

AT MICROFICHE
REFERENCE
LIBRARY

A project of Volunteers in Asia

Gully Control and Reclamation
VITA Technical Bulletin 51057-BK

by: Robert D. Flannery

Published by:
Volunteers in Technical Assistance
1815 North Lynn St. Suite 200
P.O. Box 12438
Arlington, VA 22209 USA

Paper copies are \$ 2.00.

Available from:
Volunteers in Technical Assistance
1815 North Lynn St. Suite 200
P.O. Box 12438
Arlington, VA 22209 USA

Reproduced by permission of Volunteers in
Technical Assistance.

Reproduction of this microfiche document in any
form is subject to the same restrictions as those
of the original document.



GULLY CONTROL AND RECLAMATION

by ROBERT D. FLANNERY

This manual by VITA Volunteer Robert D. Flannery was first published by the Lesotho Agricultural College in Maseru, Lesotho. It describes how soil erosion causes gullies, what can be done to stop gullies from deepening, and how to reclaim eroded soil.

The manual deals specifically with conditions in southern Africa. However, the many photographs and clearly written text make it useful for readers in other countries as well. Deforestation, poor soil management, and other factors have made erosion a growing problem for developing countries worldwide.

Mr. Flannery was a lecturer in resource conservation at Lesotho Agricultural College when he wrote this manual. He is an expert on soil management with wide experience in many countries, and now lives in Berkeley, California.

The manual was originally edited, illustrated, and printed by the Lesotho Distance Teaching Centre. Some changes in the text and photographs have been incorporated in this VITA edition. Reprinted by permission.

Please send test results, comments, suggestions, and requests for further information to:

Technical Bulletins
VITA Publications Service
1815 North Lynn Street, Suite 200, Box 12438
Arlington, Virginia 22209-8438 USA

First printing October 1980
Revised September 1981

ISBN 0-86619-143-7

VOLUNTEERS IN TECHNICAL ASSISTANCE

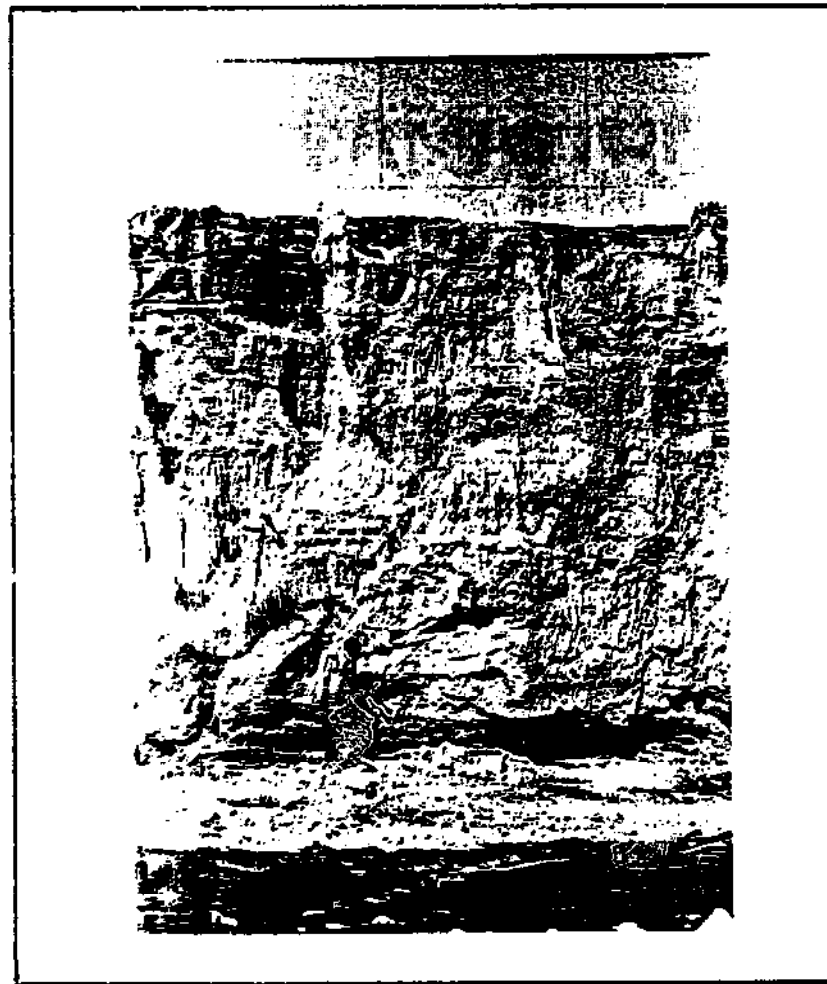
1815 NORTH LYNN STREET, SUITE 200, ARLINGTON, VIRGINIA 22209 U.S.A.

