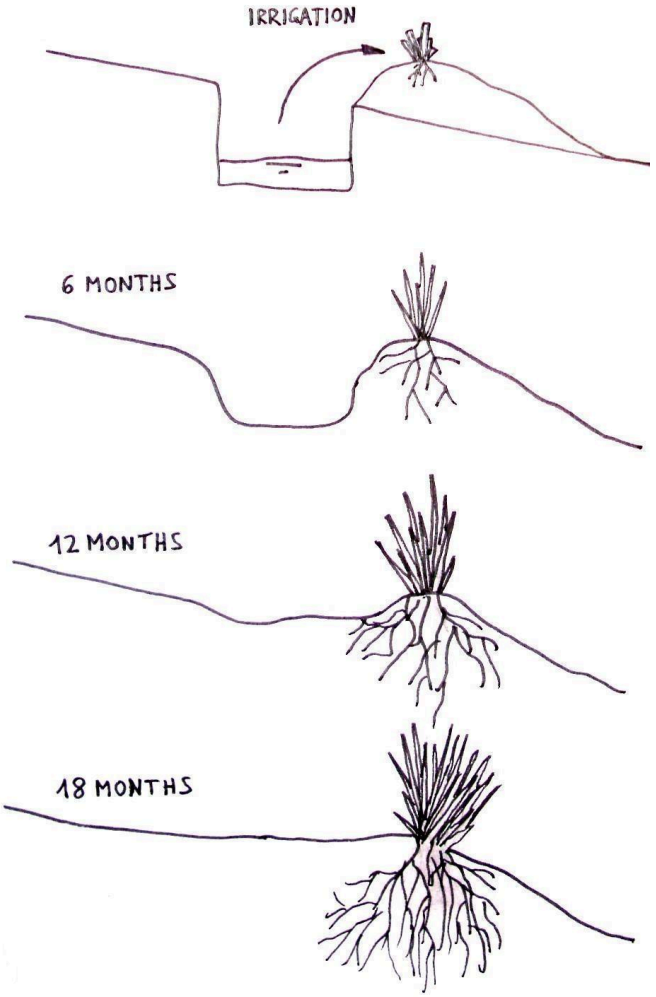
FINAL REPORT

INTERNSHIP
NOVEMBER 2007 – FEBRUARY 2008
BAOBAB TRUST
MOMBASA / KENYA



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DEVELOPMENT COOPERATION AND ENVIRONMENTAL ENGINEERING

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Abstract

This report has been realised after a three months internship of Ole Feurer at the Baobab Trust in Mombasa, Kenya. The internship took place from the 10th of November 2007 to the 5th of February 2008. The final report describes the conducted activities in order to transfer the information and know-how to successors. The main work consisted of:

- Erosion control, which included the development of a combined erosion control and rehabilitation concept for heavily eroded hill slopes. Hereby a nursery for Vetiver Grass (*Vetiveria zizaniodes)* was established. Furthermore a hill slope in a quarry was terraced for the use as a training site (for surrounding farmers) and to conduct further trials on slope rehabilitation.
- Water harvesting, which included the planning and construction of two earth dams that are part of a local community development project. These dams will be used for irrigation purpose and basic fish culture.

In addition further aspects of development cooperation will highlight some main key elements of success, which have to be taken into account when developing sustainable and effective development projects.

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1 Introduction

This final report has been realised as a result of the three months internship I have made at the Baobab Trust in Mombasa, Kenya. It has been part of my studies at the University of Applied Sciences Zurich (Zürcher Hochschule für Angewandte Wissenschaften) with the focus on Environmental Engineering. The internship took place from the 10th of November 2007 to the 5th of February 2008.

1.1 Aim of the internship

The University of Applied Sciences Zurich gives interested Student the opportunity to spend three months of their last year abroad. The Module “Development Corporation” has the aim to provide practical experience for those who intend to work in the field of development after their studies.
Besides the experience concerning the practical work with environmental engineering topics, the internship should additionally give an idea about the living and working conditions as an employee of a development agency. The student has to find an appropriate host organisation by himself. At the end a final report will include a description of the projects the student has been involved in. Furthermore the student has to present his work and the acquired knowledge in front of the appointed university committee.

Additional personal aim of the internship:
Trough my former work in crisis regions, I have understood that one has to find well thought-through and long-lasting solutions for current problems we are facing. The nowadays world produces complex challenges. To find intelligent ways of fighting the ongoing development of human manhood’s overexploitation of natural resources and inequality of people was my main motivation to start my studies. The theoretical knowledge acquired as well as the practical training can be seen as mental tools to solve problems.
I intended to learn more about the key elements involved in a sustainable project and to understand the interactions connected to ecological, social and economic dynamics. Mister Haller has proofed to be a master of finding flexible and sustainable solutions, and I have been able to get a glance of the working methods at Baobab Trust and refine my assessment capabilities concerning the sustainability of development projects.

