THE SOILS

Museum D-EFRN 8-7,8,9.A

CENTRAL RANGELANDS DEV. PROJECT

NON FORMAL EDUCATION SERVICE

PAMPHLET NO: 8

THE SOIL

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INTRODUCTION.

1. The four basics of life on earth are the sun, air, water and soil. These are the things which need to be cared about in order that life can survive.

2. The sun. In Somalia the sun is hot due to the fact that the country is tropical and mostly of low altitude. Care is needed therefore to provide shade for humans, for animals and for the soil. Dr. P. Glover, in 1951, measured soil temperatures of 65 C (154 F) where the soil was bare in Somalia. Tree planting and grass preservation are part of the need in regard to the tropical sun. Of course in other parts of the world it is quite different. Buildings are now being designed in cold areas which will take in as much sun as possible and store the warmth. Also the sun's energy is used in other ways to generate electrical energy and heat. Each area has to consider its own needs.

3. The air. Pure air is of great value. Many industrial countries have serious pollution problems due to car exhaust fumes and industrial gases. London has improved its air cover by preventing the burning of coal in domestic houses, but exhaust pollution in a large city is still a problem. Washington, Los Angeles and Tokyo are well known examples of air pollution. In Tokyo the birds have been driven from the city and a vistor hears bird song from electrical speakers hung in the trees outside his hotel. Luckily Somalia does not have these problems of pollution.

4. Water. In separate pamphlets the problems of water in Somalia are discussed. In this pamphlet it is only necessary to add that a country with poor rainfall needs to make maximum use of whatever does arrive. As a rule, anti-soil erosion methods and grass/tree encouragement have water-conservation value. Grass in particular allows water to soak into the soil and then protects it from rapid evaporation.

5. The soil. This is the subject of the present pamphlet. It is also a subject which the people of Somalia needs to think about very carefully.

NATURE OF SOILS.

6. A cover of soil lies over most of the land surface of the world. Underneath this soil, and on the mountains from which it has been eroded, is the solid rock from which the soil has been made. Soil is therefore broken down rock and the process of making soil has continued for millions of years. Because rock is of many types it follows that soils will also vary greatly in their structure. The depth of soil varies from one place to another. In desert areas there may be large windswept areas of bare rock with no soil covering. In some tropical countries the soil may be more than 30 metres deep. In the Haud of Somalia for example a hard limestone layer of rock was found at depths of from 45 cm to 90 cm, but from a locality near Dudwein, 80 kilometres southeast of Hargeisa, a driller called Parkinson found a soil thickness of 34 metres. (in 1922).

7. The surface of bare soils varies greatly. Soil colour may be anything from almost white to brown, red, orange, grey or black. All these colours are to be seen in Somalia. The surface may be soft & smooth and easy to walk on or it may be hard and rough. It may be even in its composition or it may hold pebbles or pieces of rock.

8. With different soil types, different types of vegetation will occur. This applies to grasses, shrubs and trees.

9. After rain, some soils become very sticky, whereas others just become soft. In dry periods some soils become dusty, particularly where livestock move over them regularly, and these soils are then easily blown away by the wind. Other soils are able to stick together in "crumbs" and "clods" which do not fall into dust and therefore resist wind erosion. On some soils it is seen that when they dry out, they may show large cracks in the surface areas. Other soils do not crack at all. This explanation is made in order to confirm the many differences in soils.

SOIL PROFILES.

10. If a hole is dug down through the soil, a depth view, or "profile", can be seen. This will show that the soil appears as layers, one on top of the other, of varying composition. At the surface may be old leaves, stalks, etc. which have fallen on the land and which will decompose.

These will normally be found in grassland where the grass itself holds them from being blown away. Underneath the surface there should be a darker coloured layer in which leaf, stalk or livestock droppings are partly decomposed and mixed with the soil. This is the "humus" zone which can be 1 or 2 centimetres thick. The rest of the top part of the soil is lighter in colour. It is this top-soil which provides the plants with food materials. Some of the nutrients come from the soil itself, and some from decomposing plant and animal remains (or from fertilizer of course when fertilizer is used in cultivation).

11. Below the top-soil is the sub-soil layer, which is usually of different colour. Some plant roots do go down into the subsoil and can take up nutrients from it. These nutrients would mainly have reached the subsoil by being taken down from the topsoil by rain.

12. Under the subsoil is the parent material layer. This is the material from which the surface layers have been formed by the action of climate. In its most solid state it is called bedrock.

CONTENT OF THE SOIL.

13. Soils are made up of particles of different sizes. This can be seen quite easily by mixing some soil and water in a clear bottle and shaking it. The bottle is then put to stand and the soil separates out. The large particles of gravel and heavy sand settle first, then the lighter sands and then silt. The smallest soil particles are called clay and these will remain in suspension for a time & will only settle slowly to form a layer on top of the silt.