VITA Technical Bulletins offer do-it-yourself technology information on a wide variety of subjects.

The Bulletins are idea generators intended not so much to provide a definitive answer as to guide the user's thinking and planning. Premises are sound and testing results are provided, if available.

Evaluations and comments based on each user's experience are requested. Results are incorporated into subsequent editions, thus providing additional guidelines for adaptation and use in a greater variety of conditions.

GULLY CONTROL AND RECLAMATION



Lesotho Agricultural College
Maseru , Lesotho

CONTENTS

Introduction	1
Extent of Gully Erosion in Lesotho	1
Active Gully	7
How a Gully is Formed	7
Control of Gully Erosion by Structures	9
How to Stop a Donga from Lengthening	9
How to Stop a Donga from Deepening	12
Control of Gully Erosion by Vegetative Growth	13
How to Stop a Donga from Becoming Wider	13
Gully Control by Diversion or Retention	16
Maintenance of Structural and Vegetative Measures	18
Causes of Gully Erosion	19
Plants that Help to Stabilize Structures	23
Protection	25

GULLY CONTROL AND RECLAMATION

INTRODUCTION

Most of the land in Lesotho has been greatly damaged by gully erosion. This book is written to help you and all communities interested in fighting soil erosion and in restoring the land to productive use.

The book suggests simple but effective ways to combat this disease that is gradually eating into the land. It tells you how you can prevent dongas (gullies) from forming; or, if they are already formed, how you can stop them from becoming deeper, longer, or wider.

This book will teach you how to stop a donga that is running through your field. You can also use it in your community to control dongas that are threatening your pasture land or that are ruining your village and destroying your roads.

Some people will use this book with school children while others will use it with their local groups. You can also use the book individually or with your family. The important thing is that all of us do something to control gully erosion and reclaim the land already marred by dongas.

This book was written by Robert D. Flannery, Lesotho Agricultural College lecturer in resource conservation, with the financial assistance of the Catholic Relief Services. It was first published by the Lesotho Distance Teaching Centre.

EXTENT OF GULLY EROSION IN LESOTHO

Soil erosion is one of the biggest problems of this country. Lesotho dongas are formed mainly by rain falling on bare soil. Gradually little streams of water are formed. These streams

wash away particles of soil and form small furrows, which ultimately deepen and become dongas. Gully erosion has damaged most of the land in Lesotho. It has taken away most of the soil and left us with a bare, ugly country.



Dongas interfere with farming. They encroach on our fields, carry away fertile soil, and leave us with poor subsoil that cannot supply our plants with nutrients.



Dongas are dangerous. They ruin our grazing land, leaving our animals thin and malnourished.



Gully erosion frustrates our efforts to improve this country. It washes our roads away and breaks communication between various parts of the country.



Dongas divide our villages and often become dens for murderers and robbers.