1.2 The Host Organisation

The Baobab Trust was founded in 1991 by Baobab Farm Ltd as a non-profit organisation. Babobab Farm Ltd at that time was the ‘green branch’ of Bamburi Cement Ltd. The Baobab Farm Ltd was transferred into Lafarge Ecosystem as Bamburi Cement Ltd got part of the Lafarge Industries group. Executive trustee of the Baobab Trust is Dr. Rene D. Haller, who created the well known rehabilitation projects ‘Haller Park’ and ‘Forest Trails’ during his work at Baobab Farm Ltd.
The main activities of the Baobab Trust are projects concerning sea turtle conservation, promotion of sustainable agriculture, alternative energy technologies and environmental education. The trust is committed to working with the surrounding communities trough sustainable development. The projects get financed by organisations such as the Haller Foundation, Bamburi Cement Ltd and the UNDP and Kuoni.

2 Project 1: Terracing Nguuni

Erosion is one of the several natural hazards East Africa along many other regions on the African continent has to cope with. The climate varies between drought periods and tremendously heavy rainfalls within the year. Erosion has several effects which concern the living conditions of people inhabiting these regions. A torrential downpour of a few hours is able to wash away several tons of topsoil from a hectare of field (BORLAUG et al., 1993). The consequence is a continuous degradation of the soil quality. And this results in a decrease of food production. There are several more side effects of soil erosion, such as that natural water sources get filled up with silt and decrease in volume.

Since some years the Baobab Trust has started projects dealing with erosion control measures. The local communities surrounding the north end of Mombasa are situated in a hilly region where soil erosion is one of the main reasons for the bad fertility on local farms. As the maim measure, the trust propagates the establishment of trenches which follow the contour line. Once these trenches continuously get filled up with top soil, the quality silt gets deposited instead of getting washed away. Furthermore these trenches are well suited for planting crops, as they consist of good soil and retain the rain water better than bare fields.

2.1 Aim of the project

The method of creating terraces by excavating trenches as a measure for erosion control has been propagated by the Baobab Trust at several local communities by now. Mostly the people conducting the excavation got instructed on-site. The aim of this project is to create a demonstration site which can be used to instruct and motivate local farmers within the area of the trust.

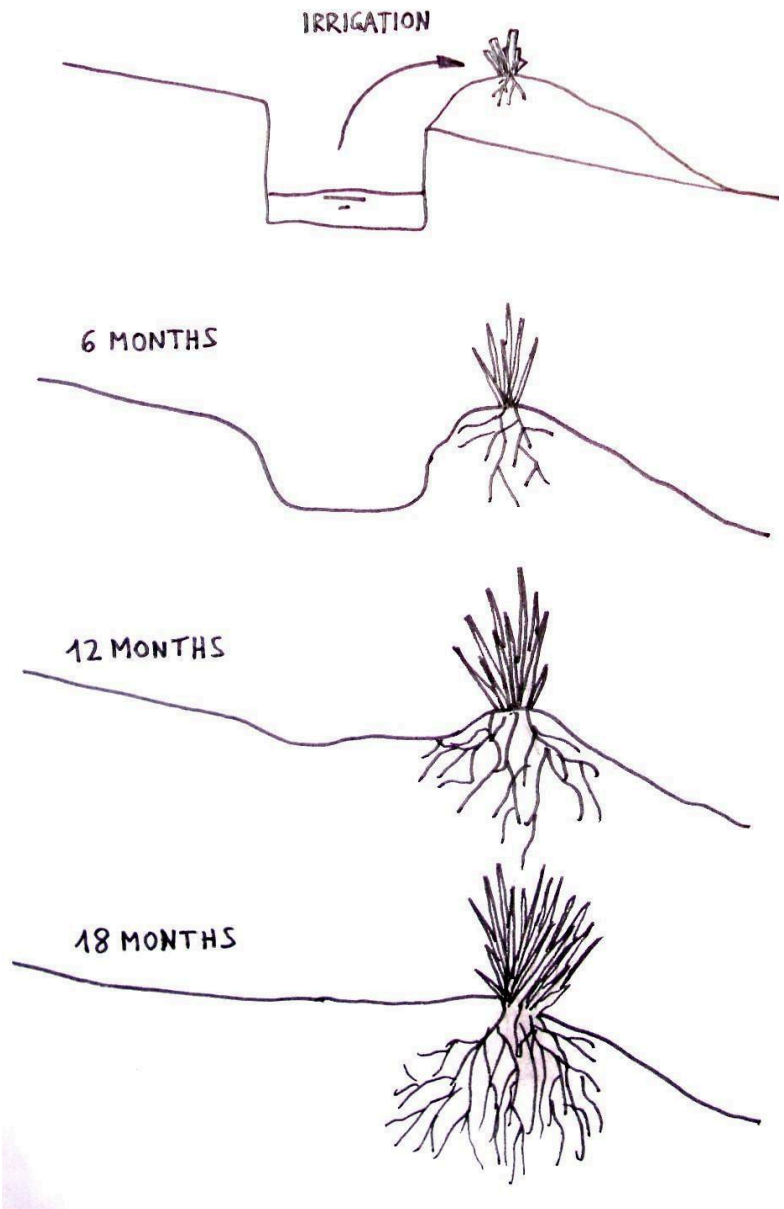
Picture 1: Overview of the rehabilitated quarry slope near Nguuni

