roof water where you live, and know how to make sure that it is safe to drink.

Where can rainwater harvesting help?

Rainwater harvesting can help to increase the supply of good water in areas where it is hard to get groundwater out with wells and pumps (or even piped water) and in areas where there is little or no surface water. It is easiest to harvest rainwater where there is regular rainfall to keep the tank topped up. However, in many parts of Uganda rainfall varies a lot throughout the year.

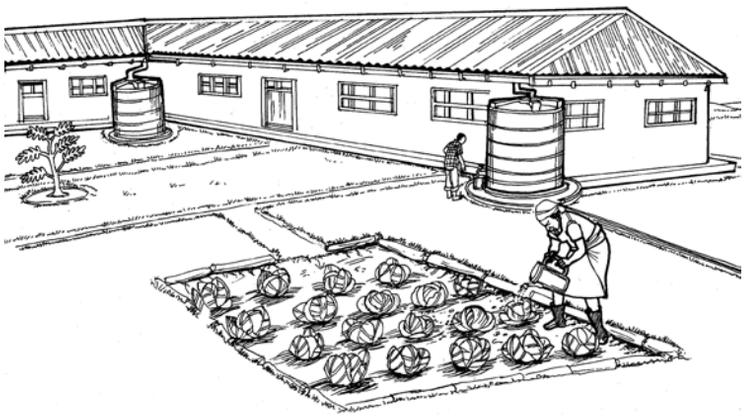
How much rainwater can we collect?

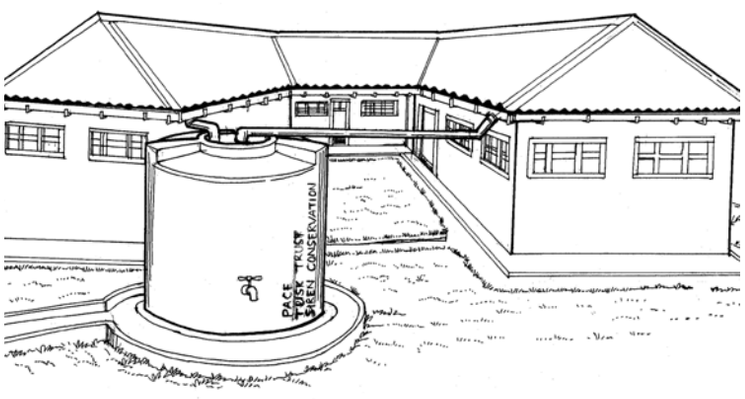
Rainwater harvesting can help supply water for individual households, for communities working together, or for schools or hospitals. The amount of water you can collect depends firstly on the rainfall in your area, secondly, on the surface area from which you are able to collect rainwater, and thirdly, on how much you can afford to spend on building and maintaining the rainwater harvesting system.

The simplest option is to collect water from the roof of your house. Every square metre of roof can collect up to one litre of water for every 1mm of rain that falls. The water that is actually collected will be between 0.5 and 0.9 of a litre of water, because some will evaporate, be spilt or get blown away by the wind. If people are able to work together to improve their water supply, rainwater can be collected in larger quantities from the roofs of larger buildings.

What can rainwater be used for?

Rainwater can be collected to use at home for washing, gardening, car-washing, flushing toilets, cleaning laundry, and if kept clean, for drinking. There are also many ways in which farmers in dry areas can harvest rainwater to help irrigate their crops and provide water for their livestock. In Naspir, Nakakwa, Kotido District, water is harvested from a rocky surface, some is for domestic use, some for animals and some for micro-irrigation.





How do you collect rainwater from a roof?

Warning: Do not collect water from lead-painted or asbestos surfaces. These can dissolve in the water, which could seriously harm your family.

The illustrations on your left show water harvesting approaches adopted by Ggaba PTC PACE project. It is easiest to collect water from a tiled or corrugated iron roof, which should be clean. You can also collect water from tightly thatched or palm-leafed surfaces, but these may be harder to clean so the water may need more treatment to make it safe to drink.

To collect rainwater from a roof, you need to make a gutter around the eaves. A gutter can be made of 22 gauge galvanised mild steel sheeting, bent to form a V in a clamp. The outer edge can be strengthened by bending it 90 degrees in a clamp and then hammering it flat. The gutters then collect the water to a central water tank.

How do you store your 'crop' of rain?

Water collected from the roof of a house can be stored in a drum but more realistically in a bigger tank (the shape and material may vary depending on available resources) so that you can store more water. These are ideas that people have developed in Uganda:

- Oil drums welded together to make a long vertical or horizontal tank.
- Basket tanks based on bamboo structures covered in mortar.
- Corrugated galvanised mild steel sheeting bent and welded or bolted into a cylinder, coated with sand/cement mortar. It is important to ensure that mosquitoes are kept out of the tank. An improperly sealed tank would greatly increase the risk of malaria for your family. Also, the tank must be kept dark so that algae do not grow in the water.

How can we make sure the rainwater is safe to drink?

Unless there is a lot of pollution from man-made sources of smoke (especially industrial sources like factories), then rainwater is very clean. However, if you are using rainwater to increase supplies of drinking water, it is important to keep the water in a clean and protected place. Otherwise, people may get ill from drinking it.

To make sure the water in the storage tank is clean, the system used to collect the water needs to stop the 'foul flush' or 'first flush'. This is the water from the first rain that washes solid objects like leaves, twigs, bird droppings and dirt off the roof into the storage container.

A simple idea is extending the down-pipe below the level of entry to the tank so that the first rainwater collects in the lower section of the pipe before it starts to flow into the storage tank. This could be blocked off with a floating rubber ball.

To ensure good quality drinking water, a filter can also be part of the system. The filter should not block easily and should be easy to clean. The simplest type of filter to use is a tilting section of cloth or fine mosquito mesh on an angled frame across the entrance to the storage tank. It needs to tilt so that water running across it cleans it off.

ACKNOWLEDGEMENTS: The original Action Sheet was compiled by Nancy Gladstone and is based on ITDG's Technical Brief on Rainwater Harvesting - (http://www.itdg.org/docs/technical_information_service/rainwater_harvesting.pdf) and on Peter Morgan's webpage on Rainwater Harvesting in Zimbabwe (http://aquamor.tripod.com/page3.htm).

FOR FURTHER INFORMATION CONTACT.
Aquamor - www.aquamor.tripod.com/index.html
GHARP - Greater Horn of Africa Rainwater Partnership - www.gharainwater.org/index.html

Vincent Alex School - A success in water harvesting at schools

The school was founded in 1984 as a Nursery School and started admitting primary pupils in 1991. Now with over 600 pupils mainly boarding and from all over East African countries, it is an impressively clean and ordered educational establishment. The pupils are universally aware of the free availability of safe water within the school, obtained from fifteen large storage tanks that harvest rainwater. The school also has a clean and relatively smoke free cooking area resulting from the use of high-efficiency wood burning stoves.

Storage tanks

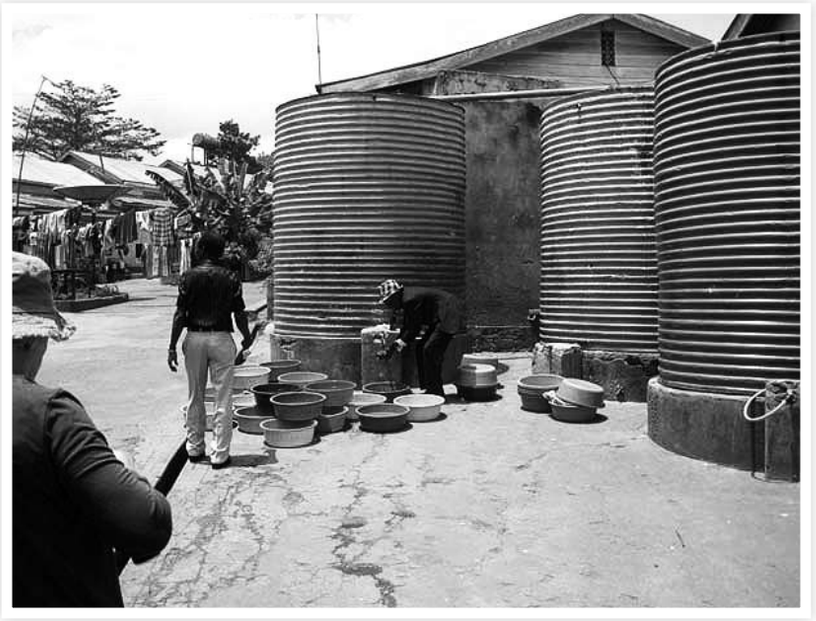
When the school was founded, there was no water supply system. Water was fetched from a well about half a kilometre away, but this source became polluted, and water had to be brought in by a truck from Kampala about 15 kilometres away from the school. The cost was big and to ease this problem the Director, Mr. Matovu Vincent began the process of installing rainwater tanks.

Mr. Matovu Vincent attended Ggaba PTC in 2006-2009 as an in service student where he found PACE materials which encouraged him to extend the process. There are now 15 tanks and every building in the school compound is part of the water harvesting process. The school is entirely self-sufficient for water, and current costs are half of the cost in 2006.

The school buildings are in a largely cemented compound covering five acres which has a number of small plots growing plants and grass that give an overall attractive look and coolness to the environment. The plots are cared for by the students with the help and guidance of the staff and a compound maintenance worker.

All of the pupils know that green plants provide us with oxygen, while we breathe out the carbon dioxide that the plants need in return, and that humans depend on plants to survive.

Medicinal plants which help treat ailments such as cough, stomach aches and skin rashes are also grown and taught about. Vegetables, fruit, bananas and even exotics such as pomegranates are here. Interaction with the pupils shows how they care for these plants.



Water harvesting tanks at Vicent Alex School

With 600 pupils, the school needs as much water as possible. Every roof in the school has gutters collecting water into galvanised 4,000 - 20,000 litre-tanks, which are dedicated to each school department. Water is also pumped to a 57,000 litre tank which is used to distribute water to all of the washrooms. The school is connected to the national water supply but this is only needed in times of severe drought.

So convinced is he by the success of his environmental policies, Vincent believes that all schools should present every pupil with environmental participatory learning as part of the core curriculum.

Water Filters

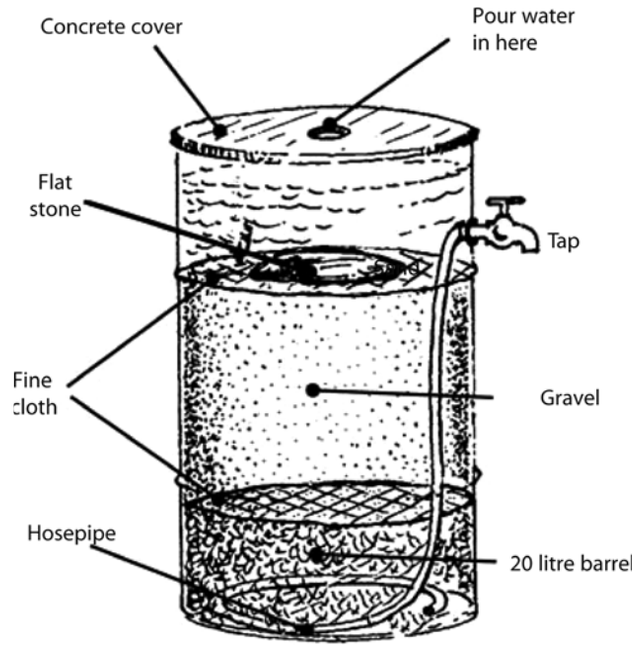
In this section, we get to know about large water filters for household and community use. The two types of water filter described here can provide water that is almost as safe from germs as water that has been boiled, treated by solar disinfection, or treated with chlorine.

A) Household Slow Sand Filter

This is one of the safest, most effective, and cheapest ways to filter water for a household. This filter can treat at least 50 litres per day — enough for a small family.

What do you need to make a slow sand filter?

- A watertight container such as a 200 litre barrel, or a large brick or cement jar, a jerrican. Make sure the container does not contain toxic materials. If it does contain toxic materials, make sure it is thoroughly cleaned.
- A 20 millimetre hosepipe with many small holes cut in the first 35 centimetres. This part with holes will lay on the bottom of the barrel
- A valve or tap.
- A small amount of gravel
- Washed river sand
- Fine cloth



How To Make A Household Slow Sand Filter

- Clean the container and disinfect it with bleaching powder. This is to make sure it is free of toxic materials.
- Drill a hole 1/3 of the way down from the top of the container for the tap. The hole should be sized for the fitting on the tap — if the tap has a 12 millimetre fitting, the hole should be 12 millimetres wide.
- Fit the tap to the hole and fix it in place with hard-setting putty. If a brick container is used, the valve can be cemented within the wall.
- Prepare the water collecting hosepipe. To do this, drill or punch many small holes in the first 35 centimetres of the hosepipe, seal the end, and form it into a ring on the bottom of the container with the holes facing downward.
- Connect the water collecting hosepipe to the tap. Seal the pipe fittings with hose clamps or wire.
- Place a layer of gravel 7 centimetres deep on the bottom of the barrel, covering the water collecting pipe. Cover the gravel with fine cloth and fill the barrel with clean river sand to about 10 centimetres below the tap. Then cover the sand with a second fine cloth.
- Make a cover for the container, with a hole in it to pour water through. Place a flat rock or dish under the hole to prevent disturbing the sand when water is poured in.
- Flush the filter with water completely. Once the filter is cleaned, it is ready for daily use.

How to use and maintain a slow sand filter

After a few days of use a layer of green scum (bacteria and algae) will grow on top of the sand. This layer helps to treat the water. For this layer to work the sand must always be covered with water. Fill the filter daily and remove water only in small quantities. If the filter is drained completely it will lose its effectiveness, and should be cleaned and refilled.

Every few weeks when water flow from the tap slows down, clean the filter. Let any water out of the filter and remove the green layer and about 1 centimetre of sand from the top. After many cleanings, when more than half of the sand has been removed, replace all the sand and gravel with new cleaned sand and gravel and start over. This may be necessary 1 or 2 times a year.

Improvements to a slow sand filter

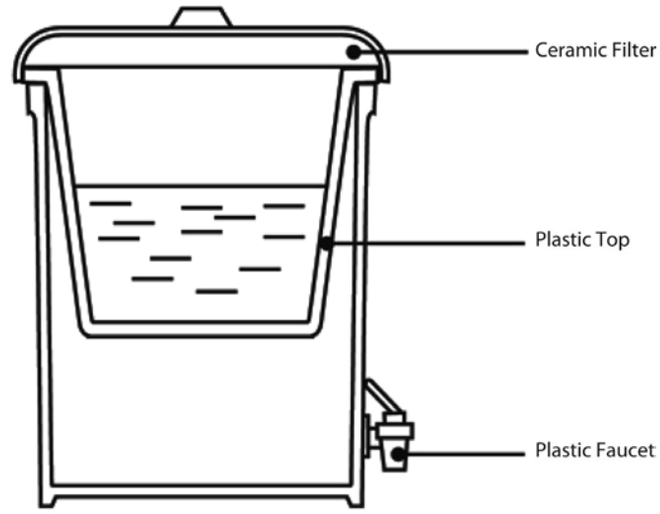
Allowing solids to settle out of the water before filtering will reduce maintenance of the filter because water will be cleaner when it enters. Letting water flow like a waterfall will add air into the water and make it taste better. A filter has been invented that uses iron nails to filter out arsenic (the arsenic binds to the iron).

Community slow sand filter

Larger filters can be made that connect to surface water sources or piped water systems to supply safe water to a whole village or neighborhood. Where surface water is the only available source, a community slow sand filter is a good way to treat large amounts of water with little work. These filters require an engineer to build and install properly, so they are not described here.

B) Ceramic Filters

A small and effective water filter can be made from fired clay coated with colloidal silver (a substance that kills germs). With basic training, a village potter can easily make these filters (see illustration).



Making water safe for drinking and cooking

Water can carry tiny creatures called germs, viruses and parasites. These are disease organisms and can make you and your family sick. Many water sources, such as harvested roof water, a river, stream, swamp or water hole are contaminated. In this case, it needs to be treated before use. Here, you will learn about ways to treat water to make it safe for drinking and cooking.

Are there other situations when water needs to be treated?

River water always needs to be treated. Water from pipes, tanks and wells needs to be treated if:

- there is any possibility that it has been contaminated.
- people refuse to drink it because of the colour or taste.
- it has been transported and stored in the home.

The methods described here do not make water safe from toxic chemicals. Water with toxic chemicals is never safe for drinking, bathing or washing clothes. It may lead to cancer, skin rashes, miscarriages, or other health problems.

How to choose which water treatment method to use?

The methods you choose to treat water will depend on how much water you need, what it is contaminated with, how you will store it, and what resources are available. No matter how it is treated it is best to either let the water settle and pour it into another container, or filter the water, before disinfecting it.

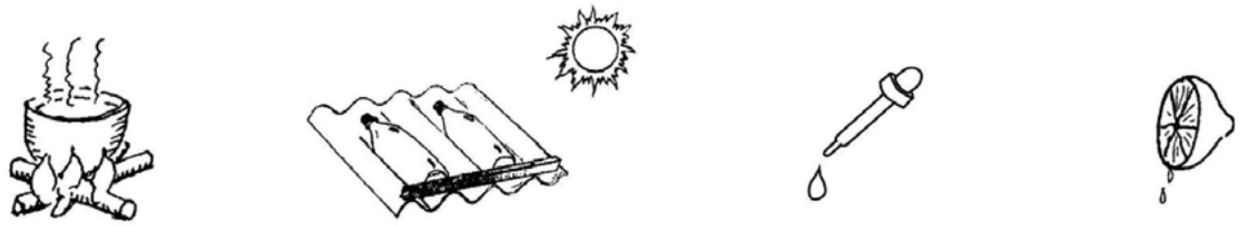
How do you make water safe from germs?

To make water safe from germs – the tiny living things that carry diseases – follow these steps:

1. Let the water settle for a few hours and pour it into a clean container or filter it, using cloth filter or charcoal filter.

These basic methods for treating water need little or no equipment.

2. Disinfect the water using one of these methods:

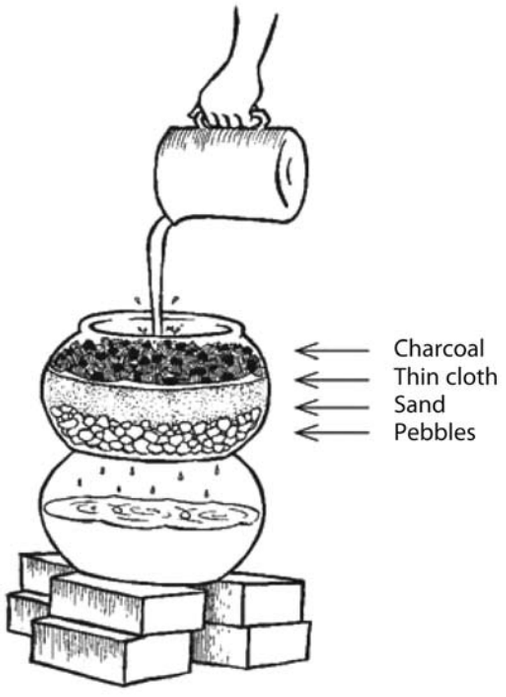


What are the different methods of filtering water?