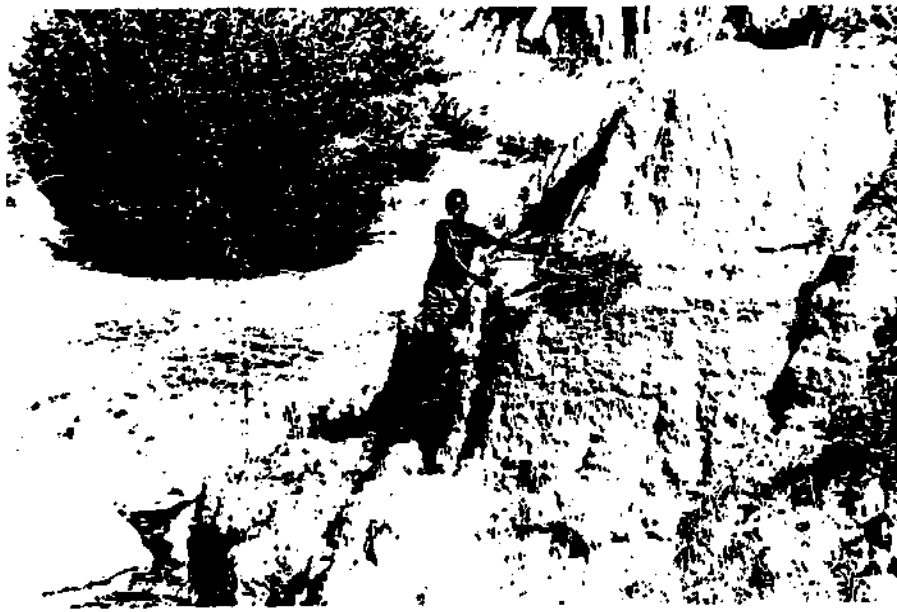
Gullies are a threat to the lives of our animals. Sometimes animals grazing along the edges of dongas slip and tumble in. All too often the fall is fatal.



Dongas are a threat to our lives also. Some people fall to their deaths in the dongas.



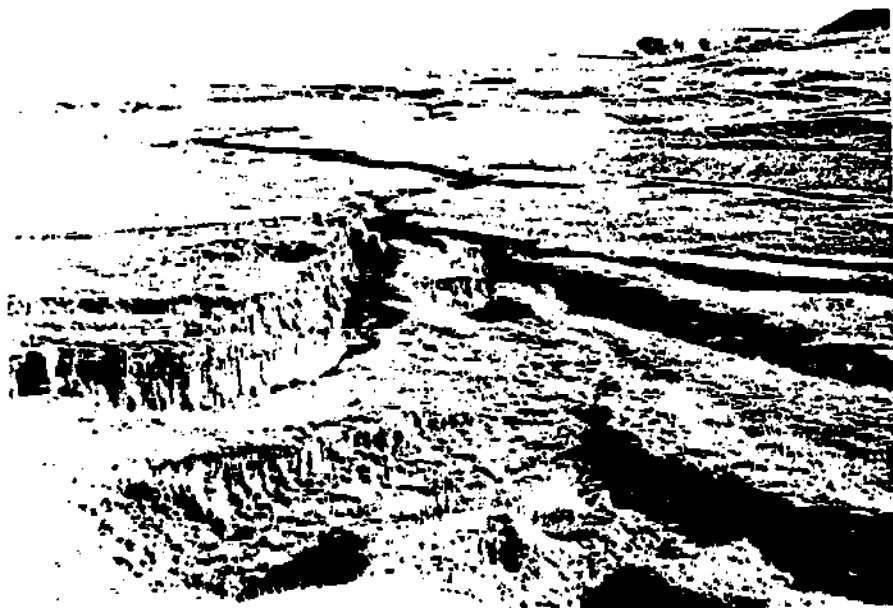
Our children like to play on the slopes of dongas. At times they miss a step, fall into a donga, and become crippled permanently.



At present, most of the dongas in Lesotho are becoming wider, deeper, and longer.



There are already 25,000 dongas in Lesotho today. Unless something is done to bring this situation under control, we will soon have land that is unusable.