Outside the Nguuni Nature Sanctuary, Bamburi Cement has got a Quarry where limestone gets mined. The quarry top line along the property is left behind in bare slopes. During this project a part of the slope along the quarry line got terraced with four rows of trenches.
In contrast to most of the trenches dug at the communities – which had the aim to conserve the soil – the measures implemented on this site should additionally point out, how even already heavily eroded slopes can be regenerated. By giving possible solutions

for the rehabilitation of the quarry slopes, it was able to get the project financed by Lafarge Ecosystems.

To reach the final state of a stable and well developed slope which can produce cash crops such as fire wood, a combination of measures has been chosen. One has to take into account that terracing as a sole measure is not very effective as long as the obtained slope structure isn't stabilised by plants.

Therefore both trees (as cash crops) and a vegetative barrier will be planted during the suitable period of year (rainy season). The vegetative barrier will consist of Vetiver Grass (*Vetiveria zizanioides*). Along each line of trenches a dense hedge of Vetiver Grass will be established. Vetiver is a tropical plant with a habitus similar to Lemon Grass. It has been used since many decades in amongst farmers worldwide, although mostly use in Asia. As it is very durable and resilient towards drought, it has been propagated in Africa since some years. For further information about V. zizanioides please refer to Project "Vetiver Nursery".



Picture 2: Development concept of a vegetative hedge with Vetiver Grass

Fig. XY shows the concept of a vegetative Vetiver barrier. A well established hedge will make maintenance of the trenches unnecessary (such as re-shaping). In contrast, once the trenches have been filled up with silt, the Vetiver hedge will create a dynamic terrace which is suitable for cultivation.

The trenches are built to stop the erosion dynamics until the hedges are established. In addition it will prevent the plants of getting covered constantly by topsoil until they have gained natural anchor.

As the deposited ground material on the downhill side of the trenches consists of bad soil, the location is in terms of growing conditions rather unsuitable for planting something. Therefore the plants will get an initial boost by creating small planting trenches, which are fitted with good soil. In

addition the irrigation will be done by using the water which collects inside the trenches. These measure will enable the plant to get a good start until is has grown effective roots and has stabilised the overburden.

If this combination is capable of restoring the slopes despite the very instable underground, this method can be used as a basis to develop a standard procedure to treat other existing and newly established slopes within the quarries of Bamburi Cement.

In terms of Development Corporation, good results in the use of Vetiver Grass hedges in this project will raise hope to have found a practical, affordable and long-term method for erosion control in the areas of local community farmers.

2.2 Implementation

Excavating effective and functional terraces is much about exact planning. As the trenches get completely filled with rainwater during the wet seasons it is indeed important to locate them exactly along the contour line. If the trench line is not level it might occur that the water will collect on one end and finally damages the trench at its weakest point.

Picture 3: The use of an A-frame to identify the contour line

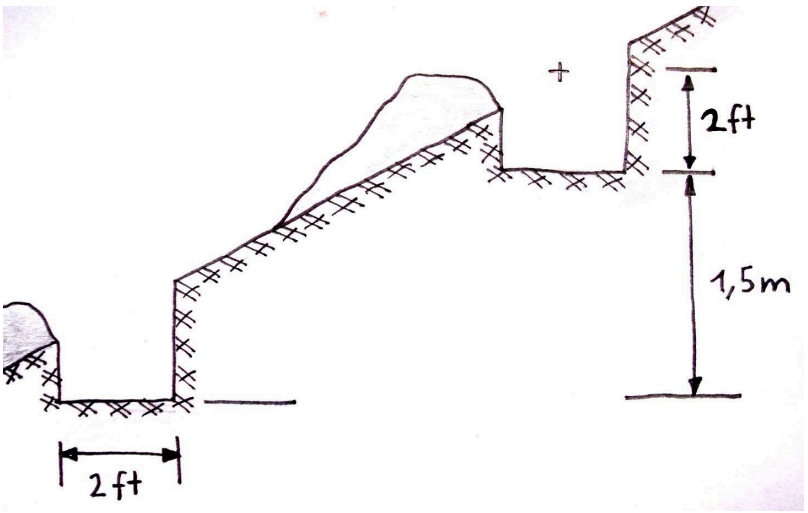
As it is difficult to determine the exact contour line while excavating at the same time, the entire slope was marked with sisal string by forehand. This allows comparing the four lines of trenches from the distance and helps to maintain the contour.