There are many ways to filter water to make it safer from germs. Some very effective filters, like slow sand and ceramic filters, require special equipment to make, but can filter large amounts of water. Other filters, like charcoal and cloth filters described below, require no special equipment and are easy to use to filter smaller amounts of water before disinfecting.

i) Charcoal filter

This filter is easy to make and works well for removing most germs from small amounts of water. Because the germs that are filtered out will grow on the charcoal, it is important to remove and clean the charcoal often if the filter is used daily, or anytime the filter has been unused for a few days.



This is how to use charcoal to filter your water:-

- Punch holes in the bottom of a container with a sharp instrument.
- Grind charcoal to a fine powder and rinse with clean water. Activated charcoal works best, but ordinary charcoal will work almost as well.
  NEVER USE CHARCOAL BRIQUETTES!
  THEY ARE POISON!

- Place layers of stones, gravel, and sand in the container. Put in a thin cloth and a layer of charcoal on top.
- Pour water into the filter and collect drinking water from the bottom vessel.

ii) Cloth filters

This is a common method used among the Baganda of central Uganda. A filter made of white cotton cloth, a finely woven cloth, is used to reduce the amount of germs and insoluble materials in drinking water. This method also filters out all sorts of worms. You can make a cloth filter out of handkerchiefs, linen, or other fabric. Old cloth is more effective than new cloth because worn fibers make the pores smaller and better for filtering. Take caution not to use dirty old cloth, as it may be carrying germs as well.

This is how to filter water using a cloth filter:-

- Let water settle in a container so that solids sink to the bottom.
- Fold the cloth 4 times and stretch or tie it over the mouth of a water jar.
- Pour water slowly into the jar through the cloth.

Always use the same side of the cloth, or germs may get into the water. After using the cloth, wash it and leave it in the sun to dry. This kills any germs that may be left in the cloth. In the rainy season, disinfect the cloth with bleach.

How does settling water get rid of germs?

When water settles, mud, other solids, germs and worms that cause illnesses fall to the bottom. Storing water for 5 to 6 days will reduce the number of germs in the water. But some germs, like Giardia, a protozoan parasite, will not be killed by any length of storage. For this reason it is best to use another method after letting the water settle, such as filtering, chlorinating, or solar disinfection. The following methods are ways to settle water that take more time but make it safe from most germs:

a) 3 pot method

The 3 pot method settles water so germs and solid matter fall to the bottom. This method is safer than settling water in 1 pot, but it does not make the water completely free of germs. The 3 pot method should be followed by disinfection.

Morning, Day 1: Fill pot 1 with water. Cover the top and let it settle for 2 days.
Morning, Day 2: Fill pot 2 with water. Cover it and leave for 2 days. The dirt in pot 1 will begin to settle
Morning, Day 3: Pour the clear water from pot 1 into empty pot 3, making sure not to disturb the sediment at the bottom of pot 1. The water in pot 3 is now ready for drinking. The dirty water left in the bottom of pot 1 can be poured out. Wash pot **1** and refill it with water. Cover it and let it settle for 2 days.

Morning, Day 4: Pour the clear water from pot 2 into pot 3 for drinking. Wash pot 2 and refill it with water.
Morning, Day 5: Pour the clear water from pot 1 into pot 3 for drinking. Wash pot 1 and refill it with water.
After a few days, wash the clear water pot (pot 3) with boiling water. If you use a clean flexible pipe to siphon water from one pot to the next, the sediment will be less disturbed than if you pour the water.

b) Using plants to clear and settle water

In many places people use plants to make water safer to drink. One plant used often is Moringa.

How do you purify water with Moringa seeds?

- Allow the Moringa seed pods to dry naturally on the tree before harvesting.
- Remove the seed husks, leaving a whitish kernel.
- Crush the seed kernels to a powder with a stone or mortar.
- Mix the powder with a small quantity of clean water in a small cup.
- Pour the mixture through a tea strainer or sieve into a cup.
- It's best to cover the strainer with a piece of clean cloth.
- Add the resulting milky fluid to the water you wish to treat in a clean vessel such as a pan or gourd.
- Stir quickly for 30 seconds, then slowly and regularly for five to ten minutes. The faster it is stirred, the less time is needed.
- Cover the water and do not disturb it for at least an hour
- The clear water may be siphoned or poured off the top of the container, or a vessel with a tap can be designed.
- The particles of dirt in the water will sink to the bottom. Most of the tiny creatures that make you sick will stick to these particles and sink to the bottom as well. However, not all of the dangerous disease organisms will be removed, so if you are able to, it is still safer to use a disinfection treatment as well.

How much seed powder do you need?

Depending on how clear the water is, you will need between 50 and 150 milligrams (1/100 of a gram) of ground Moringa seed to treat one litre of water. A good, full seed will typically purify 5 litres of water that is not turbid (muddy); two seeds will purify between 2.5 and 5 litres of water that is slightly to moderately turbid; and three seeds will purify 2.5 litres of very turbid water.

You will need to experiment with the amount of seeds and stirring time to find what works in your area. Health-workers should be consulted about quantities and materials, and about how to combine this method with other ways to make drinking water safe. Seed cake left over after extracting oil can still be used for water purification, if ground to a fine powder.

Can this be method be used on a larger scale?

Scientists have worked with water treatment works in Africa (Eritrea and Malawi) to show that powder from the seeds can replace expensive chemicals in water treatment works. If more water treatment works found out about this method, farmers might be able to sell Moringa seeds to water treatment works.

Once the water is clear, why do you need to disinfect it?

The methods of settling or filtering water described above make it clean and pleasant to drink, but some germs can still survive. Disinfecting water kills germs. If done correctly, disinfection makes water completely safe to drink. The most effective methods are boiling, solar disinfection, or using chlorine.

- **Boiling water**

Boiling water for 1 minute makes it safe from germs. Bring water to a rapid, rolling boil. Once it starts boiling, let it boil for 1 full minute before taking the pot off to cool. Water needs to boil for 3 minutes to kill germs in high mountain areas because water boils at a lower temperature high in the mountains. Boiling changes the taste of the water and boiled water takes a long time to cool, so it cannot be used right away. After boiled water cools pour it into a bottle and shake it strongly. This will add air to the water and improve the taste.

- **Solar disinfection (SODIS)**

Solar disinfection is a very effective way to treat water with only sunlight and a bottle. Filtering or settling the water first will make it clearer so it will disinfect more quickly. Solar disinfection works best in countries close to the equator, because the sun is strongest there. For this reason, this method works well in Uganda. The farther north or south you are, the more time is needed for disinfection to work. This is the procedure used in solar disinfection:

a) Clean a clear plastic or glass bottle or plastic bag.
b) Fill the bottle ¾ full, and shake it for 20 seconds. This will add air bubbles to the water. Then fill the bottle or bag to the top. The air bubbles will help to disinfect the water faster.
c) Place the bottle in an open place where there is no shade and where people and animals will not disturb it, like the roof of a house. Leave the bottle in the sun for at least 6 hours in full sun, or 2 days if it is cloudy
d) Drink directly from the bottle. This will prevent the possibility of contamination from hands or other vessels.

For another method which uses the sun to make water safe to drink (Solar pasteurisation), see Learning Unit 6 in this manual.

- **Lime or lemon juice**

Adding the juice of a lime or lemon to 1 litre of drinking water will kill most cholera and other germs as well. This does not make water completely safe, but may be better than no treatment in areas where cholera is a threat. Adding lime or lemon juice to water before using solar disinfection or the 3 pot method will improve the effectiveness.

- **Chlorine**

Chlorine is cheap and easy to use to kill most germs in drinking water. The difficulty with chlorine is that if too little is used it will not kill germs or make the water safe. If too much is used, the water will taste bad and people may not want to drink it.

How much chlorine to add to the water?

The amount of chlorine needed to disinfect water depends on how contaminated the water is (how many and what kinds of germs it contains). The more germs you have, the more chlorine you need to get rid of them. It is important to add enough chlorine so that some is left in the water after the germs are killed. The chlorine that is left is called free chlorine. This will kill any new germs that get in the water. If the water has free chlorine in it, it will smell and taste just slightly of chlorine. This tells you it is safe to drink. If it has too much, the smell and taste will be strong and unpleasant.

To use the right amount of chlorine you need to know how strong your chlorine solution is. Chlorine comes in different forms — gas, bleaching powder, high-test hypochlorite (HTH), and household liquid bleach. Because household bleach is the most common form of chlorine, this book shows how to disinfect water with household bleach.

Household bleach may have different amounts of chlorine. Most common are 3.5% and 5%. The easiest way to measure the amount of bleach needed is to first make a mother solution (about 1% chlorine) and then add this solution to the water you want to disinfect.

First prepare the mother solution:
- Add 1 cup of bleach to a clean, empty beer bottle.
- Fill the bottle with clean water.
- Shake the bottle for 30 seconds.
- Let it sit for 30 minutes.

Your mother solution is ready. If there is a lot of solid matter in the water the chlorine will be less effective in killing germs. To ensure that chlorine is most effective either filter the water through a cloth or other type of filter or let the water settle so solid matter sinks to the bottom. Pour the clear water off into a clean container and then add chlorine.

Filtered water	Chlorine solution
1 Litre	3 drops
4 Litres	12 drops
20 Litres	1 tea spoon
200 Litres	10 tea spoons

Add these amounts of the mother solution to clear water and wait at least 30 minutes before drinking the water. If the water is cloudy, you need twice as much of the bleach solution.

Acknowledgements: The original Action Sheet is an edited excerpt from "Water for Life: Community Water Security", created by the Hesperian Foundation for the UNDP, in cooperation with the Community Water Initiative partners, part of a larger book by the Hesperian Foundation.

Water hyacinth

By Agaba Patrick – Project Manager Uganda Conservation Foundation

Water Hyacinth (*Eichornia crassipes*), probably the most noxious aquatic weed in the world, is native to South America where it occurs harmlessly in streams and seasonally flooded environments. The plant is, however, now one of the most widely distributed aquatic weeds, having been trans-located over almost the entire tropical and sub-tropical world, mainly by collectors of ornamental plants.

Water Hyacinth was first reported in Uganda on Lake Kyoga in 1988 and then on Lake Victoria in 1989. The water weed spread rapidly over the years to 50% of the shores of Lake Kyoga and about 80% of Lake Victoria, over 50% of the banks of the River Nile and most of Northern Lake Albert. In 1994 weed cover was estimated at 3,100 hectares, by 1997 it was estimated at 20,000 hectares.

In Uganda, Water Hyacinth is extremely rapid in growth, particularly in nutrient-enriched areas such as Murchison Bay on Lake Victoria, the fringes of Lake Kyoga, and at the deltas of major rivers such as Kagera and Katonga. The weed occurs as resident strips or in the form of mobile mats. Resident Water Hyacinth occurs in sheltered, shallow, muddy bays and inlets in lakes where it forms shoreline strips 5 – 15 metres wide extending to 30 metres or more in especially sheltered inlets. Rapid proliferation leads to the formation of mobile mats which may be very large in sheltered conditions. Prolific weed proliferation in Uganda has produced an enormous biomass which has had serious impact on environment and resources as well as serious socioeconomic implications that are elaborated in the sub - sections below.

A mat of water hyacinth on Lake Edward

a) Fishing Sector

In areas affected by the weed, there is a reduction of the fish population due to the unsuitability of the shoreline for fish breeding and survival. The weed damages spawning and breeding grounds in bays which are also nursery areas for many fish particularly Tilapia.

In the recent past, before its harvesting, Water Hyacinth threatened the livelihood of fishermen, their income reduced by landing problems, increased fuel costs, and poor quality of fish. Subsistence fishermen who depended on in-shore fishing with hook and line were forced out of operation.

b) Drinking water supply

Drinking water supply to major towns dependent on Lake Victoria such as Kampala, Jinja, Entebbe and others was affected in quality due to decomposing organic matter from the weed and de-oxygenation of the water.

c) Transport sector

Transport to and from the islands in Lake Victoria and operations from the pier at Port Bell in Luzira were subject to delays, disruption and rising operating costs due to the large concentration of Water Hyacinth biomass.

d) Power generation

Hydro-electric power generation at the Owen Falls Dam was threatened as the weed blocked turbines and inlets leading to increased operational costs.

e) Environmental and health hazards

Water Hyacinth harbours disease vectors such as mosquitoes and snails interfering with the ecological balance of the lake and reducing biodiversity. These species also act as vectors for diseases such as malaria and bilharzia, among others.

Due to the rapid proliferation of the weed the government formed a technical team for emergency control and management of Water Hyacinth. The team came up with control options.

Control Options

The following options were used:-

1. Physical removal – this entailed the use of manual labour with suitable hand tools. It was only suitable for clearing small area infestations at for example, landing sites.

2. Mechanical removal – machines such as harvesters, barriers or booms and conveyors were mainly considered effective in the short term to remove weed infestations in large areas. This was used at Port Bell – ferry landing site, Owen Falls Dam and on various spots of the River Nile as it meanders down to Egypt. At the mouth of the Kagera River, a retractable boom/conveyor was used. These methods do not permanently eradicate the weed.

3. Biological Control – Two weevil species were introduced to Uganda from Benin, West Africa. *Neochetina bruceii* and *Neochetina eichornia* are water hyacinth specific and pose no threat to terrestrial plant species. It is the larval stage and not the adult weevil that is more destructive to the weed. Several rearing centres were set up and the periodic release of weevils began in 1997. The effect was realised after 3 years and by 2004 there was a massive decline of the water hyacinth on Lake Victoria and Lake Kyoga.

4. Utilisation Option – This was used on a limited scale, for example the weed at Port Bell was transported to Luzira Prison where it was used to make art and craft materials; chairs, baskets, mats etc. Other uses of Water Hyacinth were discouraged however as the country was aiming to control the weed and allowing utilisation would send a message implying encouragement of weed proliferation.

5. Chemical Control – The use of herbicides was deferred due to its side effects and was opposed by environment pressure groups. Much as it is used in other countries, in Uganda it was not. Small scale tests were carried out but herbicides were not used.

Learning Unit Three: Soil

An ancient folk song of the Bannabuddu, people of Masaka in central Uganda says: 'Soil is the grandmother and grandfather of humanity'.

Soil is the common term applied to the complex mixture of organic matter and minerals in which plants grow. The minerals come from rock that has been weathered by water and wind, and include several trace elements vital to life, such as iron and manganese. Healthy soil is also full of organic matter, arriving in the form of dead leaves and animals, which is continuously being broken down by millions of insects, fungi and bacteria. Soil is of paramount use to us, apart from providing a base on which to live and die, soil supports plants and animals as a reservoir of nutrients that are, in various states, food for plants and animals.

Much as our great gift of soil looks abundant and ever determined to support life, there is always a need to harness its benefits with great care and planning. We must at all times replenish the fertility of soil and stop the abuse of soil brought about by erosion.

In this unit we find a section on permaculture, the science and art of recycling and reusing waste material for cost effective gardening. Permaculture provides the missing link between waste disposal and recycling and reuse for agricultural purposes. Articles from Ggaba St John the Baptist PTC and St Theresa's, Girls Primary School, Kisubi shows what permaculture can do for soils and people on school grounds.

Good soil supporting good banana plants

Permaculture

What is permaculture?

The word permaculture comes from PERMA-nent and agri-CULTURE. Two Australians, Bill Mollison and David Holmgren - invented the term in the 1970's. Integrating lessons from ecology, organic gardening, energy-efficient building and agro-forestry. Permaculture principles help people to design rich and sustainable ways of living. Landscapes are designed to conserve water, energy and soil nutrients. The permaculture gardener saves time and energy by getting plants and animals do lots of the work - naturally.

Site at Ggaba PTC before and after perma-culture

What's good about permaculture gardens?

1. Because of the efficient design, you don't need much land.
2. You create employment and a place to chat with friends and family.
3. You can feed your family with healthy nutritious food that tastes better than vegetables bought in the shop!
4. You can sell excess fruit and vegetable to friends or the local store or swap with friends.
5. You can learn more and teach others how to work with soil and plants, producing healthy seeds from plants and keeping soil alive, so you get a good harvest of vegetables year after year.

So what might permaculture food garden look like?

Because it's all about working with nature, the design depends closely on the landscape and environment where you live. These are just a few of the principles and techniques that the permaculture gardener uses to conserve resources and protect the soil.

a) Zoning

Permaculture gardens are often zoned so that areas closer to the home or school are the ones that require most work. Then as you get further away from the centre, the areas need to be visited less often. This means the gardener uses time and energy efficiently. A zoning guide is here provided below:

- **Zone 0**: Centre of activities - the house. This is high maintenance, high use and requires considerable investment of time and energy
- **Zone 1:** Annual plants, herbs, compost, and other high use activities
- **Zone 2:** Chickens, other animals, orchard, greenhouse.
- **Zone 3:** Water storage, main crops, field shelters

- **Zone 4:** Forestry, pasture, dams, forage, beehives
- **Zone 5:** Wild zone, where nature is in charge and where we go to learn and harvest only that which is abundant

Can you identify zones 0 - 5 in the illustration above?

b) Going with the flow

This means making the most of natural flows of energy and resources in the garden. Rainwater is harvested and channelled using gravity to where it is needed. Buildings are constructed using the principles of energy efficiency, and the sun's heat energy is used to full advantage. Permaculture gardens must be arranged along the flow of energy on the compound.

c) Using biological resources to shelter and feed the soil

All organic matter produced in the garden is returned to the soil to feed it and keep it full of life as compost and manure. Trees are planted to produce mulch, green manure and give shade and shelter. Pests are controlled with natural methods, so as to avoid pollution and use of dangerous chemicals.

d) Recycling

All the leftovers from the kitchen are thrown on the compost heap - so that the waste can be recycled to improve the soil. With all the kitchen leftovers going into the garden, it is much easier to separate the other waste into recyclable materials. Some waste might also be useful in the garden, like tin cans for plant pots.

How can we find out more about permaculture?

Permaculture is gaining ground in Uganda, particularly the urban areas of Kampala, Mbarara, Jinja and Mbale. The Permaculture Association lists over 50 projects across Africa. The easiest way to learn about permaculture is to visit and work with people who already apply permaculture principles in their lives.

Tha Ggaba Environment Club sent a representative along to an international Permaculture design course held in Uganda. For details see http://permaculturedesigncourseinuganda.blogspot.com or email: info@permaculturеacrossborders.org.

ACKNOWLEDGEMENTS: The original Action Sheet was written by Nancy Gladstone and reviewed by the Permaculture Association and is based on information from the following sources:
Permaculture Association of Britain, Permaculture Design principles (www.permaculture.co.uk), Food and Trees for Africa/Landcare Permaculture booklet.

Practical composting

This section is about compost and how to make it. Compost is organic matter (bits of plant and animal) that has been rotted down by bacteria and other creatures. It is widely known that compost adds manure to the soil. You can make it yourself, and add it to the soil to improve your crops.

Why compost?

Compost is cheap and easy to make. It uses materials that would otherwise have been wasted. Instead, the nutrients in these waste materials are taken up by your crop plants, making them extra healthy to eat. Leaves, fruit skins, kitchen waste and animal manure can all be composted.

Compost improves soil fertility by adding nutrients to the soil. This produces better crop yields.

Like compost, chemical fertilisers provide nutrients for plants, but they do not feed the soil life. This means that they do not improve the soil structure, and usually only improve yields in the season in which they are applied.

Compost feeds the living creatures in the soil. Healthy soil life helps to improve soil structure, letting more air into the soil, improving drainage and reducing erosion, so the beneficial effects are long-lasting. Healthy plants from healthy soil can fight pests and diseases more easily.

How do you make compost?