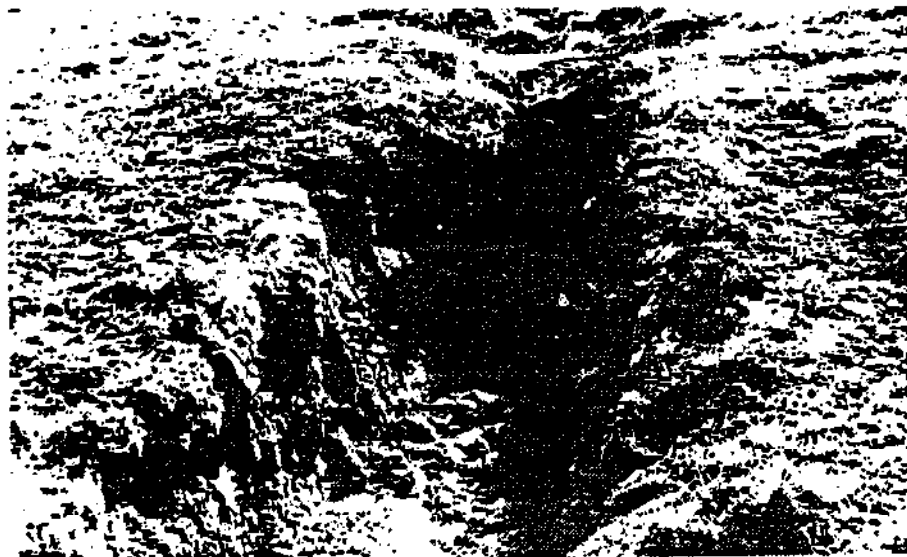
ACTIVE GULLY

An active gully is one that is continuing to widen, deepen, and lengthen. Most of the gullies in Lesotho are becoming wider, deeper, and longer. They still carry away much of our soil whenever it rains. The dongas of Lesotho are very active.



HOW A GULLY IS FORMED

A donga is formed by water. Where soil has been left loose and bare, water can move easily along the ground. As the water



moves on loose unvegetated soil, it carries away the topsoil and begins to form a small channel. A donga lengthens because the water that flows over the head erodes backwards and bores into the head's profile leaving an overhang.



This overhang will fall with time, and the cycle will begin all over again. The water that moves in a donga flows at a greater speed than the water that moves in a wide valley. This increases its erosive strength.



If there is nothing to control the speed of water in a donga, it washes away more soil from the bed and the donga then deepens.

As the donga deepens, its walls force the water into a smaller channel. When water

moves down a donga at increased speed, it requires more room. It makes more room by washing away particles of soil from the walls, particularly towards the bottom of the donga. Gradually the sides of the donga weaken and hang over. Ultimately, the overhanging walls fall and the donga widens. A donga will widen, lengthen, and deepen unless some measures are taken to control the head, bed, and walls.



CONTROL OF GULLY EROSION BY STRUCTURES

There are measures that can be carried out to prevent the soil of this country from being taken away. You can stop a donga from enlargening by building loose stone structures at the head of the donga and at certain points on the donga bed. The stone structures help to collect soil that, after some time, can be used for growing vegetation.

HOW TO STOP A DONGA FROM LENGTHENING

A donga lengthens because the head keeps collapsing and therefore receding. The head of a donga becomes an overfall. As water pours over this overfall, it erodes the bottom of the overfall and creates an overhang. The overhang eventually collapses, leaving the profile of the head straight. Then the cycle starts over again and the donga lengthens. Once more, this situation can be controlled by stopping the head from receding. To do this, you need to construct stone structures at the donga's head to reduce the speed of water. Here are the steps you should follow.

1. Dig out the head of the donga to create a gentle slope rather than a steep slope. This will reduce the erosive power of the water.



2. Put stones on the area you have dug out. These stones will slow the movement of the water. If you are dealing with a shallow donga, you should slant the head right to the bed. Then fill the part that you have slanted with flat stones.