The actual positioning of the trenches was made with a so called A-frame, which is a very simple tool for maintaining the level. First, it is estimated how many rows of trenches is needed, as their vertical difference should be around 1.5 metres. This means that they get the closer together the steeper the slope gets. At the designated site, we established four complete rows on the entire length and some two smaller rows on the top area to retain initial runoff.

Picture 4: Preparing the excavations by marking with sisal twine

After having marked the starts of each row with a wooden pole, one can use the A-frame to allocate the next pole. It is advisable to implement this method as well to the local communities. It was found that some of the trenches dug at local farming site are not very exact.

Additional to the exact allocation, the trenches have got a maximum length of 6 metres. In between the trenches there is a certain distance of unmoved ground. This prevents the mentioned movement of the water within the trench system. Furthermore the length of 6 metres was taken, because an average worker is able to throw the soil about 3 metres to each side.
The excavated soil is partly deposited underneath the trench. The other part is used to form small dams in between the trenches in a line from top to bottom of the slope. This measure assures that the water is directed into the trenches (compare with pictures).



Picture 5: Dimensions of the excavated trenches

The dimension of the trenches is variable and connected to the quality and structure of the ground. As the topsoil on the designated site is very instable and not protected by any surface vegetation, the dimensions have to be relatively large to provide enough space for the washed off topsoil. It was agreed on a width of 2 feet and a depth of 2 feet. Where the ground material has not allowed a depth of 2 feet (solid rock), the width had been adjusted to retain enough water and deposited silt.

The dimensions have been increased in comparison to the established trenches at the community sites, which prevents the coffers to get filled up too quickly. The increased dimensions ensure that the planted vegetative barrier and the trees can establish sufficiently before getting covered by moving silt.

Picture 6: Wooden measuring pole

Picture 7:Reinforcement of trenches across gullies

Every measure which has to do with erosion control has to be implemented from the top of the site downwards. The first trenches where dug directly where the water would get initial momentum. That guarantees maximum effect. If one would start from the bottom chances are likely that the entire project will get washed away during an unexpected rainfall.
Maintaining the measurements of the trenches during excavation work has proven to be tricky. As the workers got paid by each metre they have dug with the need dimensions, they automatically made sure that the trenches didn't get to deep of too wide. To make absolutely clear what the dimension will have to be and that there are no discussions or arguments during the periodical payments, I have made a wooden measure which was exactly 2 feet. As the workers were proceeding with their trenches they could check their own work independently.

On the picture can be seen that the site has already been eroded quite heavily before the implemented measures. The continuous water runoff has created gullies all over the slope. These have made it more difficult to built stable and long-lasting trenches. To prevent the trench walls across such gullies from being damaged due to water pressure, they have been reinforced with wooden poles. The poles came from a Neem tree which was cut down on the experimental Shamba (Farm) of the Baobab Trus. Neem wood is known to last very long as it gets hardly affected by insects of fungi for a long period of time. It was made sure, that all the stems were completely covered with soil as to protect the wood additionally. Also one has to make sure that the side walls covering these reinforcements are shaped with a flat angle. Otherwise they get uncovered very quickly.

Picture 8: The terraced slope at Nguuni after excavations. The first row starts right at the top

The estimated length of trenches was 179 metres. While completing work, some 6 metres of additional trenches were excavated (adjustments).

Total length of terraces: 185 metres

Amount of rows:	4 complete rows plus 9 metres at the top end of slope
Surface of impact:	1350 m^2
Trench dimensions:	2 ft wide; 2 ft deep; length according to terrain, max 6 metres

The work on site has shown, that the payment of 80 KSh per metre of trenches is the minimum salary which is need to keep the workers going in this type of soil. The finances show that the amount of invested energy and money is rather high.
The main question which arises is whether it is really necessary to excavate terraces before planting a vegetative barrier or if it would be sufficient to plant the Vetiver Grass directly. The advantage of the trenches is clearly that the water for initial irrigation can be collected directly on-site. Without the trenches, irrigation might cause significant efforts. In terms of growing conditions it would be very helpful to find out whether *V. zizanioides* would be capable at all to establish directly on the ground of these Quarry slopes, as the ground practically consists of solid rock.