There are many ways to make compost. The best way for where you live depends on what materials you have, and what the climate is like. Here are three composting techniques suitable for use in schools and on small farms. You will need:

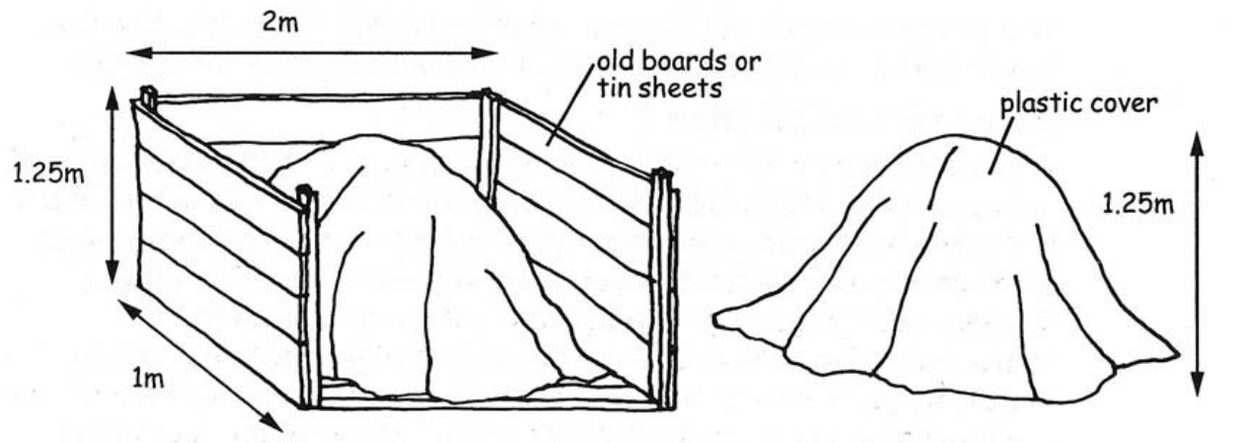
- Slashers, rakes, fork, shovel, watering can, wheelbarrow
- Organic matter, for example, cut vegetation from school grounds (grass, weed, leaves); ash from wood fires; household waste such as leftover food, outer leaves of vegetables, tea leaves, eggshells etc., topsoil, manure (not human waste) or old compost.
- Wooden stakes.
- For the cover: some tin or plastic sheeting or dry grass, or strong crop stalks such as maize, or banana leaves.
- Some large stones

a) A compost pit for dry conditions

Here is the procedure for establishment of a compost pit – suitable for dry conditions:

1. Dig a pit. Its size depends upon how much material you have available but 1.5m x 3m and 0.5m deep is a good guide.
2. Put layers of different organic materials in the pit, starting with small tree branches, maize or rice stalks, banana leaves or other tough parts of plants which will take a long time to become rotten. After a few layers of different household waste products, you can add a layer of ash (not too much) or top soil. If you are using waste food from the kitchen, bury it well or you will attract rats and other pests. Don't put meat on the heap. It is a good idea when making new compost to add some layers of old compost or manure because this contains bacteria which will start the process off.
3. Water each layer before adding the next, finishing with a layer of topsoil
4. Spread straw, plastic, or tin sheets over the mound inside the pit in the rainy season. In dry periods, the compost can be made without a cover under fruit trees like a mango tree, avocado tree or even under shade of banana plantations – the nutrients which seep out from the compost will benefit the trees.
5. The compost should be kept damp. Push a stick into the mound/pit as a 'compost thermometer'. Pull out the stick and check it each day – the stick should be warm and quite clean. If the stick is hot and showing a white fungus, dig another pit and turn the compost into it with a fork, loosening up the pile to allow air in.
6. Pour plenty of water on the mound/pit under the cover once a week, this is to prevent overheating.
7. The compost is wet enough when your hand stays damp after squeezing a handful. If the water drips or runs out, it is too wet.

b) **A compost mound for wet conditions**



Here is the procedure for establishing a compost mound for wet conditions:

1. Note that this mound is established above the ground and therefore no need to dig a pit.
2. Knock into the ground 1.25m long stick to mark the corners of a rectangle, 2m x 1m.
3. To protect the mound you can place old wooden planks, tin sheets or thick sacking between the corner sticks to make simple walls (this is optional).

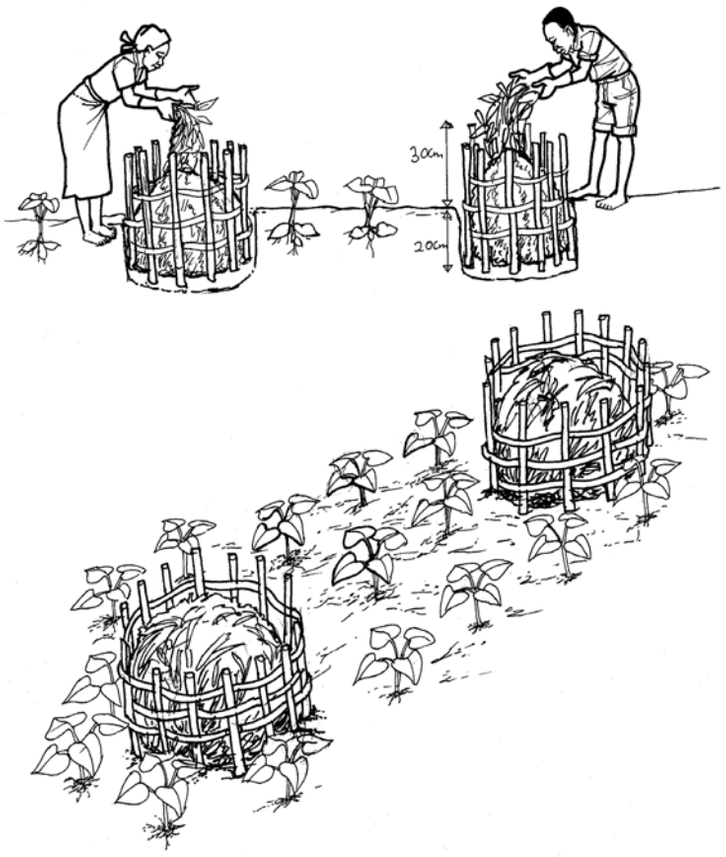
4. Then ask your students to layer the material in the same way as described for the compost pit, but build up the mound above the ground instead. When the mound is about 1.25m high, cover it with topsoil and a cover as described above.

If you only have space for one or two compost heaps of any type, you can add waste material gradually and then cover the heaps when they are big enough. It is a good idea to have several mounds or pits at different stages. That way, you can add materials when they become available and you will have a fairly consistent supply of organic fertiliser for your crops.

c) Compost basket

The illustration here below provides the procedure for establishing a compost basket – suitable for any conditions. Half bury some baskets in the garden between your crop plants and add compost material when it becomes available. Water the baskets regularly.

What will happen inside the compost?



The bacteria inside the pit/mound/ basket will break down the organic matter and release its nutrients into a form that can be used by the plants. The compost mound and pit are built so that the bacteria have enough air and water to do their job.

After 6-12 weeks (depending on the air temperature), the compost in the heaps should have rotted.
You can tell this has happened when the material has become a dark, rich, lumpy mass. You should not be able to identify the original materials that were put on the heap. The compost should not become smelly. If it does, turn it with a fork to allow air in and add more coarse materials like straw and leaves.

How can my compost be used?

Compost is often used close to home in the kitchen garden. When preparing a soil bed for sowing seed, compost can be mixed with the top 10 cm of soil. It should not be dug in any deeper as crop roots will not be able to take up the nutrients released by the compost. An effective way of using limited supplies of compost is to place

small amounts of compost directly into the planting holes. In dry areas these holes can be extended into pits or furrows to use for trapping water.

Compost can be used for mulching between crops or around trees. Compost that has not fully decomposed can be used for this; it will continue to mature on the ground and animals in the soil will draw it into the soil where it will decompose further. When using compost as mulch it should be covered with a thin layer of straw. This will avoid loss of nutrients due to direct exposure to sunlight and heat.

Compost can also be mixed with soil and used for raising tree seedlings and can be used as fish feed. Compost can be combined with water and used as a "compost tea" as a quick boost for indoor plants.

ACKNOWLEDGEMENTS: The original Action Sheet was prepared by Nancy Gladstone, based on the VSO Agricultural Science Teacher's Handbook by Peter Taylor, and the Henry Doubleday Research Association Tropical Advisory Service publications.

Mulching - So what is mulching and what does mulching do?

Mulching helps prevent soil erosion. Have you ever looked down at the ground in forests such as Budongo, Mabira, Kashyoha Kitomi, Bugoma and others? The forest floor is covered in leaf litter - a nutrient-rich, moist bed of decaying leaves, twigs and branches feeding a huge variety of fungi, microbes, and insects. These soil creatures break down all the dead organic matter, making the nutrients available to the forest plants again. It's nature's way of recycling nutrients.

Farmers and gardeners imitate nature by covering the soil with a layer of organic matter. This is called mulching, and it can improve the health of your soil and crop plants. Mulch prevents rain from hitting the soil directly, reducing the impact of the water drops. Water soaks into the soil gradually instead washing the soil away. Mulching adds organic matter to the soil as microbes decompose organic matter. The beauty of this natural nutrient cycle is that nutrients are released in harmony with the needs of the plants.

Mulching feeds soil life and improves soil structure

When a mulch of organic matter is added to the surface of the soil, it decays producing slimes and gums that help to form and stabilize soil structure. The extra organic matter is food for soil creatures. These burrow their way through the soil, mixing the organic matter in and creating passageways within the soil through which air and water can infiltrate. In this way, mulching can help loosen up heavy clay soils, making it easier for the farmer to work, and making it easier for plant roots and shoots to push their way through.

Some people call earthworms "a farmer's best friends". As earthworms multiply, the soil becomes looser and more porous - a better place for plant roots to grow.

Mulching also prevents the soil from getting a hard crust. When raindrops hit bare soil in a heavy rainstorm, it breaks into smaller pieces. These pieces stick together and form a hard crust when the soil dries. This crust makes it difficult for water to soak into the ground. It also makes it hard for young plants to push their roots through the soil crust.

Mulch around crop plants mimics the litter layer of a forest floor. The nutrients in the mulch are gradually released and taken up by the crops. Mulching is cheaper than chemical fertilizers, and because it also improves soil structure, the nutrients will not be washed away or leached from the soil by heavy rain.

Mulch decreases water loss due to evaporation

Mulch reflects a lot of the sun that otherwise beats down on the soil. This keeps the soil cooler and helps prevent evaporation. This is especially important in hot, dry climates. Also, by slowing down rainwater run-off, mulch increases the amount of water that soaks into the soil. The loose soil structure, created by the soil life fed by the mulch, helps hold water in the soil.

Are there any problems to look out for when mulching?

There are some potential drawbacks to mulching which people should know about. For one thing, mulches may provide a good environment for pests leading to losses in crop yield. Harmful insects, mice, rats, rabbits and snakes may also find thick mulches an attractive habitat. Also, mulching can sometimes lead to a lack of nitrogen for crop plants. Nitrogen deficiency may make the crop plants more susceptible to disease. However, as a long-term strategy for soil improvement, the benefits of mulching far outweigh the potential disadvantages.

What materials can be used as mulch?

You can mulch with whatever organic matter is readily available and transportable. Common materials include compost, manure, straw (crop stems and stalks), dry grass clippings, sawdust, leaves, and other left-over crop residues. Avoid using materials that do not add nutrients to the soil or improve its structure such as plastics and newspapers. Avoid using remains of a given crop to mulch the same crop. For example remains of maize to mulch a maize garden. Green vegetation is not normally used as it can take a long time to decompose and can attract pests and fungal diseases.

How do you apply mulch?

- For large plants spread the mulch between the rows and around each plant
- For small plants or seedlings apply it between the rows, not directly around the plants (see illustration below). In this way you will not encourage disease, but you will still reduce weeds and add organic matter to the soil. Try different thicknesses of mulch to see which works best for your crops.

- Always apply mulches to a warm, wet soil. Mulch applied to a dry soil will keep the soil dry
- Renew your mulch every 6 months.

How thick should the mulch be?

If you put mulch on too thickly, it might shade seedlings, so they will grow tall and spindly. Too much mulch can also prevent airflow and encourage disease. This can be a problem in areas with a lot of rain. To clear an area of land of persistent weeds a layer of 10cm or more can be used.

Isn't mulching a lot of extra work?

By improving the soil and helping to fight weeds, mulching can save gardeners time and work in the long run. You will spend less time weeding and because a soil with lots of organic matter is looser, those weeds that do grow are a lot easier to pull out. Digging in a looser soil is also a lot easier. Plus, as mulching prevents water from evaporating from the surface of the soil, less watering is necessary. However, it's true to say that it would be a lot of work to carry out enough mulching material to cover an entire field.

Acknowledgements: The original Action Sheet was compiled by Nancy Gladstone, and is based on Outreach TVE Soils Education Pack: Soil Improvement in the Tropics article on Mulching. [Source: Thurston, H.D. Slash/Mulch Sytems: Sustainable Methods for Tropical Agriculture. IT Publications, 1997

Compost Tea

Compost Tea is a nutritionally rich, well-balanced, organic plant food made by soaking aged compost in water. This section describes how to use one recipe for compost tea on crops and gardens.

How do you make compost tea?

There are several different recipes for compost tea. For this one, you will need a large container with lid (plastic drum works well) and enough water to fill the container.

This is the procedure to follow:

1. Fill the container with the water. Place the compost into an old pillowcase (fine nylon also works well), tie off the top and submerge in the container of water. Cover (to prevent bad smells and insect problems) and leave for a MINIMUM of 2 weeks
2. This steeping/fermenting time is crucial to the formation of beneficial bacteria and the required fermentation process
3. When ready to apply to plants, use a dipper to take out the "tea" into a smaller container and dilute it to make it weaker. Use 3 parts water to 1 part compost tea. The remaining tea can continue to steep/ferment until needed.
4. Compost containing some aged animal manure will make the tea effective for a longer period, but it isn't required.

Compost tea and manure tea is not the same thing. Manure teas can be made in the same way but are not as nutritionally well-balanced.

What can you use it for?

You can use the 'tea' to water at the base of any plants with the diluted tea on a weekly or as-needed basis. Use a pump spray or misting bottle to spray on to leaves and young seedlings. Re-apply after rain, and do not spray on to leaves during the heat of the day. For this, most gardeners recommend additional dilution. Manure teas are not recommended as a leaf spray. Compost tea can be used with buried clay pot irrigation.

What is it good for?

Compost tea is a great root food for any plant. It can also help control various plant diseases (blights, moulds, wilts, etc. when used as a foliar spray), and to repel and control insect pests and their damage when used on a regular basis. By encouraging the growth of beneficial soil bacteria, compost tea helps gardeners to produce healthier, more stress-tolerant plants.

ACKNOWLEDGEMENTS: The original Action Sheet was prepared by Nancy Gladstone and is based on the in Village Garden Web Frequently Asked Questions section: faq.gardenweb.com/faq/lists/organic/2000072320012926.html

Soil Erosion

By Sserunkuuma Charles, Tutor - St. John the Baptist, Ggaba Primary Teachers' College

The Oxford Advanced Learners Dictionary (6th Edition) explains the word erode as being the gradual destruction of something through the action of wind, rain etc. So, soil erosion is the gradual destruction of the soil through the action of wind, rain or human activities. Nutrients that can be available to plants are located mainly in the top layer of the soil profile which is the layer most affected during the process of erosion. Soil erosion therefore

affects the quantity and quality of soil and this impacts directly and negatively on the ability of plants to grow, which in turn affects other living organisms that depend on plants for survival, including human beings.

What causes soil erosion?

Soil erosion is caused or as a result of human activities which include:

i. De-vegetation – the removal of natural vegetation. De-vegetation occurs during deforestation where people fell trees for charcoal burning in a bid to meet the demand for fuel and timber for cooking, building and carpentry. Forests are cleared for settlements and the construction of industry and domestic houses.

ii. Bush burning is another human activity which has resulted in the creation of situations conducive to soil erosion. Bush burning not only enhances conditions that lead to global warming, air pollution, destruction of biodiversity, alteration of ecosystems but also exposes the soils to rain and wind.

iii. Overgrazing is usually as a result of keeping too many animals on a given area exceeding the capacity of the land to support that population. The animals graze all the vegetation leaving no or little plant cover for the soil and the animals hooves trample and compact the soil into a hard layer resulting in less absorption of rain. The soil dries quickly and may eventually be blown away.

iv. Farming practices such as growing food crops on steep plots and on ridges leads to formation of rivulets which often have a greater force than a single sheet of water resulting in steep sided channels called gullies. High demand for land for cultivation in mountainous areas eg. Kabale, Kapchorwa, coupled with poor methods of farming has led to huge quantities of soil being eroded into lowlands and water bodies. The eroded areas become barren and the different species that were originally present become extinct or at least threatened with extinction.

Eroded part of Ggaba PTC compound

Dry bare soils encourage the formation of dust which not only pollutes the environment but also affects the health of the inhabitants. Soil erosion can cause water reservoirs to become silted and this hinders the proliferation of aquatic life.

Natural disasters such as hunger and drought can be as a direct result of soil erosion. A place without topsoil will not sustain crop growth. This leads to low crop yields resulting in a lack of food. Soil erosion also distorts the natural beauty of the scenery. Shallow rooting herbs will not provide ground cover.

Much of Uganda's road network comprises gravel surfaces which are eroded during the rainy season causing deep gullies which inconvenience drivers making driving difficult and even lead to road accidents.

Environmental Clubs such as that at St. John the Baptist, Ggaba PTC need to take action against erosion that effects the compound. Indeed work by the club at Ggaba has greatly reduced impacts of erosion on the compound. Ggaba PTC has minimised exposed patches of soil by planting grass, flowers and even vegetables.

To bring everybody on board there is need for sensitisation of communities about the importance of conserving our environment. Environmental Education should be a compulsory subject from Primary to Tertiary level irrespective of one's professional specialty.

St.Theresa Girls Primary School, Kisubi, Uganda

St Theresa's school was founded in 1915 by the White Sisters Order of Africa to give girls a well founded academic education. In 1970 the management of the school was passed on to African Nuns and in 1995 the present head Sister Mary Valentine took over. The school has 860 pupils, mostly boarding, and 33 teachers.

Metal tank on shower block

Water was originally collected from Lake Victoria, and the National Water Supply System, but the cost and risks associated with this led to the adoption of a comprehensive policy of water harvesting, many of the school buildings now having at least one tank.

The school also carries out a large programme of animal husbandry linked to permaculture inspired by PACE information. Students of Ggaba PTC spend time in the school on teaching practice. Several of these have been members of Ggaba environmental club and have helped with the development of permaculture at the school.

Sister Mary Valentine is a long term planner, each new structure has water harvesting planned and she is currently in the process of developing grey water harvesting tank and pond of animal waste to provide water and nutrients to the permaculture plots.

To date the school only pays Kampala Water Supply System a connection fee, and it is almost self sufficient in eggs, meat, fruit and vegetables, enabling surplus money to be dedicated to maintenance of the property and improvements in school equipment.

Grey water pond ready for feeding to plots

In the thick forests of eastern Uganda's Mount Elgon a local tribe sings:

'What world would it be if the grass and the creeper,
And the soaring trees were not there;
What world would it be if the worm and the centipede
And the bee and the crawling reptile,
And the skipping monkey,
And the ape and man; were not there?'

Flora and fauna are terms applied respectively to plant and animal life. These two segments comprise life as we know it on earth. They both reveal an enormous variety of species and an amazing variety of form and function.

Plants range from very simple single-celled ones to more complex trees and shrubs with hundreds of thousands of cells. The story is similar with animals; some are simple single-celled ones whilst others are complex organisms made of multifarious tissues and organs.