3. At the end of the slanted part, dig a shallow foundation in which to put some stones. Throw in as many stones as necessary to form a loose wall of about 30cm from the level of the ground. The loose stone structure prevents water from



digging into the soil and causing damage. It also helps to check the fast-flowing water from washing away soil. This structure must, however, be loose so that water may easily pass through the stones.

4. In the middle of the stone structure you must leave a small passage called the spillway. This is an outlet that will



allow running water to pass through. Unless you allow for this outlet, the force of the water will break and wash away your structure.

HOW TO STOP A GULLY FROM DEEPENING

After building the first stone structure, you still need to check the flow of water along the bed. If water is allowed to move freely along the bed after passing through the first stone structure, it will continue to erode soil on the floor of the donga. You will, therefore, need other structures that will slow the movement of water and even trap some silt. Such structures are called stabilization structures.

The best place for building a stabilization structure is at a spot where the gradient of the donga changes. First, dig a small foundation 60cm deep and 60cm wide. Then, fill in this foundation with stones. Continue to pile loose stones until the wall of stones is about 30cm high.

Leave a spillway either at each side or at the center.



On the downstream side of the wall, make a layer of flat stones called an apron. Towards the end of the apron, make a perpendicular line of stones to slow down the speed of the run-off water.

CONTROL OF GULLY EROSION BY VEGETATIVE GROWTH

The main aim of gully control is to stabilize the gully by vegetative growth. The structures mentioned will help some plants to grow in a donga because they will trap some water and soil on which the plants can grow.

Vegetation is effective in controlling the erosive power of water and in trapping the silt carried by the water. The plants that grow naturally on the bed of a donga need to be protected from animals and fires so that they can cover the gully and the erosion scars.

Once the bed cover has been established, the donga will cease to deepen, but the walls will have no cover and the donga will continue to widen. Further steps must be taken to prevent this.



HOW TO STOP A DONGA FROM BECOMING WIDER

To stop the donga from becoming wider, you need to grow some vegetation on the walls. The vegetation that you grow to cover

the walls should have an extensive root system. You should plant this vegetation near the bottom of the donga where it will have moisture. Once it has taken root, it will extend over the walls and stop the donga from widening.



Walls are not the same in all dongas. Some dongas have sloping walls that can easily accept vegetation; others are too straight so no vegetation can grow on them. To prevent a donga with straight walls from widening, you should dig out the walls to make them slope. This will enable creeping grasses and legumes to spread across the sloping walls.



When the grasses and legumes seem to have



become established near the bottom and along the walls of a donga, you can begin to plant trees. Trees can only survive where shrubs and grasses are already growing. Trees, shrubs, and grasses help to reduce the speed of the water and trap a lot of silt and dead plants that are carried by the water.

During the establishment stage, you should not allow animals to graze on the gullied areas. Grazing hinders the growth of the vegetation. If you protect the area where you are controlling gully erosion, your land should be reclaimed in a few years.



GULLY CONTROL BY DIVERSION OR RETENTION

Diversion

You can also control donga formation by changing the course of run-off water. You can divert the water from your field, pasture land, or road by constructing a ridged furrow on the higher slope. The furrow made above your field or pasture land should be half-moon shaped, and it should empty the water into a protected or well-vegetated area.



In an area where gullies are beginning to form, you can make one diversion furrow above the heads of the gullies. This furrow can have an outlet into a location that has stabilized structures. This would be an economical way of controlling many small dongas with one diversion furrow leading into one controlled area.

At the outlet of the furrow, you can construct a loose stone structure. This should have an apron that will control the flow of water into the stabilized area. If there are enough stones, you can install some stone structures along the diversion furrow to control the velocity of the water. You should leave a

spillway in the center of every structure for times when there is too much water running through the furrow.



You should make sure that these structures are well maintained, for if they are destroyed by water, they can do more damage.