Picture 9: Before excavations; 23. November 2007

Picture 10: After completing excavations; 14. December 2007

It indicates that a Vetiver hedge as a sole measure (together with tree planting) might be a more cost-effective method, as long as the soil and ground quality allows direct planting.

Finances

The work has been realised by two employees of the Trust (Elias and Steven) and three temporarily employed men from the nearby community.

The total costs for excavation (185 metres X 80 KSh): 14800 KSh
The project-related spent costs (compare Table 1 below): 11360 KSh

Reason for the difference is the fact, that the two employee of the trust have not been paid by metres but have received their regular salary.
Additional costs (Sisal string 3 Kg; Wood and bolts for the A-Frame): 650 KSh
The cost for planning, measuring, preparation and supervision will be calculated separately, as it was done by O. Feurer, student volunteer.

Date	Person	Meters	Salary	Total/Person
30. Nov 07	Steven	*	500 KSh	500 KSh
	Elias	*	500 KSh	500 KSh
	Alfred Ndeje Santa	11.5	920 KSh	
	Cosmas Nyale Mwango	5.5	440 KSh	
7. Dec 07	Alfred Ndeje Santa	16	1280 KSh	
	Cosmas Nyale Mwango	18	1440 KSh	
	Rama Mbura Chitu	19	1520 KSh	
14. Dec 07	Alfred Ndeje Santa	25	2000 KSh	4200 KSh
	Cosmas Nyale Mwango	15.5	1240 KSh	3120 KSh
	Rama Mbura Chitu	19	1520 KSh	3040 KSh
Total				*11360 KSh*

- Remarks: The trenches made by Steven and Elias have not been paid by meters. Instead the two have received a bonus of 500 KSh each in addition to their normal salary.

2.3 Assessment of impact

In long term only the combination of terracing and use of suitable plants will have satisfactory effect on erosion dynamics. Nevertheless the established trenches can be assessed as success, as they are obviously fulfilling their expected impact on the surface runoff. The aim of trenches like these is to prevent the surface water getting momentum along the hill slope so that the erosion capacity of the runoff can be reduced. It is expected that the trenches will be filled up with topsoil within the next 18 to 24 months, which will create four terraces that consist of comparatively suitable soil.

Regarding the ground structure, the majority of the treated area consists of a fine layer of surface soil (ca. 1 cm; very little or no organic compounds), whereas the material underneath consist of stones or rocks. During the excavations works it has been observed that the deposited ground material changes its structure very fast as soon it gets exposed to the sun. This means that the dams along the excavated trenches are changing from solid rocks to smaller soil particles. This indicates that the Vetiver Grass and trees might be able to access the minerals relatively easy from the ground soil, as long as they get some quality soil (compost) to start with.

Picture 11: The ground materials becomes weathered quickly

Planting trial with indigenous grass

I decided to conduct a small planting experiment to assess the growing conditions the Vetiver hedges will be confronted with. Four units of a local grass were transplanted directly onto the overburden of one of the trenches. The grass was chosen because its initial location resembles the conditions on the site quite well (direct sun exposure, sloped ground, dry). It was then planted on one of the upper trenches where the excavated ground material has already been fractioned into smaller particles.

Picture 12 and 13: Planting trial with local grass on top of a terrace contour

The plants have been transplanted only with the soil which stuck to the roots. Watering was done four times during the following three weeks. As the pictures show, two out of four units have established well despite the harsh environmental conditions and minimal planting practice.

This planting trial indicates that V. zizanioides will most likely be able to establish on the overburden of the trenches. One might ask why it would not be advisable to use one of these local grass species to establish the vegetative barrier. The main differences between these species and the Vetiver Grass are the habitus, the further use and the spreading dynamics. The local grass does not establish such an effective barrier close to the ground as the Vetiver. It is less rigid and might be damaged when the terraces start to increase in their height. Vetiver will adapt and sprout on a higher level as the silt covers it. Furthermore Vetiver Grass can be trimmed at a height of ca. 40cm and used as kettle fodder. And the most important aspect is that Vetiver subspecies available here in Africa are nearly sterile. This means that they will not spread by seeds but only by growing tillers around their stock. This prevents the contour hedges from becoming a pest. This fact is especially important if the system of vegetative barriers is used as erosion control measure on farmland.

Recent rainfalls in the area have shown that the trenches retain the surface runoff very well. In addition, the amount of fine soil which was deposited already during these minor rainfalls indicates, that the decision to increase the dimension of the trenches was correct.