This section includes ideas about planting trees to improve soil and supply fuelwood, timber and fruit for people, followed by an article on Uganda's Tree Talk programme for schools. Wonders and worries about wildlife are covered in a report on a visit to a National Park by student teachers of St John the Baptist, Ggaba PTC, and a warning to the world from the World Wildlife Fund on biodiversity conservation.

Planting Trees

What are the benefits of tree-planting?

Trees give us foods, spices, medicines, rope, as well as wood for tools, fuel, and construction. Some trees are so important to our survival that they are viewed as sacred.

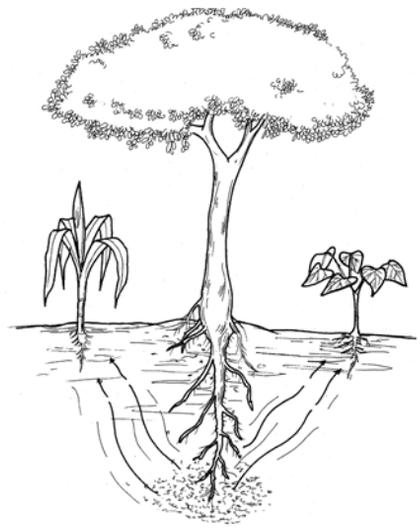
Trees can improve soil structure. Roots of trees make soils more porous, helping soils take in and hold water —and air— more easily. Some trees - known as leguminous trees - can improve soil fertility by adding nitrogen to the soil. Where there are plenty of trees, the soil is protected, stopping erosion by wind or water.

In the city, trees give shade and help reduce noise and air pollution. Trees can help entrepreneurs and community groups make money. Raising tree seedlings in nurseries and selling them can become a successful business.

Planting trees in cities, school gardens and on farms can help people realise the value of trees, so they are more willing to manage natural forests in a sustainable way. If people can find ways to cultivate useful indigenous species, it may be possible to protect rare tree species in the wild. Harvesting fuelwood or timber from trees that have been grown for the purpose can help take pressure off wild resources.

Which kinds of tree should we grow?

This depends on what you want and where you live. Observe nature! Find out which trees grow well in your area. Ask people what goods and services local trees already provide? What trees do people want more of? What needs could be met by growing trees? Can one 'multipurpose' kind of tree meet more than one need? Talk to people who are already growing trees! Forestry Extension Officers, Agroforestry organisations, and Botanic Gardens will also be able to help.



When you plant trees, it takes time before the benefits can be reaped. And planting trees takes some work, as we have to plan for, plant and care for the trees, especially when they are young. That's why it a good idea to plant multipurpose trees that can offer many rewards. Planting trees to improve or maintain soil fertility is important. But if you plan carefully, and choose trees wisely, there should be many other benefits to tree-planting.

Choose multipurpose trees which not only help improve the soil, but also give you products that you need at home or can sell for cash: food, fruits, nuts, fuelwood, fodder, medicine, fibres, latex or construction materials. For example, if you rely on fuelwood for cooking, growing trees for fuelwood could save you time and effort collecting wood, or money, if you usually have to buy it. Growing more fuelwood may also take pressure off existing woodlands.

When choosing which trees to plant, one important consideration is whether to plant indigenous or exotic tree species.

What's the difference between indigenous and exotic trees?

Indigenous plants are native to the area where they are grown. They are your well-known local trees. Growing them can help attract the local wildlife - birds, insects and mammals - which have always lived alongside such plants. More research into the best ways to plant and propagate indigenous trees is needed!

Exotic plants have been brought in from another country or continent. Some exotic species of tree, like neem, mango and papaya have been grown in Africa for centuries and are essential to people's livelihoods. However, environmentalists are concerned when large

areas of land are planted with exotic species, such as plantations of Australian Eucalyptus and pines, because of the effects on local environment and wildlife.

Another cause for concern is 'invasion' by exotic species. Some exotic tree species need careful management to stop them going wild and weedy. For example, *Leucaena leucocephala*, a Central American nitrogen-fixing tree, grown in Africa for soil-improvement and fodder production, has now been reported as a weed in over 20 countries, including Uganda.

Advice to new tree-planters - THINK OF TREES AS A LONG-TERM INVESTMENT

Before you plan a tree-planting project look around, and observe how nature works in your area. See how well different plants grow in different areas, on different terrains, and in different soils. Find out about local trees and what special features they each have, how they grow, and how well they serve other plants, animals and people. Ask advice from farmers and local experts who have had experience in tree-planting.

Sort out ahead of time whether you are entitled to use all the products at all times from the trees you plant. Rights to trees vary from one society to another. It is important to know who has the right to inherit or own trees; the right to plant trees; the right to use trees; the right to dispose of trees.

Tree-planting is a lot of work, especially at the beginning. If you start small, you won't be overworked, and you can do things right.

ACKNOWLEDGEMENTS

The original Action Sheet was compiled by Nancy Gladstone and is based on pages 1-5 and 11-14 of the OUTREACH Information for Educators and Communicators Soil Series Solution Pack: 'Trees for Soil and People' written by Gillian Dorfman and Sharon Kahkonen, M.S., Ed.D and edited by James V. Connor, M.S., Ed.D; and the Action Environmental Health Magazine SOURCES: P.K.R. Nair, 1990. The prospects for Agroforestry in the Tropics. The World Bank, Washington D.C. Brils, C et al. 1996. Agrodok 16: Agroforestry. Agromisa Foundation, Wageningen, The Netherlands. Van Schöll, L. 1998. Agrodok 2: Soil Fertility Management. Agromisa Foundation, Wageningen, The Netherlands. Forestry/Fuelwood Research and Development Project. 1992. Growing Multipurpose Trees on Small Farms. Bangkok, Thailand. Winrock International. Wilkinson, K. and Elevitch, C. The Overstory #5. Start Small....And Expand on Successes. [Online] Available at http://agroforester.com/overstory/osprev.html on April 29, 2002; Bonkoungou, E. G. Network on Agroforestry and Soil Conservation: Lomé, Togo, 13-15 June, 2001. Background Document. Secretariat of the Convention to Combat Desertification ICRAF, 2000.

Planting Trees at Schools

By Gaster Kiyingi, National Program Manager, Tree Talk

Schools have an increasing demand for forest products and services and therefore should consider tree growing. Schools are centres of social capital. In harsh environments, they are often bleak, hot, and dusty because they are tree-less. This discourages learning, leading

to pupil drop out. Tree Talk Uganda (www.treetalk.or.ug) helps schools to plant trees for shade and fuel and teach the science of tree growing. The school appoints two teachers who Tree Talk train. They in turn lead pupils and fellow teachers in greening the school.

Tree Talk has a big presence in northern Uganda and aims at each school to have 1-4 acres of woodlot. Each acre holds about 436-990 trees. Tree Talk supports the establishment of woodlots of indigenous trees and planting of ornamental trees on school compounds.

One high performing school is Lokung Primary School in Kitgum district. After three years of collaboration with Tree Talk, it has a four acre woodlot containing 3000 trees (700 *Markhamia lutea*, 2000 *Senna siamea* and 300 Neem). It also has boundaries planted with ten Mvule (*Milicia excelsa*) and 40 Mahogany trees. It has an additional 40 compound trees.

The attempt by Tree Talk is to try and use the young generation, motivate them and build their capacity to grow trees. Children are known to be particularly receptive to messages about trees and the nation's future prosperity. In this case, children need to be encouraged to see forests and trees as part of their future, and as a source of income for their further education. Among other things:

- Children will take this information home, and influence the attitudes of their parents and other adults.
- Schools should be encouraged to include forestry in their teaching programmes.
- Schools should see tree growing as one way of earning extra income, and to meet their own fuel and timber needs.
- Communities around each school will learn how to manage trees.
- Communities will realise the need to restore their watershed and ecological stability including the restoration of wild life, both flora and fauna.

Tree Talk addresses energy and wood crisis since 97% of Ugandans, including schools, cook on wood and yet it is children and women that walk more than 5 kilometres for more than 3 hours looking for firewood.

Tree Talk is also responding to climate change by increasing appreciation and awareness of biodiversity values, through Tree Talk newspaper in English. Over 1,000,000 people are reached with social change communication campaign around conservation and climate change through radio programs.

This has helped enhance the teaching of science and agriculture since Tree Talk magazine is now

Pupils of a Tree Talk beneficiary school prepare seedlings for planting

used as a teaching aid in schools, and in promoting sound science at community level.

Schools can be part of this intiative by contacting Tree Talk on the contacts provided below.

Contact information: Tree Talk, Straight Talk Foundation, Plot 4, Acacia Avenue, Kololo, P. O. Box 22366, Kampala Uganda, Tel: (General) +256-312-262-030/1, Tel: (Direct) +256-312-266-148, Email: info@treetalk.or.ug www.treetalk.or.ug

A visit to the National Park, March 2010

By Hellen Mwebaze, Student at Ggaba St John the Baptist Ggaba PTC

It is a memory that is now so engraved in my heart that telling about that extraordinary trip to the National Park rekindles so much pleasure.

We set off from our college early on a mildly cloudy Friday morning. We had been instructed by our patron to be observant of various features both man made and natural as we traversed the countryside to the Park. Kampala city's sprawling neighbourhoods soon gave way to rural countryside, with occasional forest patches catching up with the black tarmac road. Most of the roadside was savannah vegetation, and dotted here and there could be seen indigenous animals grazing, indifferent to half-naked children playing in nearby sweet potato fields.

Our first stopover was at Kayabwe, that historic place where the Equator slices the Earth into two halves, the Northern and Southern hemispheres. Here we were able to refresh ourselves and take 'once in a lifetime' photos. From Kayabwe, we went on to the hilly town of Masaka that was once a host to abundant numbers of antelopes and buffalo and a huge variety of birds. Today the animals have given way to human settlement, a reduced number of birds still seek to defeat the odds against human expansion.

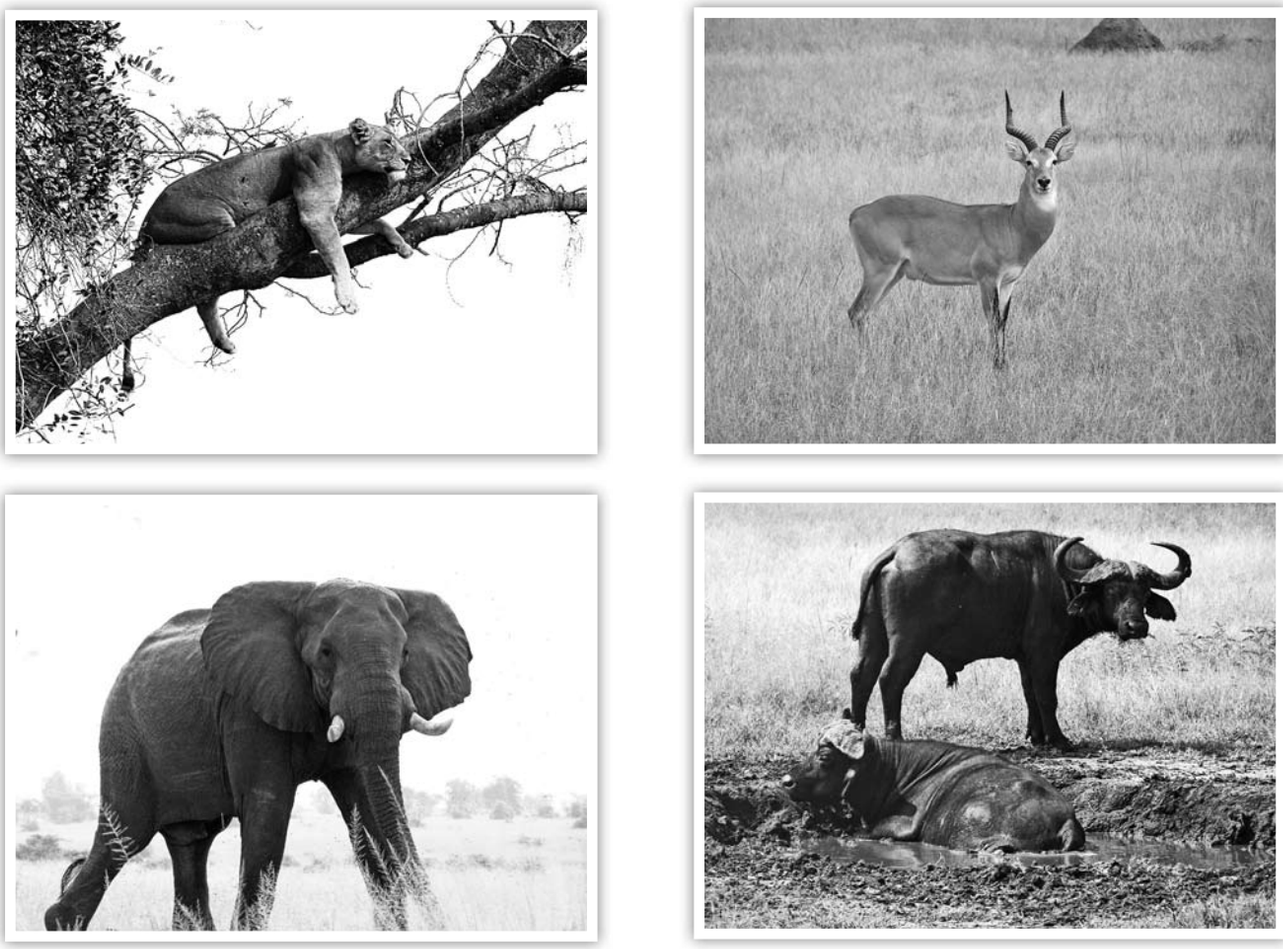
On the border of the ancient Buganda Kingdom, and the Ankole region at Lyantonde we noticed a very marked change in the physical form of the land from gentle undulating hills to sometimes riotous upshots of earth. These hills were clad in green foliage interrupted only by the beige of the rocks.

Soon we were into the Lake Mburo National Park. The road ran like silver lace through the huge tribe of thickets. From left and right the Impala and a variety of other smaller animals made their way hurriedly across the road as if pursuing important business. We had to drive at a cautious speed.

Mbarara town was soon in sight, this is where we had our lunch. We were soon speeding deeper west across a land where mouth watering fruits decked roadside market shacks complemented by smiling market women with their babies safely strapped to their backs. It was at the setting of the sun that our van made its turn into Queen Elizabeth National

Park, a vast expanse of nature at her very best. It is as if time has stood still allowing plant and animal to maintain their way of life as deemed best. Here we came to closely view buffalo, elephants, zebras, kob and the unforgettable warthog. All along birds of many colours, shapes and sizes flew above our van as if in welcoming serenade.

Saturday was the day for the daybreak game drive, it did not disappoint, for we were able to come very close to the 'King of the Jungle.' a pride of lions as if in conference went about their business undisturbed by our presence and the clicking of digital cameras.



Clockwise: A climbing Lion, Uganda Kob, Buffalo and Elephant found in Ugandan National Parks

In the afternoon we had a boat ride on the Kazinga Channel where the hippopotamus were plentiful and an assembly of them would make a sound like a choir in panic. There were birds and birds and birds which often flew close to the water surface as if to whisper some secret to the seemingly relaxed crocodile.

The safari team also visited the Park museum and later the salt water works at Katwe town. Here we came face to face with Uganda's pricelessly valuable wealth of naturally occurring salt. Sunday was our day to drive back home. We took the alternative route through Hima, where we saw the cement manufacturing factory. We were dismayed at the amount of pollution that the factory was constantly pumping into the atmosphere!

The towering Rwenzori mountains dominated the landscape like some god watching over a race of people who would never be able to realize the wealth at their disposal! We then went through Kasese town and on to Fort Portal, the regional hub of this area. Here the hills seem to chorus a mysterious harmony and the people seemed to move as if in dance to the unheard rhythm of the hills.

Along the road to Mubende and Mityana one would sigh at the sight of scattered charcoal burning sites. Soot-coated vendors of this forest-depleting merchandise yelled out their 'bargain prices' as I pondered how to popularise fuel-efficient and cost-effective technology. Soon twinkling lights of late evening welcomed us back to Kampala. The sun had just pulled under his massive blanket when the gates of Ggaba PTC opened for us with our load of unforgettable memories of the trip to the Park in the west.

World Wildlife Fund (WWF) for Nature – a warning;

By D.K. Mayanja Tutor, St John the Baptist, Ggaba PTC

In 2007, Earth's 6.8 billion humans were living 50% beyond the planets biological capacity, according to an assessment by WWF. Even with modest UN predictions for population growth, by 2030 humanity will need the capacity of two Earths to absorb carbon dioxide waste and keep pace with natural resource consumption; says the WWF website. If we all used resources at the same per-capita rate as the United States of America or the United Arab Emirates, 34.5 planets would be needed.

Habitat loss, over-exploitation, global warming, and hunting of threatened species and misuse of fresh water are factors driving many species towards extinction. According to the International Union of Conservation of Nature (IUCN) at least 869 species have been driven to extinction in the last 500 years. They could be joined by nearly 17,000 others on current trends. A quarter of all animals, a third of amphibians, and a fifth of all plant species and one eighth of all bird species could vanish.

The worldwide appetite for tackling the environmental crisis has dulled in the light of the economic recession, which has also darkened hopes for the Nagoya Eco-Summit in 2010. Three big issues are on the conference table at Nagoya:

i. Setting 2020 as the target for species loss.
ii. Boosting medium-term financial support for poorer countries to help protect wild-life and associated ecosystems.
iii. Forging an accord called the Access and Benefits Sharing (ABS) protocol, where poorer countries would receive in effect a form of 'gene-fee' if scientists discovered new, unique plants or animals which may have an overall beneficial use in say drugs or energy, or a commercial value.

The ABS protocol could be the question that makes or breaks forth-coming summits on conservation. Brazil's minister of the Environment, Izabella Teixeira has warned that 'it is not acceptable for world leaders to leave eco-summits such as the one in Nagoya without comprehensive, practical, time limited agreements based on the Access and Benefits Sharing (ABS) ideals which bring all of us on this planet on board'.

The environmental scenario is as real as these grim facts attest. The challenge to all of us is to take the bull by the horns and adopt practical and universal measures to hold back the tragedy that looms on the horizon, unless humankind makes fundamental pro-eco choices.

Uganda is exceptionally important in terms of biodiversity, with surveys so far reporting the occurrence of 18,783 species. Although the country covers just 241,551 km2 and accounts for only 0.18% of the world's terrestrial and freshwater surface, Uganda hosts 4.6% of the dragonflies, 6.8% of the butterflies, 7.5% of the mammals, and 10.2% of the world's bird species.

Uganda has more species of primates than anywhere else on Earth of similar area. While Kibale National Park has an area of just 760 km2, it has 12 species of primates. In two Ugandan forests (Bwindi and Kibale), scientists have recorded 173 species of polypore fungi, which is 16% of the total number of species known in North America, Tropical Africa and Europe together.

Uganda has these spectacularly high levels of biodiversity because it crosses the zone between the ecological communities of the drier savannas of East Africa and the more moist rainforests of West Africa. Uganda includes several sites along the Nile River with spectacular waterfalls, including the Bujagali Falls, Karuma Falls and Murchison Falls. The ecosystems of Uganda range from the snow-capped peaks of the Rwenzori Mountains (Mountains of the Moon), to the high altitude montane forests of the Virunga Volcanoes and Mount Elgon, to the open waters of Lakes Victoria, Albert and others, to the islands of Lake Victoria and Bunyonyi.