Retention

There are other means of controlling the speed of run-off water. You can construct terraces on gentle slopes in your field to check the flow of water. These terraces should be made on open soil. If the terraces hold any water, the water will easily soak into your field.

The terraces should be left open to allow excess water to escape. Remember that you should have some structures at the open ends, to prevent the water from beginning a gully.

You can also make dams in gullies to retain the run-off water. A dam should be made near the head of a donga so that the steepness of a donga may be reduced. This will lessen the force of water over the head and stop the head from lengthening.

The dam should be big enough to hold the water. It should also have a spillway for emergencies. The spillway should have stone structures to prevent the escaping water from cutting into the



ground to form a deeper donga. The spillway should be built in such a way that it is not used very often, i.e., only when the dam is very full.

If the spillway is not well maintained, it will be washed away by water and a donga will result. If there is no natural vegetation below the dam, you should encourage vegetative growth.

MAINTENANCE OF STRUCTURAL AND VEGETATIVE MEASURES

When you have constructed the stone structures along the channel of a donga, you must check that they are not destroyed by water, humans, or animals.

If the stone structures begin to collapse, make immediate repairs. Inspect the sides of the structures and repair all the cracks that might have been caused by animal burrows, dry weather, or flood water. Repair the structures before they fall

apart. If you maintain the structures properly, you will save yourself costly repair jobs when unusual storms occur.



When the vegetation you have planted begins to grow, protect it from grazing animals. Even when the vegetation is established you should only allow limited grazing. The young vegetation should be protected from fires and from being trampled on. Spread manure around any plants that are not growing well, but you do not need to manure the whole gully.

By maintaining structures and caring for plants grown in stabilized dongas, you will be able to restore your land.

CAUSES OF GULLY EROSION

You have learned how the dongas that eat into this land and leave us with a desolate and ugly country can be controlled. You should now learn how they are caused so that you can prevent them from occurring again.

There are many causes of gully erosion in this country. Some causes are man-made, while others are due to animal trails.

1. Improper land use. Men sometimes become a cause of gully erosion by using their land improperly. They plow the slopes; and when rain falls, it carries away the soil that has already been loosened by plowing. A small gully begins to form. If it is not controlled in time, run-off water will enlarge it until a big gully is formed.

Before you plow along the slopes, you should build a diversion furrow to protect your land from run-off water from the higher slopes. The furrow should reduce the speed of the water that runs down the slope. Once you have made the diversion furrow, you should make sure that it is not destroyed by water. You can strengthen it with the stone structures that I have mentioned and by planting grasses or legumes that have extensive root systems.

This diversion will prevent your field from being cut in two by run-off water. It will also protect your crops from the run-off water that can take your plants away.



Land can carry a certain amount of run-off water as long as the surface of the land is not disturbed. Sometimes farmers plow their land up and down. This enables the water to move easily along the furrows made by the plow. The water that moves along the furrows will carry soil as it flows down the field. If this is allowed to go on year after year without any check, a gully will be formed in the field. It is, therefore, advisable to stop this type of plowing, as it is a definite cause of gully erosion.

2. **Farm tracks.** These are other sources of gully erosion. If you look at farm tracks between fields, you will realize that the tracks become deeper and deeper. This is caused by sledges and carts that are pulled by animals. The sledges or carts cut into the ground, sometimes uprooting grasses that have grown along the track.



They break up the track into loose soil, which is easily carried away by water. Given time, the farm track will eventually turn into a donga. To protect this country from gully erosion, we should make terraces or other structures along farm tracks and roads to reduce the erosive power of run-off water.

3. **Footpaths.** Through frequent usage, footpaths become torn and small channels begin to form. When a footpath begins to deepen, men stop using it and begin a new path alongside the old one. When it rains, the run-off water is channeled into the deepened path. The channeling of water increases its erosive power; and with time, the path will deepen more and more until a donga is formed. To protect this country from gully erosion, we should never leave abandoned footpaths unprotected. We should build terraces or other structures to reduce the erosive power of the run-off water.
4. **Road drainage.** Road drainage may also encourage gully erosion. When drainage ditches are dug, they should be properly protected so that water does not flow freely on the already prepared surface. If the water moves freely, it will carry away the soil, and finally a donga will form because of the drainage channel.