One of the most important facts which has to be taken into account is, that the restoring of an already eroded slope is much more costly, more complicated and more likely to fail than protecting a slope right after it has been established.

Picture 14: The trenches retain surface runoff well and the excavated ground material breaks weatjers omtp samller particles.

Further Steps

To finish the restoration of the project site, it is planned to plant Vetiver Grass along the trenches of each row. Trees will be planted in a scattered pattern across the site. The trees can be used as fuel wood later on. Also a good established stock of trees does a significant impact on the erosion control as it stops the rain drops from falling directly onto the ground surface.

It seems not to be suitable to plant neither the Vetiver Grass nor the trees right now, as the dry season will make additional irrigation needed. Additionally the soil along the terraces will have time to get further divided into smaller fragments until the rain season starts.
As soon as the rainfalls start, at least some of the stock multiplied in the nursery will be ready or transplanting. Probably it will be necessary to buy in Vetiver tillers from other places.
Regarding the planting of trees, it will be necessary to choose the most suitable species and the exact location to plant them.

3 Erosion Control: Vetiver Nursery

The system of using Vetiver Grass as a vegetative barrier is not a completely new idea. Since several decades Vetiver has been in use in many countries worldwide. In the 1980s the World Bank created a movement called the Vetiver Network to propagate the use of this particular plant. Since then, further research has proven that V. zizanioides cannot only be used for erosion control but also as a bioengineering technique for wastewater disposal and phyto-remediation of contaminated land and water. The various techniques of applying Vetiver Grass are called the Vetiver System (VS), although *Vetiveria zizanioides* has been reclassified recently as *Chrysopogon zizanioides.* The grass itself is tropical plant which has its origin in south India. There is a number of published literatures on Vetiver and a homepage of the Vetiver Network (www.vetiver.org). Most of the information in this chapter has been gathered from the Newsletters of the Network as well as the publication “Vetiver System Applications; Technical Reference Manual” of Paul Truong et al. (available through the homepage). Please refer to these publications for detailed information.

Summary of the main advantages:

- Highly resistant to pest, diseases and fire
- Develops a massive root system which stabilises the ground soil
- Can be propagated by clump division
- High multiplication rate trough tillering (up to 1:30 after three months!)
- Not invasive, as subspecies are sterile
- Tolerance to extreme climatic variations and severe conditions (such as prolonged drought, salinity, varying pH etc.)
- Tolerates coverage by silt
- Forms a dense hedgerow, which filters and spreads surface run off while silt settles

Picture 15: The stock of Vetiver Grass found at the Baobab Trust office

The stock of Vetiver Grass found at the Baobab Trust has been brought here by Dr. Haller several years ago. Its provenance is Tanzania.

3.1 Aim of the Project

The multiplication of the Vetiver stock at the Trust's office has been started to provide initial planting material for the terracing project at the quarry near Nguuni. It is obvious that this small scale nursery will not deliver enough planting material to stabilise all of the 185 metres of trenches in one go. More likely, the nursery is the starting point to propagation of the Vetiver System in the working area of the Baobab Trust. Through the establishment of a small stock and first hand experience, the Trust will be enabled to find appropriate ways of using the plant for erosion control purposes on a larger scale in the supported local communities later on.
Literature information indicates that it is indeed important to establish nurseries with good starting material. Preferably, the starting plant should not have flowered yet thus this decreases the vegetative growth (tillers). To make sure the Trust has got well adapted planting material, in a later stage some Vetiver Grass of other provenances should be propagated as well.
If it proofs that V. zizanioides performs well in the area where the Trust operates, several uses are possible. First of all, the already widely applicated terraces in local communities can be reinforced and stabilised. For that purpose the Trust will establish local nurseries in each community of interest. These nurseries will be allocated near or around the water harvesting dams. This ensures enough water resources for irrigation. Additionally these nurseries (as they are planted already around the dams) will protect the ponds from being filled up with silt. To protect the slopes and spillways of dams could be a further usage of Vetiver Grass. To provide enough planting material for these local nurseries, it will be necessary to buy in planting material from other providers.