Action needs to be taken as a high proportion of the vegetation of Uganda has been modified by cutting, cultivation, burning, grazing and other anthropogenic actions, and many of these vegetation types have been significantly reduced in quality and range.

'Air is all around us,
and in us
if air was to spy on us, to reveal our
secrets who could be bold enough
to deny?'

Air is a mixture of a number of gases. The greatest percentage is however made up of Nitrogen 78% and Oxygen 21%. Then there is water vapour, carbon dioxide, neon, krypton, helium, hydrogen, xenon and ozone. Air is a recipient of waste gaseous matter, for example smoke, which can impact directly on the air quality that is so vital for the well-being of all living creatures on the Earth. Smoking cigarettes directly destroys the quality of the air you breath, and can affect your family and friend's health as well.

In this unit we look at aspects of air quality that are important to human life, including practical ways to avoid polluted air inside our houses.

Air Quality

Air quality refers to the chemical and physical state of the air at any given time. The chemical quality of air may be affected if the percentages of particular air components (elements) are altered. For example if oxygen falls below the normal 21% the chemical composition of the air would be altered. The physical state of air may be affected through for example the discharge of waste gaseous matter into the atmosphere, smoke, exhaust fumes, and dust particles etc. Plants contribute to good air quality through the process of photosynthesis by which they take in carbon dioxide from the air and return much needed oxygen for animals to breathe.

In today's world we face the challenge of poor air quality because human activity has escalated beyond the point where a logical balance is struck between such activity and the environment's capacity to maintain air quality. It is a sad fact that with every new human discovery a problem is created with regards to air quality. Look for example at the marvelous motor car and how it has helped turn many cities into havens of smog and haze. Our industrialised culture may be on one hand a blessing, if handled with an eye on the environment, or it may be a curse if we carelessly pour tons of pollutants into the innocent skies.

The peasant who sets fire to grass in the mistaken belief that he is refreshing the land; and the rich industrialist who hides his head in the sands of financial benefits, discharging waste into the skies, are both guilty of cruel abuse of our clean air resource.

The change of heart has to begin with each and every one of us in our homes through to the wider communities. The message must be clear that clean air is not an infinite resource, and air cannot take an infinite amount of abuse. There is a limit to what we may or may not do to keep the extraordinary gift of clean clear air.

Be informed! There are actions you can take to reduce air pollution and to keep the air cleaner and healthier for everyone to breathe. Take action at home, on the road, at work, at school, and in your community. Aim to reduce those activities that increase pollution. Ugandan communities are essential to protecting our environment and improving public health. The National Environment Management Authority is committed to finding ways to help build the capacity of communities to improve their quality of life.

Smoke hoods

What is a smoke hood?

A smoke hood is a metal hood built over a stove or open fire. Cooking smoke goes up into a chimney, so that it is taken out of the house. With a well-designed smoke hood, up to 80% of the smoke from the cooking fire goes out of the house.

Smoky air is dangerous for health. When solid biomass - wood, charcoal, husks of maize, straw, sticks and wood shavings - is burnt, smoke, soot and gases are produced. When tiny particles of soot get into your lungs, they can make you ill. Breathing too much smoke every day can lead to pneumonia, bronchitis and emphysema. Smoke and soot also make your house, your children and your clothes dirty, adding to the burden of everyday life.

It's a serious problem. Each year, more than 2 million people die from indoor smoke pollution worldwide. Women and children who spend a lot of time in the kitchen suffer the most. Fitting a smoke hood is one of many things that people can do to make their homes less smoky.

What are the benefits?

Women with smoke hoods in their kitchens say that their lives are improved because:

- Cooking is cooler and the kitchen more comfortable to work in.
- No more headaches, fever or smoke-sickness.
- The air is healthier, so you can see and breathe more easily.
- Children get fewer coughs and colds.
- Men like to spend more time in the smoke-free kitchen.
- There is less soot, so it is easier to keep the kitchen clean.

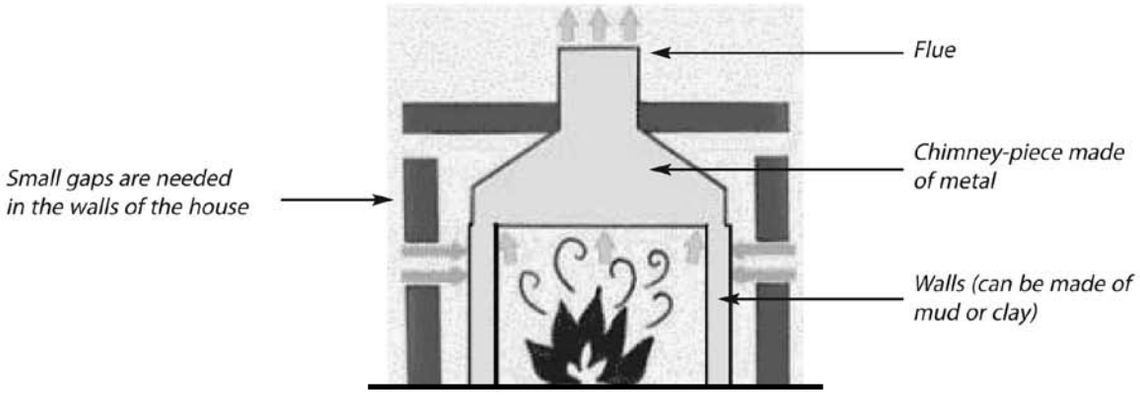
How do you design and make a smoke hood?

Smoke hoods are widely used in Ugandan restaurants that use a lot of firewood and charcoal for cooking.

The most effective design of smoke hood and chimney depends on your house and way of cooking. There are many places in Uganda where you can seek advice on designing smoke hoods for homes and institutions. First, models of the smoke hoods are built using thick Manila paper or plywood. Then local artisans constuct bricks or heavy gauge galvanised sheet metal to make smoke hoods and chimneys as illustrated.

How do smoke hoods work?

Smoke hoods work because hot air rises. This creates a draught, drawing the smoke up into the flue (see illustration below). As the air blows across the roof of the house, the smoke is drawn up and out of the chimney. This is why the stove or fireplace needs to be kept under the hole leading up the chimney. Even though it might be easier to reach into the cooking pot if it was wider, the walls of the stove area need to be close to the edges of the hood, or smoke will go into the room.



Do smoke hoods need maintenance?

The smoke hood flue needs to be cleaned out at least twice a year. This stops the flue from blocking up and makes sure that soot does not drop down into the food.

Are smoke hoods appropriate in every situation?

In Uganda, there are situations when the smoke hoods and chimney stoves may not be appropriate.

- Where people like a traditional fire and are unused to cleaning chimneys.
- Where people have very little money and no chance of a subsidy, chimney stoves can be too expensive
- If people want space heating, the smoke hood does not work well because it insulates the fire so little heat escapes.

How much do smoke hoods cost?

In Uganda, a metal smoke hood may cost 212,300/= (US$100), about as much as five goats. To get the costs down to 100,000/= (US$50), good quality recycled metal can be used for the hood and chimney, and mud or clay to build the walls, although it may not last as long.

In order to get round the cost, people could get together to set up a revolving fund or other credit system to pay for the costs of installation. When the first household has paid the costs back, the next household gets a loan for installation, and so on.

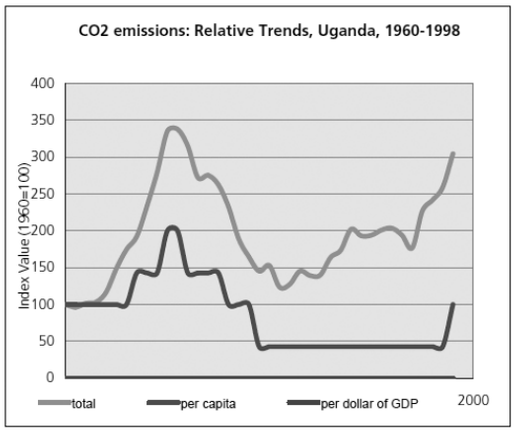
ACKNOWLEDGEMENTS: The original Action Sheet was prepared by Nancy Gladstone and reviewed by Hellen Owala and Liz Bates of Practical Action.
Much of the information is based on: Bates, L. (Editor), 2005, Smoke, Health and Household Energy, Volume 1, Participatory methods for design, installation, monitoring and assessment of smoke alleviation technologies, ITDG
FOR MORE INFORMATION

Contact Practical Action (formerly known as ITDG): www.practicalaction.org

Carbon Dioxide - What is Uganda doing about global warming?

Most electricity and motor transport is produced by burning fossil fuels such as gas, oil and coal. The by-product of all this burning is carbon dioxide and other carbon gases. These collect in the atmosphere, high in the sky. There they act like glass in a window, creating a 'glasshouse' effect over the whole world. This is a good thing, because it keeps the heat in. If it wasn't for gases like carbon dioxide, the earth would be on average minus 18° C which is very cold! But as we keep burning more and more fossil fuels, the planet is getting warmer and the climate is changing. Weather is becoming unpredictable. Drought, heat waves, floods and cyclones will be more frequent.

Between 1950 and 1998, Uganda registered substantial increases in emission of carbon dioxide and the per capita carbon dioxide emission has also increased greatly. That said, Uganda's contribution to carbon dioxide emissions is very small in the global context, when compared to major polluting economies of the United States and Europe. Unjustly, it is people in countries like Uganda, who have burnt only a small amount of the world's supply of fossil fuels, who will probably suffer the most as the climate changes.



Source: Earth trends (www.earthtrends.wri.org)

As part of the global efforts to address the threat of global warming, the Government of Uganda is working to ensure that the forests of Uganda play their part in removing carbon from the atmosphere. Uganda is among the many countries to benefit from efforts by the World Bank to support tree-planting and the United Nations Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries.

At the individual level, there are many things we can do to protect against runaway climate change:

- Save energy! Turn off electric lights and computers when they are not needed; If you use an electric kettle, boil only as much water as you need. Keep the backs of refrigerators clean, so that the cooling coils use as little electricity as possible to keep the fridge cold. Keep cars well-maintained. Of course, what you can do depends on your circumstances and the types of energy you use.

- Get efficient - Use less fuel to do the same thing. For example, a bus is more efficient than a car because it carries more people; Energy efficient stoves are one way to reduce the amount of fuelwood used to prepare food.
- Choose or campaign for alternative and renewable ways to produce electricity such as solar panels, wind turbines or micro-hydropower schemes
- Plant trees and protect forests. This means that carbon will stay in the forests, instead of adding to the carbon dioxide in the atmosphere.

Air pollution and its consequences for human health

By Nabbanja Joseline; Student Teacher at St. John the Baptist PTC; with excerpts from a presentation by Professor Freers Juergen at a public talk for Nature Uganda (7th October 2010)

Pollution is the presence of unwanted substances in the environment. Air pollution is mainly from emission of gases, fumes or smoke into the atmosphere.

There are many causes of air pollution; for example car fumes, fumes emitted from industry and factories, burning and leaving rubbish to rot, cigarette smoke and stove fumes. Different types of emissions have caused a hole in the ozone layer, changed climatic conditions or can be dangerous when inhaled by people or animals.

Burning of used motor oil or leaded gasoline is particularly dangerous as it can cause lead pollution which can damage the kidneys or the brain. Other substances that pollute the air include benzene, sulphur dioxide and nitrogen oxides (causing acid rain) and dioxins and furans, which are highly poisonous and carcinogenic organic compounds and can enter the food chain.

Inhalation of very fine particles from air pollution produces inflammation of the lungs. This can affect the ability to absorb oxygen, leading to respiratory problems and even death. Air pollution is thought to have an effect on children causing lower Intelligence Quotients (I.Q) and birth defects.

What are the direct health impacts of air pollution?

Running noses in children and watery eyes in adults are a constant reminder of air pollution in rural households in Uganda. Biomass fires contain health-damaging pollutants such as carbon monoxide to which women and children are exposed on a daily basis in the process of cooking.

These pollutants have adverse effects on human health, including impairment of mental functions, cardiovascular disease and lung diseases. In addition, the gaseous emissions aggravate respiratory diseases such as asthma, chronic bronchitis and emphysema.

Smoke produced from burning of biomass has been linked by fairly consistent evidence to a

range of common and serious diseases both in children and adults. Low birth weight is one of the factors that impact on infant mortality. The poisonous effects of smoke pollution are especially detrimental during pregnancy leading to delivery of low weight babies. In turn, low birth weight, ranked by WHO as the world's number one killer has been found to be linked to high levels of pollution.

In Uganda Acute Respiratory Infection is the third most common cause of infant deaths responsible for 8.2% of all recorded deaths in Uganda. The disease is linked to poor ventilation in kitchens as one of the commonest and major risk factors where children as young as three weeks are exposed to very high levels of indoor air pollution while they stay with their mothers during the process of cooking.

Though many of the diseases resulting from smoke-pollution are not yet quantified, the most recent information on Global Burden of Disease, published in the 2002 world health report found that that air pollution is responsible for around 3% of Disability Adjusted Life Years (a measure of the number of years lost worldwide due to ill-health, disability or early death).

How can we improve air quality?

- Sensitise everyone about the consequences of pollution.
- Government should provide public transport to reduce number of automobiles on our roads.
- Maintain all vehicles and write off vehicles under dangerous mechanical conditions.
- Recycle and re-use plastic and other forms of waste.
- Avoid burning rubbish and waste.
- Tarmac all roads and cover potholes to reduce dust in Uganda's towns.

What to do if an area is polluted?

- Vacate the area.
- Tell everyone to stop polluting (no burning rubbish, maintain all vehicles).
- Establish a landfill, where all the waste is dumped and compressed such as the Kitezi landfill used by Kampala City Council to collect, treat and compress Kampala's waste.

The word energy comes from the Greek word energo meaning active or working and is understood as the ability to do work. Energy comes from our environment and is either renewable, for example wood, wind or solar energy, or non-renewable such as fossil fuels. These fuels are literally made of fossils, the dead bodies of trees which died during the Carboniferous Period (354-292 million years ago), which were squashed by geological forces to produce coal, oil and gas.

As we consider our use of energy we need to understand whether our choice of energy resource is renewable or non-renewable and if it is renewable, how long will that process take. We may replant trees when we cut them down for wood for construction or burning but how long will it take for that tree to grow?

In Uganda most cooking is done using wood or charcoal. In this learning unit we see how to conserve these energy sources and how an alternative source of energy - the sun - can also be used for cooking and even making water safe to drink. The first topic, improved stoves, can also help address the indoor air pollution issues mentioned in Unit Five.

Improved stoves

If you are looking for ways to use less fuel and make less smoke when cooking, at home, at school or at the workplace, this section tells you about improved stoves, which aim to do just that.

What is an improved stove?

An improved stove is a cooking stove which has been especially/specifically designed to use less fuel, cook food more quickly, and produce less smoke. One example of an improved stove is The Rocket Stove, an amazing design that produces less smoke. There may be no smoke without fire, but there can be fire with less smoke!

What are the benefits of cooking with an improved stove?

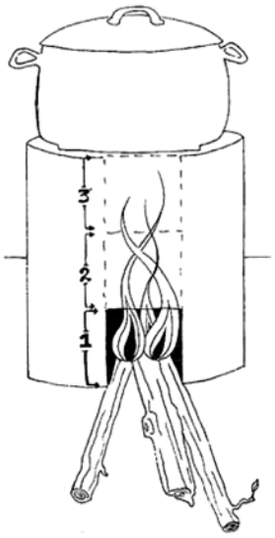
With an improved stove, your kitchen will be healthier, more comfortable and easier to keep clean. Using less fuel can save you time and money, and reduce impacts of fuel collection on the local environment. It will also reduce respiratory diseases that affect women and children that cook for families.

What are the principles behind improved stove design?

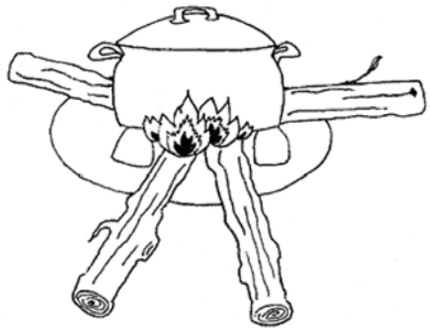
Stove designers learnt four important design principles from people who cook on traditional three-stone fires. Expert cooks know exactly how to set the fire to burn hot enough to

avoid making a lot of smoke, how to feed wood to the fire to avoid using more fuel than necessary and how to place the pot to get the most heat from the fire. Stove designers use these lessons to design better stoves, creating easier, safer and faster ways to cook with fire.

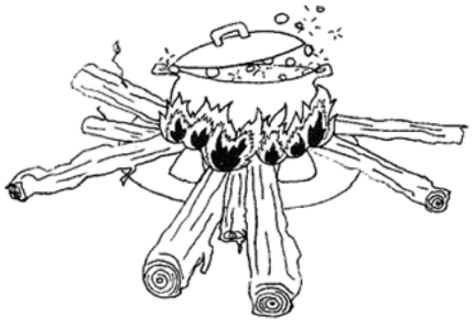
LESSON 1. BURN FIERCE Inside a fire, pieces of wood get hot, and release gases. These gases catch fire and burn, releasing heat energy used to cook your food. A short chimney on top of the fire place as illustrated will provide a combustion chamber for more gases to burn producing flames. Smoke is un-burnt gas and soot particles released from the wood. The hotter the fire is, the less smoke will be produced.



LESSON 2. BURN WISE A fire that burns only the tips of wood will burn hotter and make less smoke. It will also use much less fuel. The temperature of the fire depends on how many tips of wood are burning. Well-designed stoves help users meter the amount of fuel they use, feeding in only as much as they need to cook their food.

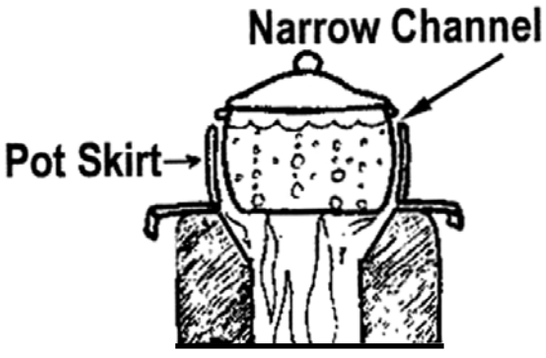


Burn a few tips for a low heat



Burn more tips for high heat

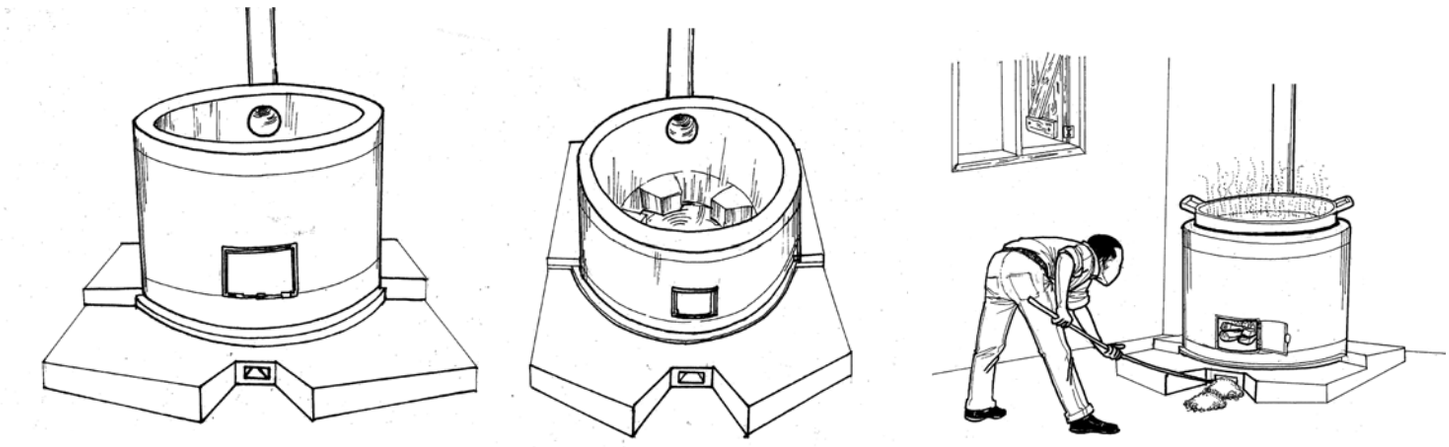
LESSON 3. COOK CLEVER: Cooks want their fires to get to work quickly, and they don't want to waste fuel to produce energy that doesn't help cook the food. Stoves can be designed to deliver energy straight to the cooking pot. The pot skirt here allows the stove to deliver heat directly onto the pot. Insulating the path of heat flow to the pot and forcing hot flue gases to pass right by the pot gives maximum energy input where it is needed.