Since you cannot avoid making farm tracks, footpaths, and drainage ditches, it is important that you should make sure that these are protected so that they do not encourage donga formation. You will need to make terraces and stone structures and plant vegetation to ensure that water does not flow freely along the tracks, footpaths, and road drainage.

5. Livestock. Animals also contribute towards gully formation. Excessive grazing on the same pasture every day leaves the ground bare. When sheep graze where grass is short, they remove all the grass from the soil. This leaves the soil bare and unprotected. When it rains, water flows freely over this bare ground and at greater speed than it does where there is grass cover. If there is no grass growing on this bare land, a small gully will begin to form.

To preserve the grass cover on the pasture land, you should practice grazing rotation. Do not let the animals graze on the same pasture day in and day out. Keep animals away from one area to encourage the grass to regrow. This is not easy to do; but, if you want this country to be restored to vegetative growth, some effort is necessary.

Like men, animals tend to form trails where they walk. Their hoofs loosen the soil. When it rains, the water carries the loose soil away. Animals will trample on the same trail again and loosen the soil more. After some time, you will see a small channel beginning to form. If you do not take



immediate measures, a donga will result from the livestock trails. To avoid this, make sure you do not drive your animals along the same trail every day.

PLANTS THAT HELP TO STABILIZE STRUCTURES

When all your structures seem to be working well, you should supplement them with some vegetation. It is better to encourage the vegetation that is already growing in the controlled area. You can supplement the natural local vegetation with other plants that you can find within your area or buy from local nurseries.

As mentioned before, grasses and legumes can be planted to grow up the walls of dongas. These can be planted near the bottom of the dongas. The best plants to grow are sod-forming grass, creepers, or leguminous plants. Grasses such as the Kikuyu, Mohlomo (Kweekgrass), Ookoa, Thitapoho, and many other grasses you know can be transplanted to the controlled gully area. You can plant some grasses by using their seeds, e.g., Mohlomo, Ookoa, and Thitapoho.



Two legumes can be used at the base of dongas. These legumes creep along the walls of dongas. They are called Kudzu and Crown Vetch. You can probably obtain plants or seeds from local nurseries or agriculture departments. The grasses and legumes make a good base for future growth of trees. Trees cannot easily grow on a bare area.

There are several native kinds of trees that can be grown to stabilize the controlled eroded area. The trees will grow well providing there is a grass base already prepared for them.

If there are trees already growing in the gullied area, it is better to plant trees of the same species. If the gullied area has some poplar trees already, continue growing a similar species in the area. It would be useless to grow wattle trees for they may not adapt themselves to this area as easily as the poplar trees.

You should not forget that if you grow trees in a gullied area, the banks of the dongas will need to be sloped. Trees that have proved to be useful in stabilizing gullied areas are locusts, poplars, wattles, willows, and wild olives. You can also try cheche, kolitsane, leloka, and lesika, if these are available. A local nursery can advise you about other stabilizing species.



PROTECTION

Once you have established vegetation in the gullied area, animals should stop grazing on that land. There should be no disturbance to the plants or structures. Check the vegetation

and structures regularly to see if there is any need for repairs or to allow limited grazing to control competitive weeds and shrubs. The area should also be protected from fires. A fire will burn the seeds and roots of the plants.