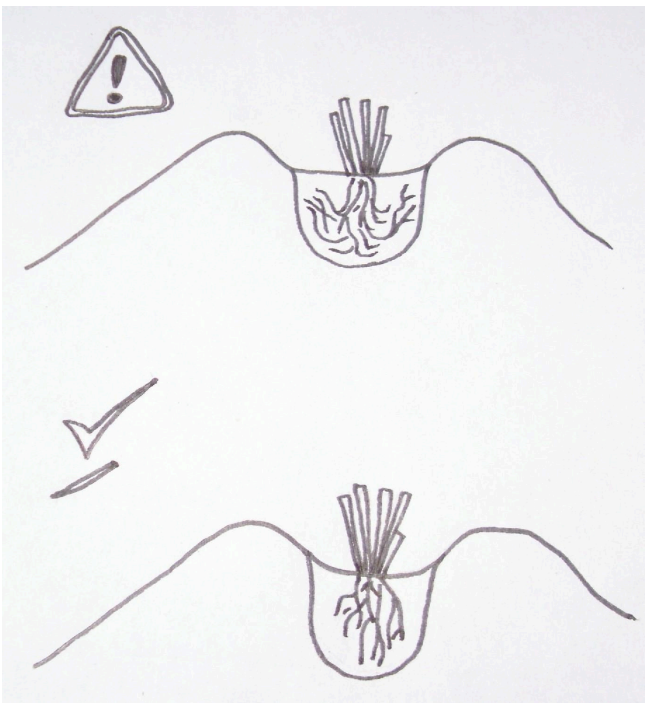
3.2 Implementation

To multiply the already existing plant an area of about 5 m^2 was prepared at the Nguuni tree nursery. Although the Vetiver plant will survive severe mistreatment it is very advisable to provide nursery plants with ideal conditions. The aim of a nursery is multiply planting material as effective as possible.

Half of the existing Vetiver stock was used to establish the nursery. Although this means a smaller nursery this was done to guarantee that not all the planting material gets lost if something goes wrong.
The plant gets divided into smaller units by hand. Some part of the plant had to be dug out of the ground, other could be harvested directly from the surface (as the existing plant was quite old and had established superficial subunits). Each of the subunits harvested has to include the crown (the place of growth), some leaves and some roots. If planting discipline is good and the growing conditions are ideal, a planting unit can consist of only three tillers. But as this was the first planting trial with Vetiver, I decided to take bigger subunits. This will ensure a quicker an saver development of the nursery.
The tillers were transported in a box which was held humid. Again, it is advisable to protect the material rather than risk some tillers to fail due to bad transplantation practice.
The planting bed should consist of a soil with rather sandy texture. This will simplify the second multiplication when the plants have to be dug out of the ground again. The plot was well irrigated

before planting the tillers. Each group of tillers has got a own little planting hole. After location of the tillers, the hole was filled up half way. The top layer consisted of a mixture of compost and chicken manure. The planting pattern was 1 foot in between the plants and 1 foot between the rows, too.

Picture 16: A group of Vetiver tillers



Picture 17: Avoiding J-roots is essential for good growth

To receive best results, the group of tillers has to be planted with an exact planting discipline. The tillers get pruned such as that the roots have a length of ca. 10 centimetres, the leave a length of ca. 15-30 centimetres. The plant has to be allocated in the planting hole without any roots getting bent upwards. The so called 'J-root mistake' will produce plants which do not stabilise the ground as well as normal plants because their root system will stay superficial.

The plot will be irrigated twice a day in the early stage. After the plants have established, the irrigation will be continuously reduced, such as to adapt the plants to the local conditions.

Picture 18:The tillers get pruned and planted in groups

According to literature, the amount of tiller multiplication is increased when the Vetiver plant is regularly pruned to a length of 40 centimetres. The minimal time the plants should stay at the nursery is about three months. Each plant can be divided in subunits, where one part gets planted in the field and the other part goes back into the planting bed.

The material which was cut off from the tiller during pruning was used to mulch 40% of the planting bed. Mulching is said

to decrease the loss of water due to evaporation and to improve the microclimate on the surface around the plant. A further advantage should be that herbs are slowed down in their growth.
Additionally the plants can use the decomposing mulch as nutrient. The partial use of mulch will enable to assess whether the effect is significant or not.

Picture 19: The established Vetiver Grass nursery. Part of it got mulched with the pruned leaves

As *V. zizanioides* is a C4-species (increased fixation of carbon dioxide), it will perform with substancial growth as long as there is enough water and sun available. This means that the plants should be transplanted to a bigger nursery as soon as they start to give shade to each other. Also the nursery should be weeded regularly to prevent vegetative concurrence.