LESSON 4 GO LOCAL: Stove designers work with cooks to make sure stoves work well with local cooking methods. Local manufacturers help stove designers find ways to use easily available materials, so that improved stoves can be sold as cheaply as possible.

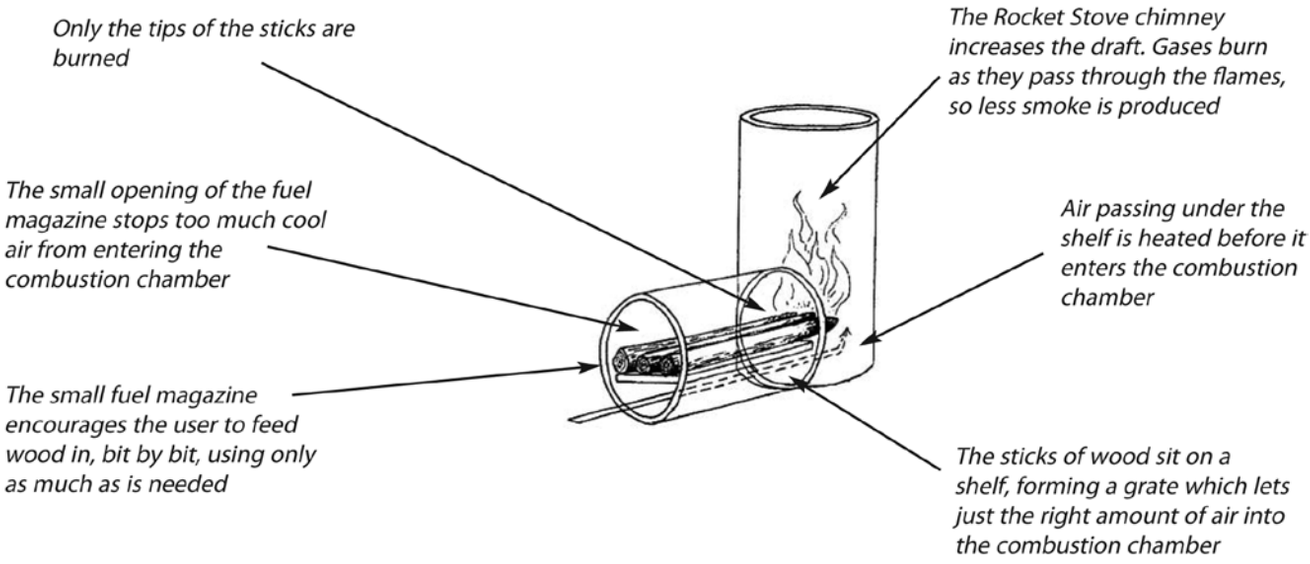
Example of the Ggaba PTC stoves

The Ggaba PTC stoves shown in the illustration below observe all the principles behind improved stoves. The fire in the stove is hot enough to prepare a meal in the shortest possible time. There is no smoke, they use less firewood and the pot sits on top to allow fierce burning. This has made cooking food for students easier, safer, and faster.



How does the Rocket Stove use these design principles?

The household Rocket Stove is a small stove made of metal and ceramics (with the gaps between walls filled with sand) that burns small pieces of wood or other plant material at a very high temperature. This diagram shows how a rocket stove works, and how it burns wood efficiently without producing smoke.



What about Upesi stove design?

The Upesi stove is made of a pottery cylinder (known as the stove liner), built into a mud surround in the kitchen. It can be used to burn wood or farm waste such as maize stalks and animal dung. Upesi means 'fast' in Swahili, because the stove not only cuts fuel use, it also cooks food faster.

How can we get an improved stove?

Find out locally whether there are any improved stoves for sale, and whether there are any credit schemes being developed to help people buy them. Working with stove design engineers, schools and businesses can also use the design principles to invent larger improved stoves to save fuel and improve the health of their workers.

ACKNOWLEDGEMENTS: The original Action Sheet was written by Nancy Gladstone and reviewed by Dean Still at the Aprovecho Research Centre. It is based on information from the following documents: Design Principles for Wood-burning Cook Stoves by Aprovecho Research Centre, Shell Foundation, Partnership for Clean Indoor Air www.repp.org/discussiongroups/resources/stoves/#Dean_Still; Introduction of Rocket Stove Cooking Devices in Uganda by Peter Scott, Aprovecho/GTZ EAP Consultant; How to make an Upesi Stove – Guidelines for small businesses by Vivienne Abbott, Clare Heyting, Rose Akinyi.

Solar cookers

A solar cooker is a device which uses sunlight as its energy source. Because they use no fuel and they cost nothing to run, humanitarian organizations are promoting their use worldwide with an overall intention to reduce deforestation and desertification, caused by using wood as fuel for cooking.

Solar Cookers are a form of outdoor cooking and are often used in situations where minimal fuel consumption is important, or the danger of accidental fires is high.

This section introduces you to the design developed by Solar Cookers International and is known as the Solar CooKit. It works by reflecting sunlight on to a pot inside a plastic bag, which traps heat from the sun during cooking.

What's good about the Solar CooKit?

- No fire: No burns, no risk of house-fire
- No smoke: Less eye and lung disease.
- No fuel: Save time and money. If you usually burn plant matter left over from farming, it is much better for the soil and your farming if you can leave the plant materials on the ground
- No burnt food: With a Solar CooKit, you don't need to stir and watch
- Cooks gently: Saves vitamins and flavour

- Good for meat: Gets very tender
- Good for beans and maize: Use little or no fuel to cook them
- Portable: A foldable Solar CooKit can be carried to the field or work for midday meal
- Healthy: You can use the sun's heat to pasteurise milk and water in the CooKit, getting rid of the bacteria that cause diseases
- Good for business: Some people use Solar CooKits to make bread and cakes for sale. They cost less to make because less fuel is needed, so you could make more of a profit

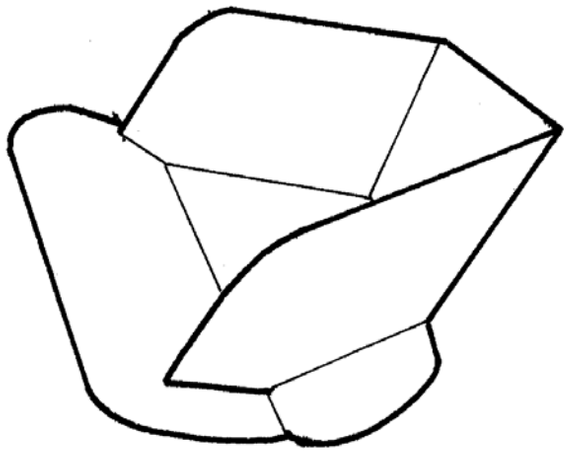
Are there any disadvantages to cooking with a Solar CooKit?

The Solar CooKit design shown here is not good for flat breads or deep-fried food or pastries with bottom crusts.

You need to be able to organise an on-going supply of transparent, heat-resistant plastic bags. Each CooKit will use between 10 and 20 plastic bags every year. Solar cooking takes time, and works best when the sun is high in a clear sky, so you may need to change your daily schedule to get the most out of your Solar CooKit. You also need to have a good place to cook outside. It may help if you can leave the food to cook while you do something else.

How do you make a Solar CooKit?

This design is large enough to cook one large pot of food for about 6 people.



What do I need to make a Solar Cooker?

a) For the reflector:

Corrugated cardboard (carton board) – 0.9 x 1.2 m
Aluminium foil (0.3 x 3m)
Glue (non-toxic, water based, diluted 1:1 with water)
Paintbrush
Utility knife or cutting device
Pencil, pen or other marking device
Large rule or other straight edge

b) For use when cooking with the reflector:

Three big stones to hold reflector down on a windy day. A black pot with a black lid to absorb sunlight and food – a wide shallow thin metal pot with a tight-fitting lid is best. You can paint the pot black yourself. Paint the tops and sides of the pot (outsides only). Use any non-toxic paint, but dry in the sun until the paint smell has gone. Make sure the lid of the pot fits well. Some people have experimented with paint made of wheat-paste and soot. A clear heat-resistant plastic bag (optional). For fastest cooking, raise the pot on three small sticks or stones, or simply some twisted old cloths or cooking bags.

Construction:

a. Draw, cut and fold lines on the cardboard as shown

b. Cut out the CooKit shape and slots. Cut out the CooKit shape and the two 60° angled slots in the front panel. Be sure to make the slots narrow so the 76° angled corners from the back panel fit snugly to hold up the front panel.

c. Score the fold lines with a blunt edge, such as a wooden spoon handle, score the fold lines. Make straight folds by folding against a firm straight edge. Only score the optional fold lines if you intend to fold the CooKit for compact storage.

d. Glue foil on CooKit, using a paintbrush, spread the glue/water mixture on the dull side of aluminum foil and press the glued sheets of aluminum foil tightly and smoothly like wallpaper onto one entire side of the CooKit. A few wrinkles won't hurt.

e. Leave flat until dry. Trim any excess foil

f. Set up the CooKit

Assemble the cooker in a shaded area, to avoid dazzling your eyes. Lay the panel flat with shiny side up, and the wide back panel away from you. Tilt the back panel towards you and carefully slide the ends of its flaps into the slots on the shorter front panel that is nearest to you. As you do this, you will also need to tilt the front panel up. Clamp the inserted flaps, on the underside of the front panel, using clothespins or similar device. You are ready to cook!

When can I use the CooKit?

You can use the CooKit whenever the length of your shadow on the ground is shorter than your height. This tells you that the sun is high enough in the sky. Cooking is not possible on cloudy days, very early in the morning, or after sunset. Put the cooker in a sunny place, free from wind and shadows, where your food will be safe.

Put food in the dark-coloured pot. The food should be no deeper than a hand-width. Put the pot into a plastic bag with the pot rest under the pot and inside the bag. Close the bag with a string or tuck the open end in under the pot. Leave a little air in the bag so the bag mostly doesn't touch the pot lid.

What can I cook with the CooKit?

Almost anything! Experiment! You can put all the ingredients in at once!
Heat dried grains, pre-soaked beans, or rice with water and cook without stirring

- Rice: 1 measure of water to 1 measure of rice
- Maize meal: 2 measures or less of water to 1 measure of maize meal
- Pre-soaked beans: Add water so it is just a little above the beans
- Cook fresh meat and vegetables with little or no water. They cook in their own juices.
- Bake bread and cakes in dark, covered pots in the middle of the day when the sun is strongest (from 2 hours before midday to 2 hours past midday).
- Make tea with half as many tea leaves as usual

How long will it take to cook?

Cooking times vary with time of year, time of day, amount of sun, amount of wind, thickness of pot, amount and size of food, amount of water. Food cooks fastest between 10am and 2pm, when the sun's energy is most intense. Food always cooks faster if it is chopped into small pieces.

How should I position the CooKit to catch the most sunshine?

The CooKit cooks best if the short front panel is facing towards the sun so that the shadows are behind the sides and under the front. Raise or lower the front flap so there is a small shadow, about half its width under it. The flap should be angled higher when the sun is high and lower when the sun is low. You want this flap to reflect the sun, not block it.

As the sun moves through the sky, you can move the cooker to catch the sun. But if you don't have time, just position it to catch the most sun for the time when you are cooking.

How should I look after the CooKit?

After use, wipe the foil gently and fold the CooKit flat. Store it in a safe place away from moisture and animals. If it gets very wet, keep it flat with the shiny side down until it is dry, so it keeps its shape.

Plastic bags: After use, air-dry bags or wipe gently. Store bags flat inside the cooker, and protect from sharp objects. With care, bags can be re-used 10 to 15 times. When the bags have been worn out they can be used to make ropes, mats, baskets, bags, fans and containers.

How hot does it get inside a Solar CooKit?

The temperature inside the pot will reach between 82 and 121°C or more. Most food cooks at or below 82°C, so these temperatures are hot enough to cook the food but not hot enough to burn or dry out the food, or damage nutrients.

ACKNOWLEDGEMENTS: The original Action Sheet was prepared by Nancy Gladstone and is based on the following sources: Solar Cookers: How to Use, Make and Enjoy by Solar Cooker International; Teaching Solar Cooking, Solar Cookers International Trainers Manual, and has been reviewed by Kevin Porter, Education Resources Director, Solar Cookers International. Illustrations are reproduced from source documents with permission. For more information on solar cooking in Uganda, see: http://solarcooking.wikia.com/wiki/Uganda.

Solar pasteurization

Water and milk contaminated by human and animal waste spreads diarrhea, cholera, TB, giardia, hepatitis, typhoid, and other diseases. Heating water and milk and keeping it hot for a certain amount of time kills disease-causing organisms, making them safe to drink. In this section, we learn about how you can use the heat of the sun to do this.

What is solar pasteurization?

Pasteurization is a process of heating a food, usually liquid, to a specific temperature for a definite length of time, and then cooling it immediately. This process slows microbial

growth in food. The process was named after its creator, French chemist and microbiologist Louis Pasteur.

Pasteurization aims to reduce the number of viable pathogens so they are unlikely to cause disease (assuming the pasteurized product is stored as indicated and consumed before its expiration date). Commercial-scale sterilization of food is not common because it adversely affects the taste and quality of the product. Certain food products, like dairy products, are superheated to ensure pathogenic microbes are destroyed.

In general, the higher the temperature, the shorter the time required to kill the organisms. Heating water to 65°C (149°F) for 6 minutes (0.1 hours), or to a lower temperature for a longer time, will kill all germs, viruses, and parasites that cause illness in humans.

What are the benefits?

It is especially dangerous for young children and old people to get the kinds of illnesses that are carried in water and milk that has not been treated to remove disease organisms. Because it doesn't depend on fuel, electricity or expensive equipment, solar pasteurization is one of the least expensive ways to make sure that the water and milk you and your family drink, is safe.

How can we use the sun to pasteurize drinking water?

It is easy. It involves leaving water out in the sun in clear plastic or glass bottles. Fill the bottle 3/4 full and shake it to create air bubbles, before filling it up to the top. Leave outside in a safe place for at least 6 hours in full sun, or 2 days if it is cloudy. After the sun has done its work, drink straight from the bottle to avoid contamination.

Another simple way to use sunshine to make drinking water safe is using a solar cooker. Use the solar cooker to heat your drinking water or milk in the middle of the day when the sun is hottest. Put the liquid in a jar covered in black paint, or a black cooking pot with a lid, and then put the container in the cooker. A general rule is to heat the liquid in the solar cooker for 1 hour per litre. For example, heat 1 litre for 1 hour, 2 litres for 2 hours, 4 litres for 4 hours.

Putting a Water Pasteurization Indicator (WAPI) into the cooking pot or water jar can help you to know whether the germs have been killed. A WAPI is a re-useable tube containing wax or a fatty substance that melts at 69C. When the wax melts, it flows from the top to the bottom of the tube, to indicate that the water has been pasteurised. If you use a cooking stove to heat and pasteurise water, a WAPI can help you save fuel, as you will know when the pasteurisation is complete.

ACKNOWLEDGEMENTS: The original Action Sheet was prepared by Nancy Gladstone, based on materials produced by Dale Andreatta, Solar Cookers International, and Safe Water Systems and was reviewed by Dale Andreatta.

Learning Unit Seven: Waste Management

Waste is what remains when the useable component of a product has been exhausted. Waste is a fact of life. All life's processes produce waste at one time or another. This is all part of the ecological cycle, and cannot really be avoided. What we must do is develop ways and means to deal with waste creatively and efficiently in order to harness whatever benefits can be gained from its effective management.

There are two broad categories of waste; domestic and industrial.

Domestic waste is that which is associated with people's homes, food waste, washing and bathing water (grey water), waste paper and materials, plastic, metals, electrical goods and worn out gadgets. Human waste, stool, and urine are also in this category. In Uganda, one of the most common and ugliest forms of waste is polythene bags, a familiar sight in many parts of this beautiful country. They are also a major cause of soil degradation, being non–biodegradable and interfering with the free flow of water within the soil.

Sacks of domestic waste at Kitezi landfill in Kampala

Industrial waste is that which comes from industries, and includes liquid effluents and solid left-over materials, such as metallic scrap.

Before we consider recycling, we must consider whether a process can be done in such a way that avoids the production of waste in the first place. Only then should we consider recycling. Fortunately, there are many clever ways to re-use everyday waste. For example, much of the water we use at home can be safely used to water our gardens and wash our cars, which reduces the water we take from reservoirs every day. Waste food could be recycled to feed domestic animals, turned into compost to feed the soil, or used as the raw material for bio-gas for cooking and lighting.

This unit addresses the critical issue of managing human waste, including how to build safe and cost effective composting toilets which take human waste and turn it into manure that can be used to improve soils. There is also an article on the vexing issue of litter. The section concludes with details of the ways in which environmental initiatives can help people with disabilities and special needs.

Building Toilets

Every person and every community has a way of dealing with sanitation, even if it just means that people go into the bush to urinate and defecate. In any community — and even in a single household — there may be several sanitation methods in use at one time. Whilst some people may want to change the way they take care of their sanitation needs, others may not. Sanitation may be improved by building a new kind of toilet, helping to meet the needs of those without access to safe toilets. By putting germs and worms out of contact with people, toilets help us stay healthy.

What do people want from toilets?

Privacy: A toilet can be as simple as a deep hole in the ground. But the need for privacy makes it important for a toilet to have a good shelter, with a door and built away from where people usually walk.

Safety: For a toilet to be safe it must be well-built and in a safe place, for both women and children.

Comfort: People will more likely use a toilet with a comfortable place to sit or squat, and a shelter large enough to stand up and move around in.

Cleanliness: If a toilet is dirty and smelly, no one will want to use it — and it may spread disease. Share the task of cleaning or pay a cleaner to keep the toilet clean.

Respect: A well-kept toilet brings status and respect to its owner. Often this is a very important reason for people to spend the money and effort to build one.