TECHNICAL BULLETINS

IDEA GENERATORS FOR BETTER LIVING

BLACKSMITH'S FORGE AND BELLOWS

Uses wood scraps and old inner tubes.
51005-TB - E, F 17 pages

CENTRIFUGAL HONEY EXTRACTOR

Easy-to-build, simple-to-operate device to extract honey from the comb.
51035-TB - E 9 pages

CHAIN LINK FENCE MAKING MACHINE

Hand-operated machine can produce fencing up to 96" long.
51025-TB - E, F 21 pages

CHRIS AHRENS' GREENHOUSE

Simple to construct A-frame greenhouse.
51058-TB - E 8 pages

COMPOSTING PRIVY

Complete instructions for digging pit, building the shelter.
51007-TB - E, F, S 13 pages

DOUBLE-DRUM SAWDUST STOVE

Sawdust burning heat stove constructed from empty oil drums.
51029-TB - E, F, S 4 pages

GRAIN MILL FOR HOME USE

Easy-to-build wooden grinder for corn, wheat, and other grains.
51018-TB - E, F, S 9 pages

GULLY CONTROL AND RECLAMATION

How to stop gully formation, reclaim eroded soil.
51057-TB - E 26 pages

HAND-OPERATED CLOTHES WASHER

Two simple clothes washers--a covered metal tub w/long-handle agitator; other, all wood.
51013-TB - E, F 9 pages

HOME FLOUR MILL

Made almost entirely of wood. Powered with a 1/4 hp electric motor, by wind power, or by hand.
51033-TB - E, F, S 14 pages

HOW TO MAKE FERTILIZER

Compost organic materials for fertilizer.
51008-TB - E, F, S 9 pages

INTRODUCTION TO SOAP MAKING

Procedures, recipes, techniques for home or village use.
51003-TB - E, F 24 pages

ONE-KW RIVER GENERATOR

Operates a 6.0 ft/sec with 80% efficiency for each of 3 "V" belt speed-up stages.
51001-TB - E, F, S 9 pages

POUR FLUSH LATRINE

Step-by-step photo guide to siting and building a pour-flush latrine.
51059-TB - E 25 pages

SMALL-SCALE PAPER BAG MANUFACTURING PROCESS

Includes plans for making simple paper bag manufacturing machines.
51045-TB - E, F 15 pages

SOLAR CONVECTION GRAIN DRYER

Experimental, low-cost grain dryer uses movement of heated air.
51063-TB - E 4 pages

SOLAR OVEN

Insulated top fits on base of gypsumboard and plywood.
51006-TB - E, F 7 pages

SOLAR OVEN FOR VILLAGE BAKERIES

Large size solar oven is spacious enough for a small business enterprise.
51062-TB - E 5 pages

WASTE OIL FIRED KILN

Developed in Tanzania. Unique way to mix and burn oil and water.
51064-TB - E 11 pages

WASTE OIL FIRED OVEN

Made from 55-gallon and 42-gallon steel drums. Some welding, metal work needed.
51060-TB - E 20 pages

WOOD BURNING OVEN

Wood-burning oven of solid brick with sheet iron door.
51011-TB - E, F, S 5 pages

All Bulletins, \$2.00 each. Available in English, French, or Spanish, as indicated. Please specify TB number and language (E, F, S).

Shipping: US and Canada, please add 95¢. Overseas surface mail, please add \$1.75. Overseas air mail, please add \$3.50.

Fill out the form below. Print clearly. Make check or money order payable to VITA, and mail to: VITA, 1815 North Lynn St., Suite 200, Box 12438, Arlington, Virginia 22209-8438 USA.



ABOUT VITA

Volunteers in Technical Assistance (VITA) is a private, nonprofit, international development organization. Started in 1959 by a group of concerned scientists and engineers, VITA maintains an extensive documentation center and worldwide roster of volunteer technical experts. VITA makes available to individuals and groups in developing countries a variety of information and technical resources aimed at fostering self-sufficiency--needs assessment and program development support; by-mail and on-site consulting services; information systems training. It also publishes a quarterly newsletter and a variety of technical manuals and bulletins.

For more information, contact: VITA, 1815 North Lynn Street, Suite 200, Box 12438, Arlington, Virginia 22209-8438 USA.