Suppliers of Vetiver Grass in Kenya

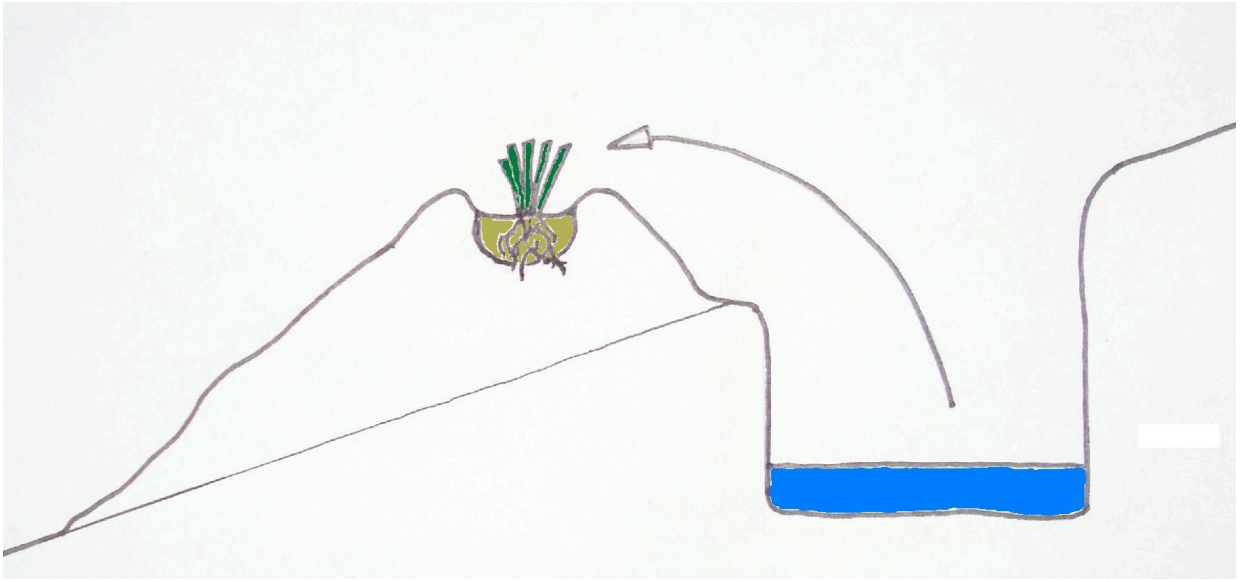
Source: www.vetiver.org

Dr. James Owino, PHd. Senior Lecturer Dept. of Agriculture Engineering Egerton University P.O. Box 95 Egerton 20115 Kenya	Joshua Machinga Kitale Arch Agencies. Tel: (0325)-44205 Email: vitus@net2000ke.com Cost approximately US$ 57 per pickup truck

Mobile PN: 011-254-0721 242906 E mail: joowin@yahoo.com	
Latah Tree Nursery Anthony Nyatta Mwasagha, Chairman P.O. Box 223 Voi 80300 Kenya E-mail: anthonynyatta@yahoo.com	Paul Mwadime Kombo Voi Vetiver Project, P.O. Box 223 Voi 80300 Kenya Mobile:0734835029 E-mail: mwadimekombo@yahoo.com

The Kenya Agricultural Research Institute should also be able to provide planting material.

The planting of Vetiver hedges along the trenches in the quarry will take place during the rainy season (from April onwards). This ensures that there is enough water for irrigation purpose available. This is also the time when the trees are planted. Considering the time period between the establishment of the nursery and the rain season, there should be enough planting material available from the own stock to stabilise at least a part of the terraces.



Picture 20: Planting scheme on top of the terrace contour. Retained water can be used for irrigation.

On top of the overburden along the terraces a small planting trench has to be dug. It will be filled with a mixture of local soil, compost and manure. The planting trenches have a concave design to trap the rainwater. This ensures a good start of the hedges. Irrigation will be conducted manually by using the water trapped inside the trenches.

The Vetiver tillers will be planted in groups of at least 3 together. The planting distance will be about 15 centimetres. Here as well, one has to maintain good planting discipline: the roots must not get J-shaped and the crown between leafs and roots should be covered completely with about 2 centimetres of topsoil.

3.3 Assessment of Impact

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4 Project 3: Dams in Mitedi

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4.1 Aim of the project

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4.2 Implementation

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4.3 Assessment of impact

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In my point of view it might be very interesting to develop a concept to use Vetiver hedges to stabilise the slopes of freshly built dams in the communities. In contrast to the use of Napier Grass, Vetiver will create a much denser barrier at the surface. And still it will provide fodder or mulch as it can be cut at 30-40 cm length. Correctly planted it could also be used to protect the spillways of the dams from getting damaged. It would be much cheaper than coral stones and gabions.

5 Project 4: Spillways Vikvatani

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5.1 Aim of the Project

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5.2 Implementation

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5.3 Assessment of Impact

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6 Project 5: Water Surface of Dams in Kimbunga

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6.1 Aim of the Project

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6.2 Assessment of Impact

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7 Further aspect of Development Cooperation

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7.1 Financiation

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7.2 Social Acceptance

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7.3 Cooperation with local employees

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7.4 Personal Opinion

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8 Literature

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