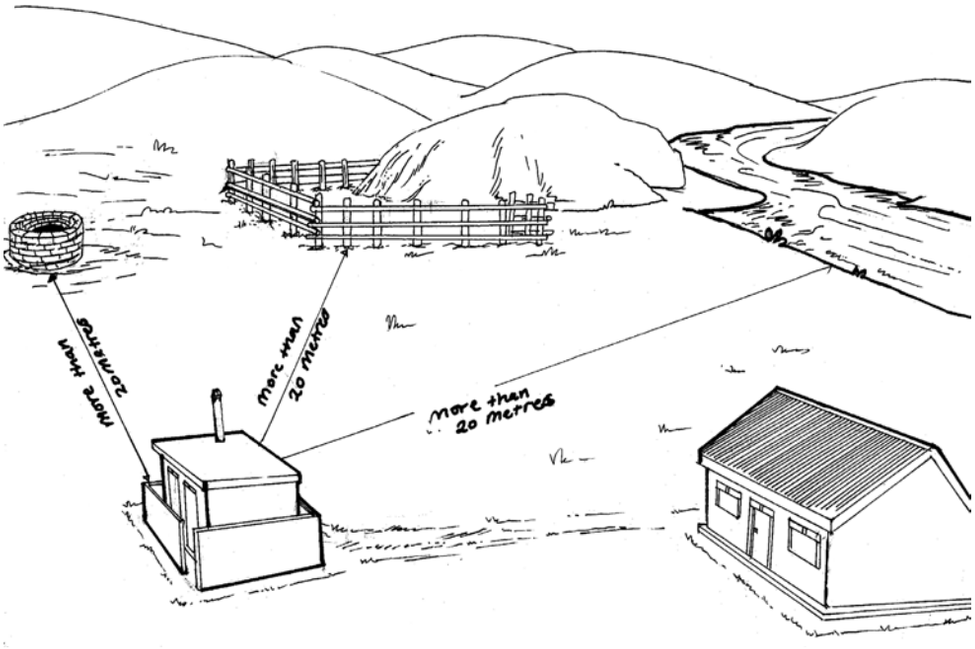
How to choose which type of toilet to build?

No one toilet design is right for every community or household, so it is important to understand the benefits of each choice.

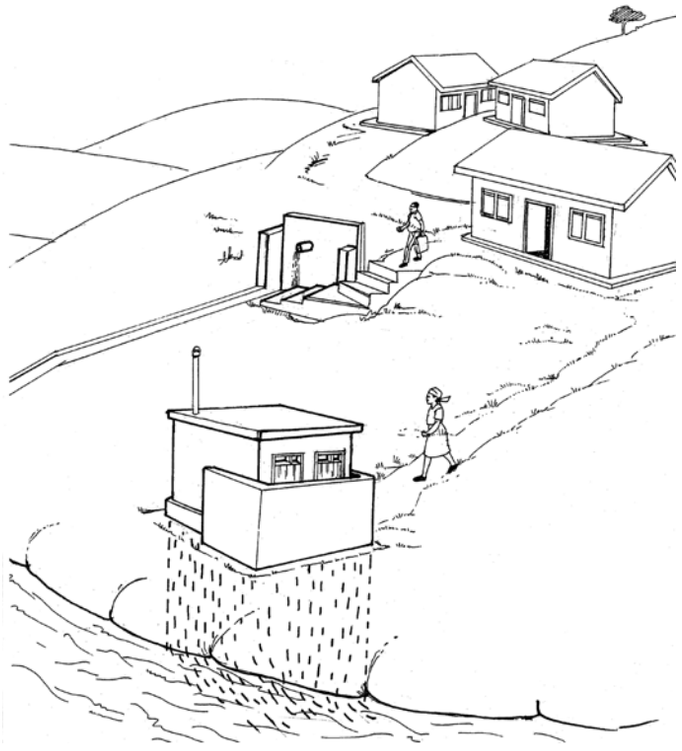
Where should we build the toilets?

When deciding where to build a toilet, make sure you will not pollute wells or groundwater. Some general rules can ensure safety under most conditions.

The bottom of the pit (if it is a pit latrine) or the chamber (if it is a compost toilet) should be at least two and a half metres above the groundwater. If you dig a pit for a toilet and the soil is very wet, or fills with water, this is a bad place to put a toilet. Do not build pit latrines on ground that gets flooded. Consider building an above-ground toilet in areas that may flood.



Groundwater flows downhill. So, if there is no choice but to build a toilet in a place where there is a risk of groundwater pollution, place the toilet downhill from nearby wells.



The chamber (if it is a compost toilet) should be at least 2½ metres above the groundwater. Keep in mind that water levels are much higher in the wet season than in the dry season. When there is a risk of groundwater pollution from pit toilets, build an above-ground toilet. Any toilet should be at least 20 metres from rivers, lakes, springs, streams and wells.

Groundwater flows downhill. So, if there is no choice but to build a toilet in a place where there is a risk of groundwater pollution, place the toilet downhill from nearby wells.

Ecological sanitation

What are ecological toilets?

Ecological toilets turn faeces and urine into soil conditioner and fertilizer. This improves people's health and the environment by preventing germs from spreading and turning harmful human waste into something useful. Ecological toilets are safer for groundwater than other toilets because they sit above ground or use shallow pits. They produce fertilizer and they can be used for many years. These toilets need more maintenance than pit toilets (but not pour-flush toilets), so it is important that people understand how they work.

There are 2 main types of ecological toilets: 'compost toilets' and 'urine-diverting' or 'dry' toilets. Both kinds can create safe fertilizer. Many people call both kinds 'compost toilets.' But there are some important differences.

In compost toilets:

- Faeces and urine go into a container that will not leak into the groundwater, like a shallow pit or a large concrete box.
- The user adds a mix of dry matter such as straw, leaves, sawdust, and soil after each use. This reduces smells and helps the waste to break down.
- Excrement is stored until it heats up and breaks down. The mix will heat up and kill most germs, including roundworm eggs (the hardest to kill). To heat up well, it must be slightly damp.
- After the mix has had a long time to kill germs (usually 1 year), it is removed for use as fertilizer.
- To be safe, it is best to mix it into a compost pile, where it will break down more. Then it can be mixed into the soil for planting.

In dry toilets:

- Urine is kept separate from faeces. It is collected, processed, and used as fertilizer.
- Faeces go into a container, like a large concrete box or a hard plastic movable container that will not leak into groundwater.
- The user adds soil mixed with dry plant matter and ash to the faeces after each use. This reduces smells and helps the waste to dry out.
- The faeces never get mixed with water. A dry mix will kill most germs, including roundworm eggs.
- The faeces are stored for up to 1 year, until it has the texture of dry soil. Then it can be mixed into a compost pile, emptied into a shallow pit for planting a tree, or added directly into the soil for planting.

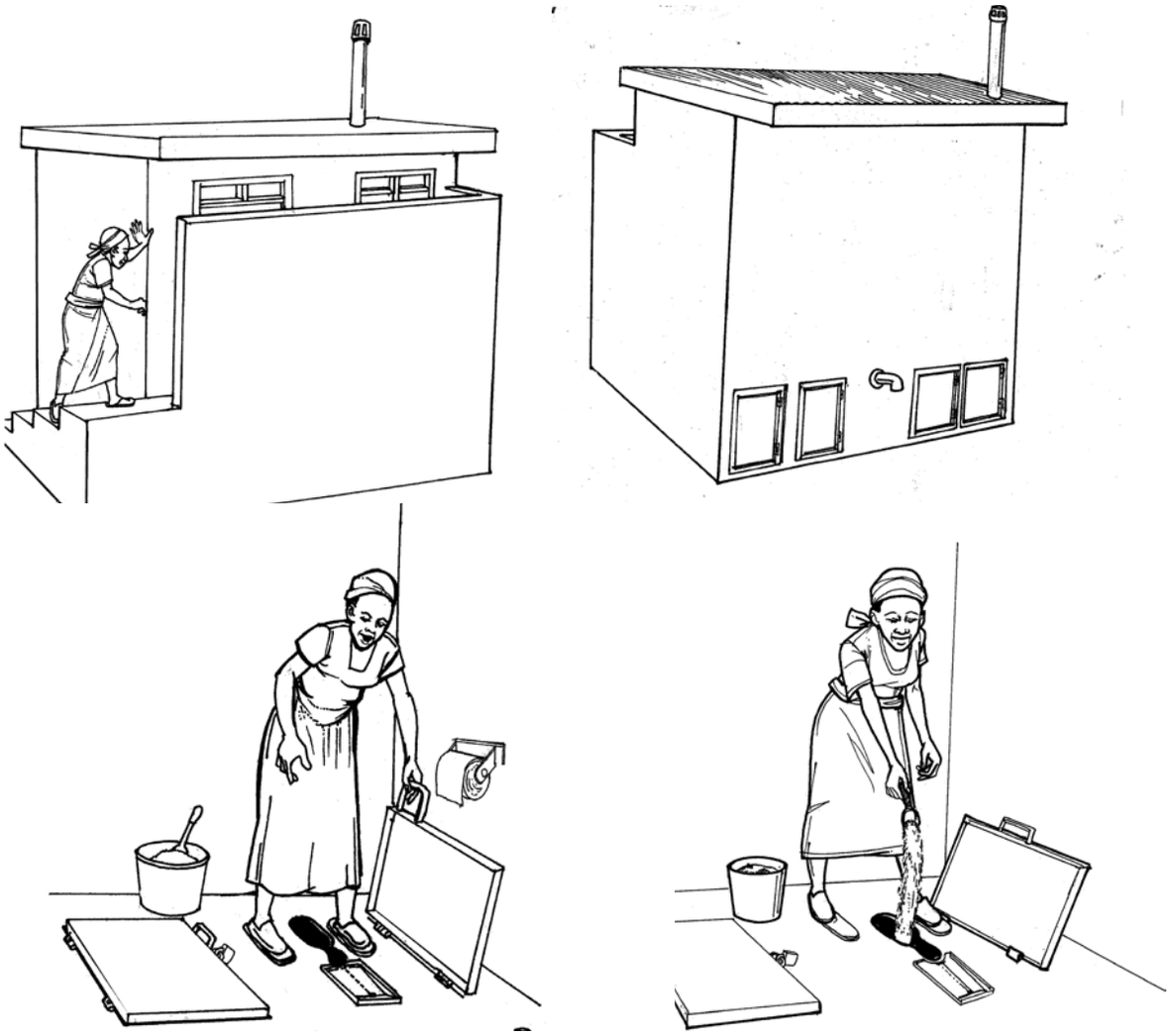
Urine-diverting dry toilets

Dry toilets do not use pits. They are built above ground, so it is easier to remove the contents. They also have a toilet bowl with separate compartments that keep urine and faeces apart. This helps the contents of the toilet stay dry, killing germs and reducing smells. This also allows the urine to be used as fertilizer. Because they are built above ground and lined on the bottom, they are safe for groundwater.

Dry toilets are more costly to build than pit toilets. Their safe use requires training, because they are used differently from pit toilets and water-based toilets. And it takes some work to keep them well maintained. But they are very good for people who want to produce fertilizer from their wastes. They are also a good option in places where:

- The groundwater is too high for pit toilets
- Flooding is common
- The ground is too hard to dig
- People want a permanent toilet in or near their house

The 2 chamber dry toilets



This dry toilet has 2 chambers where faeces break down into safe fertilizer. One side is used while the faeces on the other side dry and break down. A special toilet bowl separates urine into a hose for collection in a container outside of the toilet. After about a year, the dried faeces are removed and added to a compost pile or used on fields or gardens. If the urine is collected in a container, it can be mixed with water and used as fertilizer by diluting 1 litre of urine with 3 litres of clean water.

Urine-diverting toilet bowls can be built or bought in some places. If they are available, they are very easy to install and use. Please note the following:

- Keep a pot of mixed soil, ash and dry plant matter in the shelter. After each use, throw 2 handfuls down the dry part of the toilet bowl. Then close the top.
- Make sure no water gets in the toilet chamber.
- If the contents of the toilet get wet, add more dry matter.
- If the toilet smells bad, add more dry matter, and make sure the vent pipe is clear.
- If the pile builds up too high, use a stick to push it back down.
- When the urine pot is full, empty it and make fertilizer.
- When the first chamber is full, use the other chamber. Be sure to cover the first chamber.

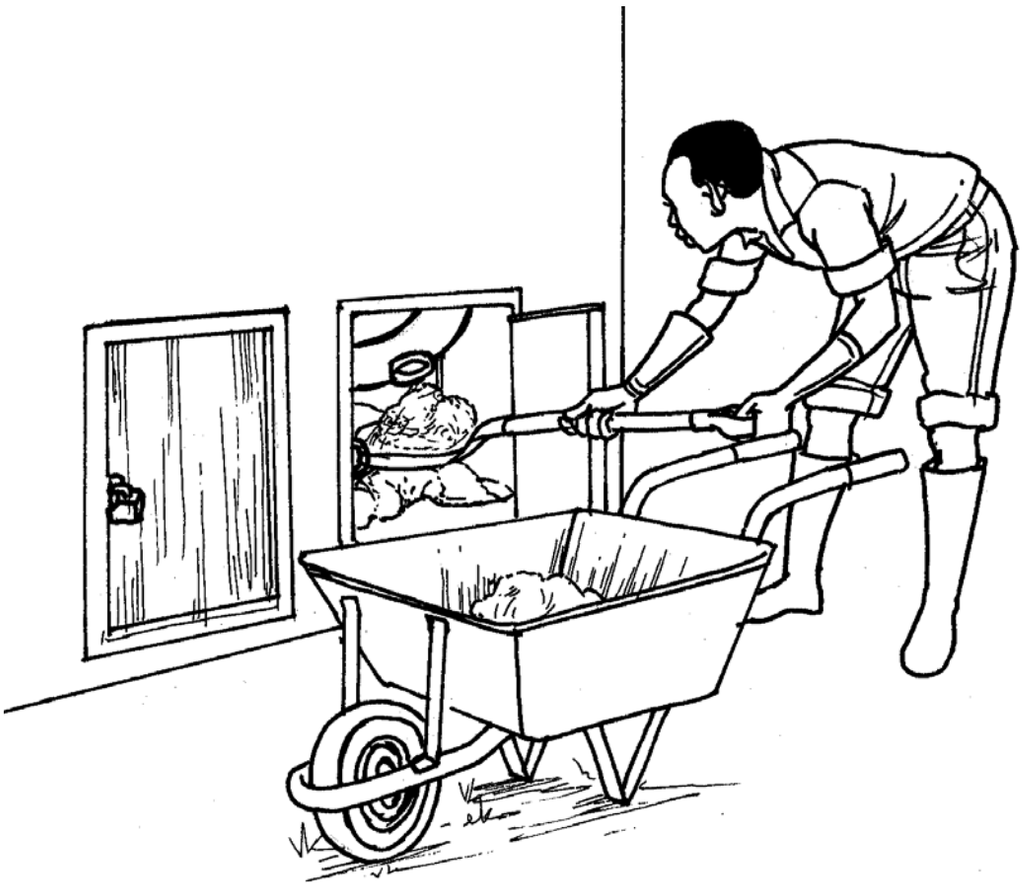
It is best to let the faeces sit for a full year before emptying the chamber. After a year, or when the second chamber is full, empty the first chamber and repeat the process.

For ecological toilets to work, they must only be used for excrement. Women having their monthly bleeding may safely use ecological toilets. But sanitary pads and other products should be put in trash bins – not in the toilet. Ecological toilets cannot be used to dispose of things that will not break down, such as cans, bottles, plastic, tampons, or large amounts of paper. They can take small amounts of paper, leaves, sawdust and other plant matter because these things break down and can be turned back into the soil. Do not put garbage in the toilet.

Simple rules to use this type of toilet are that:

1. Post instructions to help people use and maintain the toilet.
2. Keep a pot of water in the shelter. Add a little water to the urinal and the urine separator of the toilet bowl after each use, to control the smell.
3. Keep unused chamber covered when not in use

Germs, nutrients and fertilisers



Both urine and faeces carry nutrients. Ecological sanitation turns waste into a resource that can improve soil. But faeces can also have many germs that cause disease. For this reason, making fertilizer from faeces takes more care than composting animal manure and food scraps.

Faeces should never be used raw. But once they are made into fertilizer, it can safely help to grow food, trees, and other crops without chemical fertilizers.

Urine carries far fewer germs than faeces and has more nutrients. This makes it safer to handle and very valuable as fertilizer. But because it does carry some germs and is too strong to use directly on plants, it also needs special handling.

How do you know when the solid fertilizer is safe for use?

The contents of a dry toilet are ready to remove when they are dry, have little or no smell, and look like ordinary soil. For this to happen, they should be kept dry inside the toilet chamber for 1 year.

When you think the contents should be ready to remove, open the chamber. If the pile is wet, add dry plant matter or soil mixed with ash and let it sit for several weeks more. If the pile is dry and does not have a strong smell, it is ready. Remove it with a shovel.

After drying out for 1 year, most germs will be dead and the material should be safe to handle and to add directly to garden soil. But if there is any doubt, the contents of the toilet can be given extra treatment to ensure that all germs are killed.

To completely dry the contents of the toilet, store it in bags or buckets for a few weeks. To heat it up, leave it in a dry, sunny area, or add it to a compost pile. Since there still may be some germs, it is important to wear gloves and shoes when handling the contents, and to wash well after emptying the toilet.

How do you use urine fertilizer?

Some farmers use urine mixed with water as a fertilizer because urine carries valuable nutrients like nitrogen and phosphorous that can help plants grow. Urine is much safer to handle than faeces. However, the same nutrients that make it a good fertilizer can pollute water sources. Also, it can carry blood-flukes (schistosomiasis) - common in only some parts of the world. Because of this, it is important not to put urine into water sources, or near where people drink or bathe.

To make simple urine fertilizer

Store urine for a few days in a closed container before use. This will kill any germs it contains, and will also prevent nutrients from escaping into the air. To make fertilizer, dilute the urine with water — mix 3 containers of water for every 1 of urine. (Undiluted, fresh urine is too strong and may damage plants.) You can fertilize plants with diluted urine as often as 3 times a week.

Plants fertilized with urine can grow as well as plants grown with chemical fertilizers, and need less water. Plants that make edible leaves, like spinach, grow best. Always wash hands after handling human fertilizer.

To make fermented urine fertilizer

Adding compost to urine, and letting this mixture ferment (rot and turn sour), can create new soil for planting.

i. Collect urine from dry toilets. For each litre of urine, add 1 tablespoon of rich soil or compost.
ii. Let the mix sit uncovered for 4 weeks. This will smell bad, so do it in a place away from people. The urine mixture will ferment and turn brown.
iii. Fill a large container with dry leaves or other dry plant matter. A large container can be made by cutting one face off an old car tire and turning it inside out. Line the container with thick plastic to prevent water leakage through the hole in the bottom.
iv. Add fermented urine. The best mix is 7 parts plant matter to 1 part urine (about 3 litres of urine for every 30 cubic centimetres of plant matter.)
v. Cover with a thin layer of soil – no more than 10 centimetres. Plant seeds or seedlings.

vi. Water every 2 days with a mix of 1 part urine to 10 parts water. (This is a weaker mix than we suggest above, because it will be used in closed containers rather than open gardens or fields.)

The dry plant matter will turn to rich soil in 10 to 12 months. The new soil can be used as compost or to top up another container.

Are there any ways to improve or adapt dry toilets?

The toilets in this book are only some of the options for ecological sanitation. They can be improved and adapted to meet the needs of different communities. Some things that will make a dry toilet work better are:

- Heat from the sun - Build the toilet so that the chamber doors face the sun, and paint the door panels black. This will make the chambers heat up, improve ventilation, and kill germs faster.
- More air flow - Laying bamboo, corn stalks, branches, or other dry plant matter on the floor of the chamber before use will help air flow through the faeces for faster drying.
- Wash toilet with reed bed - People in India have adapted the dry toilet to let both urine and wash water drain into a bed of reeds

How to make a concrete toilet platform

A well-made concrete platform will last many years. One 50 kilo bag of cement is enough to make 4 platforms or 2 platforms and 2 ring beams. You will also need reinforcing wires, bricks, and boards to form the mould, and a piece of wood cut to the shape of a keyhole to mould the hole. This platform can be square, or round.

Constructing a brick chamber for an ecological sanitation toilet at Ggaba PTC

1. Lay down a plastic sheet or used cement bag
2. Place a wooden "keyhole" mould in the centre, to shape the toilet hole. On top of this, make a mould of bricks or boards .Block out the hole, and shape the hole, about 120 centimetres long, 90 centimetres wide and 6 centimetres deep.
3. Make a concrete mix of 1 part cement, 2 parts gravel, 3 parts sand, and water. Pour the concrete into the mould until it is half-way to the top.
4. Place reinforcing wires 3 millimetres thick on top of the wet concrete. Use 4 to 6 wires going in each direction. Make handles of wire 8 to 10 set them in the concrete near the corners.
5. Pour the rest of the concrete, and level it with a block of wood.
6. Remove the keyhole mould when the concrete begins to harden (after about 3 hours). If you used a brick mould, remove the bricks and form the hole into a keyhole shape. Leave the slab overnight and cover it with wet cement sacks, damp cloth or a plastic sheet.

Wet it several times a day to keep it damp for 7 days. Keeping it wet lets the concrete dry slowly so that it hardens well and becomes strong.

How to make a concrete ring beam

A ring beam is a square piece of cast concrete with an open centre. It is set into the top of a toilet chamber to support the platform and shelter, and help to keep the side walls from collapsing. The ring beam described here can be used along with the platform for all toilets. Adjust the size of the ring beam to fit the width of the chamber

1. Lay down a plastic sheet or cement bags on level ground.
2. Make a mould of bricks, wooden boards, or both. For a platform that is 120 centimetres by 90 centimetres, the ring beam will be 130 centimetres by 1 metre on the outside, and 1 metre by 70 centimetres on the inside.
3. Make a concrete mix of 1 part cement, 2 parts gravel, 3 parts sand, and water. Pour the concrete into the mould until it is half-way to the top.
4. Place 2 pieces of reinforcing wire 3 millimetres thick on top of the wet concrete on each side of the ring beam. If you want, you can make handles of wire 8 to 10 millimetres thick, and set them in the concrete near the corners.
5. Pour the rest of the concrete, and level it with a block of wood.
6. Cover the concrete with wet cement sacks, wet cloth, or a plastic sheet and leave it overnight. Wet it several times a day to keep it damp for 7 days.
7. When the ring beam is solid, carry it to the site of the toilet. Place it on top of the chamber.
8. Place the toilet platform on top, then build the shelter.

ACKNOWLEDGEMENTS: This Action Sheet was reproduced with permission from the booklet "Sanitation and Cleanliness for a Healthy Environment", created by the Hesperian Foundation for the UNDP, in cooperation with the Community Water Initiative partners, part of a larger book by the Hesperian Foundation, A Community Guide to Environmental Health.

Littering - For a better global village: let's say no to littering

By D.K. Mayanja, Tutor, St John the Baptist, Ggaba PTC

The term littering is derived from the noun litter which refers to waste, trash, garbage, junk and refuse. In simpler terms that which is left over after we have derived or taken out what is of immediate use to us. For as long as humanity has lived on earth litter has been generated as a by-product of useful materials that humans use. Littering is consequently the bad habit and activity of disposing of litter in an unplanned, un-thoughtful, and harmful way.

It may sound strange but the fact is that littering is not as old as humanity. Human kind was not born with the littering habit but acquired it in more recent times. Scientists who have spent considerable time studying animal habits point to the fact that animals in the wild exhibit a peculiar trait or instinct whereby they show a very limited tendency to throw things everywhere and anywhere. If this was not the case, forest stretches would be impassable due to a lot of chaotic stuff that would be found all over the place! Indeed some animals are well known for having specific places where they dispose of their excreta while others such as snakes will only shed their old skins in special locations. Humans instinctively enjoy living in places surrounded by some sort of order and therefore would not be expected to deposit all types of garbage in their surroundings.

In traditional African society, littering was ranked as one of the worst acts and an example of shameful backwardness. The reasons seem to be simple and straight forward: all land belonged to the gods and ancestors who were incarnated in the person of the King (in the case of Buganda – the Kabaka). Thus the land and the atmosphere above it had to be treated with maximum respect on peril of very serious consequences for the offender. That is why the English explorer John Speke had this to say when he visited Buganda's Kabaka Mutesa I's court in 1862;

> 'one of the things that strikes one as strange is that given the hordes of dark natives who seem to keep eternal vigil at the king's court, there is hardly any garbage to be seen in that vast expanse of reed palace and its environs… .!'

Hence we may construe that littering is an acquired habit, that humanity out of laziness and insufficient enforcement finds herself trapped in.

Several developments such as industrialisation, the decline of home based traditional character formation and neo-modern mentality of 'laissez-faire' (liberalism coupled with individualism), have all given rise to and fuelled littering. Today's industry has not made matters any better by concentrating on use-once-and-throw-away products, many of them of very suspicious quality! The growing inclination towards individual interest has made us overlook the interest of our neighbour with dire consequences to ourselves too. Governments all over Africa have still to do much in balancing commercial interests/ taxation benefits, with the care for the environment by enforcing clean environment laws such as those against the notorious polythene bag.

Ultimately to litter is to desecrate ourselves and humanity's own dignity, whenever one carelessly disposes of trash one degrades, demeans, disgraces, and worst of all corrupts human kind. Human rights activists believe that the very first step towards the observance of human rights and indeed good governance must begin with the respect for our environment; because that is the true testimony that we respect ourselves, our neighbour and those of generations to come.

Moreover, waste or garbage, if thoughtfully disposed, can be useful as compost for our gardens, generate bio-gas as fuel and be recycled into many useful materials. The garbage we generate could be a terrible nuisance to us if we do not apply proper disposal methods; yet the very same garbage could be a blessing to our families and community if we correctly and resourcefully dispose of it through recycling.

Garbage collection bins at St. Theresa Primary School intended to reduce littering

A Kampala City Council truck takes garbage to the dump site

Ten major challenges

Uganda is faced with many challenges but those that specifically affect the issues discussed in this manual include population explosion, industrialisation, competitive commerce and trade, weak environmental conservation laws and the need to mainstream environmental education in schools. The subsections below take a broader look at the root causes of environmental degradation and hint at potential ways forward.

a) Population explosion

As you read this article Uganda's population of 33,398,682 people is increasing at an estimated rate of 2.5 persons per minute, or 149.1 per hour, 3,578.43 per day, 100,196 per month, or 1,202,352 per year. At this rate the population of Uganda will hit the 50 million mark by 2022 or twelve years from today. This is a very real population explosion.

This phenomenon is a prime challenge to the environment from, firstly, over-utilisation of resources and secondly, the excess dumping of untreated waste into the environment. Population explosion also leads to the escalating incidence of slum and shanty towns with the attendant problems of poor housing, inadequate sanitation, disastrous waste disposal and above all poor access to clean water. This is environmental degradation. We must discuss population growth and look for acceptable ways to reduce the rate.

b) Rapid industrialisation

Uganda like many other developing countries has joined the race to use modern manufacturing techniques to access the benefits of global markets. Industries generate huge amounts of pollutants in the form of gases, liquids, solids, and radiation. Without well thought-out and funded mitigating interventions, the environment suffers the brunt of this rapid industrialisation. Industry has been cited as a major culprit in the degradation of Lake Victoria, the world's second largest lake. Some rivers have been choked almost 'to death' by pollution from urban centres such as Mbarara, Soroti, Luwero and Mbale.

The industries also produce some products which are not environmentally-friendly such as polythene bags, insecticides and herbicides. The factories may encourage unplanned and unsanitary settlements as their workforce expands. The true costs of industrialisation must be taken into account and polluters should pay.

c) Competitive trade and commerce

Highly competitive trade and commerce is another challenge to our environment. Traders are often caught in a 'life and death' race in order to make necessary profits to compete and survive in business. This results in ruthless trade practices that directly hurt the environment, counterfeiting goods and adulterating food and beverages. As described below, laws must be applied to mitigate and prevent negative impacts on the environment.

d) Weak environmental conservation laws

The constitution of Uganda enshrines conservation of the environment as a cardinal principle. There is a National Environment Management Act, the Forest and Tree Planting Act, Uganda Wildlife Statute, Town and Country Planning Act, the Local Government Act, the Land Act – all of which seek to protect our environment. However, there are gaps and disparities during implementation of these laws. Often times, politicians have exploited the laws to their benefit and degraded the environment. Local Authorities, the Police, and communities have to do more in order to ensure compliance with the national law and local government bye-laws.

e) Unco-ordinated global policies

The Rio Earth Summit in 1992 led to a number of environmental resolutions which were not universally accepted and which in many cases still remain on paper. A similar story may be related for the Kyoto Protocol which sought to bring about a serious reduction in carbon emissions but to date the levels aimed at remain elusive. Resolutions arising from Bali and Copenhagen resolutions on climate change appear to have run into the same problems. As individuals we must put pressure on our elected representatives to take part in these global debates to try to bring about a positive outcome.

f) Globalisation

As the world has become a 'global village' negative environmental impacts in one part of the world are directly and almost instantaneously felt on the other side of the world. With globalisation there is very rapid and much freer movement of peoples and goods, meaning that cultures, traditions, customs and outlooks are experiencing repeated, varied and frequent battering. This has reduced the influence of traditional authority on environmental matters to its detriment. We should listen to our elders and consider the long term as we go about our daily lives.

g) Environmental issues in general education

Uganda still has progress to make in order to adequately cover environment issues in the teaching/learning curriculum at all levels. It is a similar case for the teaching of climate change which requires detailing of content in the curriculum. The newly introduced thematic curriculum at primary one to four, which stresses integration and delivery in

more accessible local area language, is a significant step in the right direction. It is hoped that initiatives like this one will further environmental education and action in schools and colleges throughout the country.

h) Retrogressive Cultural Practices

Uganda has a rich culture of impressive diversity. Most customs and traditions are well thought out and have stood the test of time. We would all like to maintain such aspects of our culture, for example the clan system, extended family and its values, the sacredness of marriage and bearing children, hard work and honesty. Nevertheless there are a few retrogressive practices that challenge our environment. In some ethnic communities the use of latrines is discouraged, land fragmentation is encouraged with its attendant problems of land and soil degradation. Some customs do not allow hand washing after toilet use, and others promote the keeping of animals in part of the main residence. Practices which challenge the environment or human health should be discouraged.

I) Political will to tackle environmental problems

This is a very real challenge as progress towards a better environment cannot take place without adequate and unequivocal political will and support.

Uganda's constitution enshrines environmental conservation; there are institutions with the mandate to manage environmental issues such as the National Environmental Management Authority (NEMA), National Forestry Authority (NFA), and the Uganda Wildlife Authority (UWA). Despite this there are still considerable constraints arising from lack of political support at the central and local government level. Kampala City Council is often featured in dispute with NEMA over the allocation of wetlands for development (contrary to the NEMA act), and to date Kampala's wetlands are disappearing at the rate of 11 hectares per month. The country's forests are fast disappearing, as bush burning continues rampantly in many parts of the country. At government level there is still much to do to ensure proper implementation of environmental laws and guidelines. As individuals, we must do what we can to hold government and civil society organisations to account.

How environmental projects can help people with special needs

By Janice Mercer, VSO

People with special needs are those who require situations or resources to be changed or adapted to enable them to take part fully and lead successful lives. It includes those with physical disabilities, sensory impairments such as deafness or blindness, mental problems or difficulties because of health issues. In fact many of us have times in our lives when we have some special needs.

The projects featured in the PACE resources promote water conservation; efficient fuel use and sustainable agriculture that are valuable for everyone and could be adapted for home,

schools, colleges – in fact any institution could benefit. Many of the projects could have particular benefits for people with disabilities, who can find themselves unable to work and affected by poverty.

Using rainwater harvesting, St. John the Baptist Primary Teachers College, Ggaba have reduced water bills by 60%. At Vincent Alex school, fifteen water harvesting tanks mean they pay no water bills for their six hundred pupils and staff and all have access to safe, clean water. As part of the community, people with special needs may enjoy a better standard of living through the application of these ideas. Water stored in harvesting tanks is more available with no need to travel to rivers or wells to collect clean water. Rainwater harvesting also reduces erosion and pathways become easier to negotiate for those with disabilities.

Composting toilets offer a clean, disease free option for waste management. The toilets use no water and provide safe compost for plants. Improved sanitation reduces the risk of infections such as cholera, diarrhoea and other water born diseases. People with disabilities can be more susceptible to disease and any step to reduce risk and improve health is positive. The toilets can be adapted for those with disabilities for example a raised toilet seat, slopes instead of steps and handrails.

Fuel efficient stoves can also be especially useful to people with special needs. The smaller pieces of wood needed for fuel efficient stoves are easier to handle. Stoves are safer as the heat is confined and if smoke hoods are fitted the cooking area becomes cleaner and less likely to cause breathing problems.

Permaculture relies on naturally occurring, easily available materials rather than expensive chemical pesticides and fertilisers. These free, natural resources are easier and safer to use and produce healthy crops and good yields. Raised permaculture beds can be made more accessible for digging, planting, weeding and harvesting crops. Vocational skills of animal husbandry and crop production can be taught to all including less academic students.

Inclusive schools where pupils of all abilities are welcome and disability is not seen as inability will educate their pupils to live full and successful lives. Ideas and practical strategies demonstrated by the PACE project at Ggaba and in this manual can support teachers to plan lessons which address all learning styles and abilities. Skills can be taught and practical projects can be adapted to include all learners. PACE materials can be integrated into the thematic curriculum, providing opportunities for lessons on Mathematics, Language, Social Studies, Art and Craft and more.

If we are thoughtful as we make progress and consider access for all and how to support people with a range of disabilities we will all benefit.

These sample Lesson Plans were developed by Janice Mercer in collaboration with student teachers and tutors of Ggaba PTC.

Date:	Class: P1	Learning area: Literacy I	No. of chn.	Time:

Theme	**11. Our Environment**	
Sub - theme	11.3 Conservation of the environment	Planting trees
Content	Discovery learning	Trees in pupils' immediate environment How trees help us. How to plant trees.
Competences	Speaking and Listening Reading Sentence structure	 Related Vocabulary What is she/he doing? What are they doing? When do we water/plant?
Methods/Techniques	Discussion Excursion Demonstration/Practical work	 Compound/village Tree planting
Activities	Talking – identifying, describing Reading Practical activities	
Indicators of Life Skills/Values	Confidence, Responsibility, Audibility, Articulation, Persuasion, Debate	
Instructional Materials	Trees Tree seedlings Resources for planting Chart/word cards	Growing in compound or village Prepared by teacher or donated by local people or organisation Soil, pots (plastic water bottles with tops cut off) sticks, water. Relevant words/pictures (soil, tree, watering can, plant)
References	National Primary School Curriculum for Uganda Primary 1 Africa Our Home Forests Chapter	Ministry of Education and Sports Teachers Resource Book – English Sasha Norris – Pan African Education Project

Lesson Procedure

Teaching Procedure			
Time	**Step**	**Teachers Activity**	**Pupils Activity**
2 minutes	**I**	Remind children of song 'Trees in the Forest' (See below)	Sing and perform actions
10 minutes	**II**	Introduce the topic – Planting Trees Questions: Where do you see trees? How do trees help us? Children asked to discuss with a partner (2 mins) then teacher takes feedback from chosen pupils	Listen to teachers input Discuss questions with their partner Explain their ideas to class during feedback
5 minutes	**III**	Excursion into compound or walk into village Ask children as they walk where there are trees and where more could be planted. Note any places where trees have been cut down.	Children survey the compound/village Discuss and agree where more trees could be planted.
10 minutes	**IV**	Demonstrate how to plant the tree seedling in the pot and water it	In pairs/small groups (depending on class size) plant tree seedlings
3 minutes	**V**	Using vocabulary words start a song 'This is the way we plant our tree…….' Continue new verses 'First we make a very small hole'	Complete final pictures and write descriptive sentences in pairs or individually depending on ability.
Self evaluation Strengths Areas that need improvement Way forward			

Song/Rhyme: Trees in the forest stood, stood, stood.
Along came a man for wood, wood, wood.
He picked up his axe to chop, chop, chop.
He chopped down the tree chop, chop, chop,
And the tree fell down

Date:	Class: P3	Learning area: **Literacy Hour**	No. of chn.	Time:

Theme	**4. Our Environment and Weather**	
Sub - theme	1.3 Managing Water	Water Harvesting
Content	Discussion Discovery Learning	What is water harvesting? Who can explain/give examples of water harvesting Importance of water conservation
Competences	Speaking and Listening Identifying examples of water harvesting Writing about water harvesting	 Observational drawing Descriptions of the examples they see to accompany drawings
Methods/Techniques	Discussion Excursion Sentence construction	Compound (If there is no water harvesting in the area the teacher should set up a demonstration – a folded banana leaf into a container or a piece of tree bark with a watering can to simulate rain) We can harvest water by…….. Conserving water is important because……..
Activities	Talking – identifying, describing Reading Writing – descriptive sentences	
Indicators of Life Skills/Values	Confidence Responsibility Audibility Articulation Persuasion Debate	
Instructional Materials	Water harvesting tanks (Banana leaves, watering can, basin for demonstration if needed)	If present around school or nearby
References	National Primary School Curriculum for Uganda Primary 3 Africa Our Home Water Chapter	Ministry of Education and Sports Teachers Guide P3 (page 72) Sasha Norris – Pan African Conservation Education Project

Lesson procedure for Primary 3

Teaching Procedure			
Time	**Step**	**Teachers Activity**	**Pupils Activity**
2 minutes	**I**	Start by saying 'We need water for……..' ask pupils to finish the sentence- choose different pupils to add to the sentence each time	Complete/add to sentence 'We need water to drink' Next pupil says 'We need water to drink and wash clothes.'
10 minutes	**II**	Introduce the topic – Rainwater harvesting Questions: What is rainwater harvesting? Do you know somewhere this is being done? Children asked to discuss with a partner (2 mins) then teacher takes feedback from chosen pupils	Listen to teachers input Discuss questions with their partner Explain their ideas to class during feedback
20 minutes	**III**	Excursion into compound or walk into village Ask children to look for and point out any ways that rainwater is being harvested and make sketches of what they see. If there are no examples you could ask where it could be done.	Children survey the compound/village Discuss what they see together Make sketches of their observations
15 minutes	**IV**	Ask children to use their sketches to draw final pictures and add sentences to describe their drawings	In pairs or individually depending on ability
10 minutes	**V**	Teacher moves around class helping/encouraging pupils chooses examples for feedback/presentation to class	Chosen pupils show pictures and read sentences out to class. Work can then be displayed.
3 minutes	**VI**	'Mime guesses' Ask pupils to mime one way to use water. Others guess what they are demonstrating	Children to mime ways to use water and guess what is being shown…..no speaking until the guess is correct. Then they say 'Yes, I am …….'
Self evaluation Strengths Areas that need improvement Way forward			

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UGANDA CONSERVATION FOUNDATION

The aim of Uganda Conservation Foundation is to strike a balance between human development, wildlife and habitat conservation.

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Somebody somewhere has found a solution! The idea behind the PACE project is to help spread simple solutions to environmental problems between communities, from fuel-saving stoves, to rainwater harvesting, compost making to tree planting techniques. This book aims to share information about environmental issues and the practical ways in which schools and colleges in Uganda are addressing environmental problems on campus.