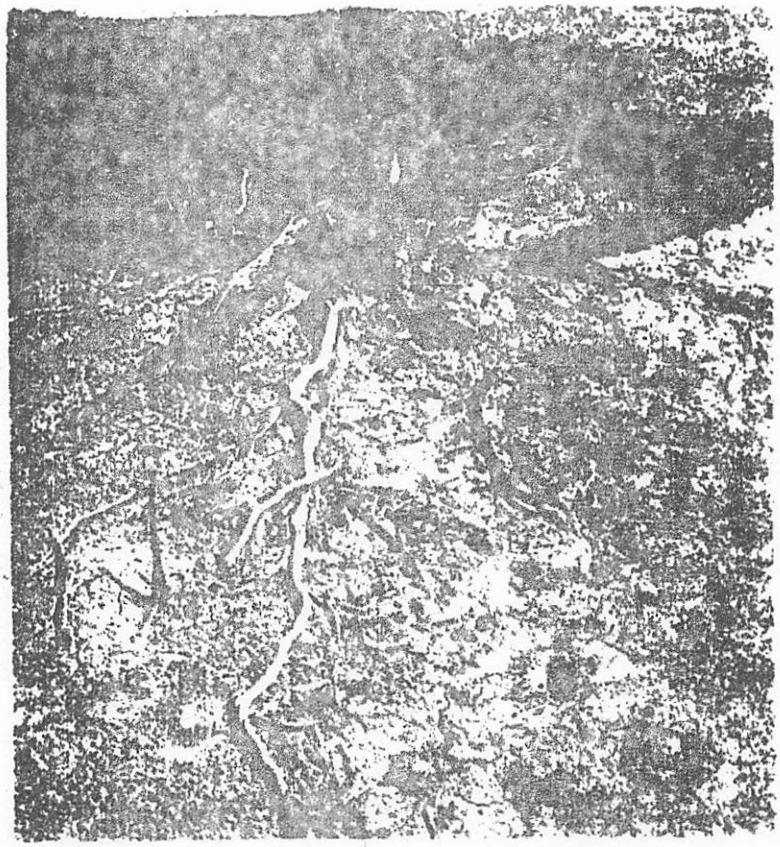
14. Included in the soil also are dead leaves & roots etc. as well as earthworms, grubs, snails, ants or other small animal life. The spaces within the soil, i.e around the soil particles, are filled with air and water and these two components can make up about 50% of the total soil volume.

15. The contents of a good soil are therefore :-

a. Gravel & stones = mineral matter.

Figure 5. A deep gully that has undermined the tree leaving the roots dangling in the air.

Figure 1. Sheet erosion. The surface of the soil has been washed away exposing the roots which may eventually die due to drying out.



b. Sand = mineral matter

c. Silt ,, ,,

d. Clay ,, ,, about 45%

e. Dead leaves etc decomposing = organic matter

f. Decompsed material (darker coloured) = organic matter

g. Living plants & animals = ,, ,, about 5%

h. Air about 25%

i. Water about 25%

Such a soil is called "loam". Most of the Somalia rangeland soils are not of this quality. However the description is useful because in small areas (as around water points) where organic material can be built up in the soil, then good quality soil can develop, and loam may be seen.

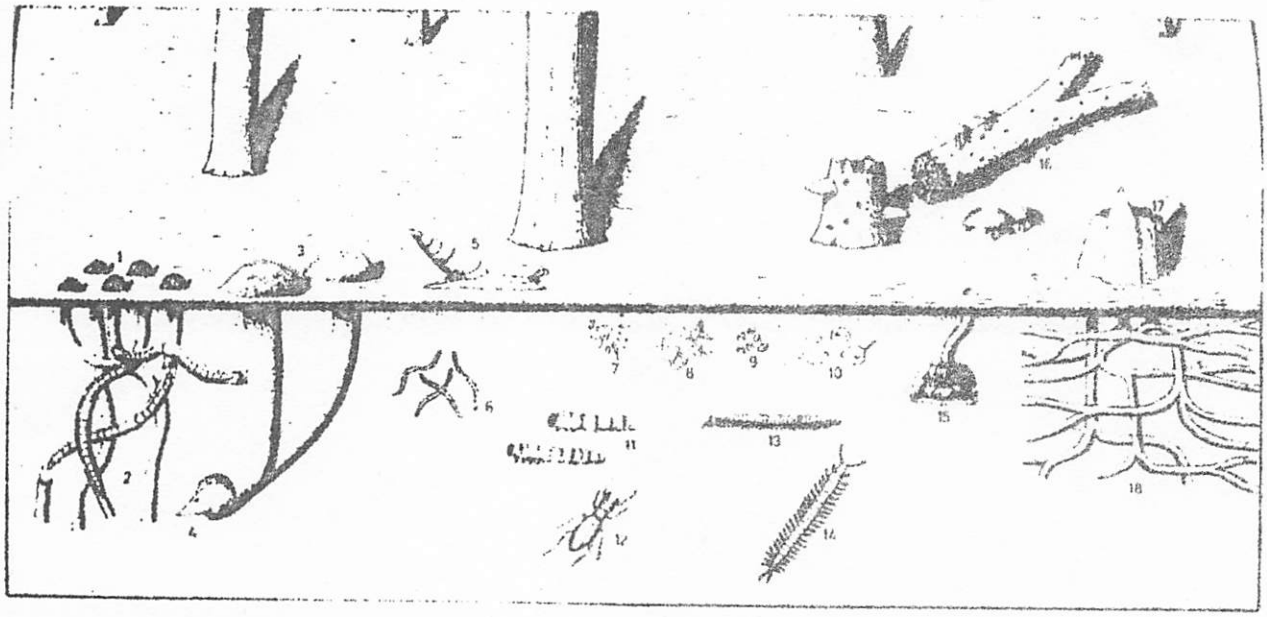
SOIL TEXTURE.

16. The texture of soil can be felt by rubbing it between the fingers when it is damp. Soils may be smooth, or rough and gritty. The texture depends upon the proportions of sand, silt and clay in the soil. Soil is classified according to the size of the grains as follows :-

Gravel	more than 2 mm.
Course-sand	0.2 mm to 2 mm.
Fine-sand	0.02 mm to 0.2 mm.
Silt	0.002 mm to 0.02 mm.
Clay	less than to 0.002 mm.

It is the proportion of each of the grain sizes mentioned which gives the appropriate name to the soil, as follows :-

a. Clay Soil more than 35% clay

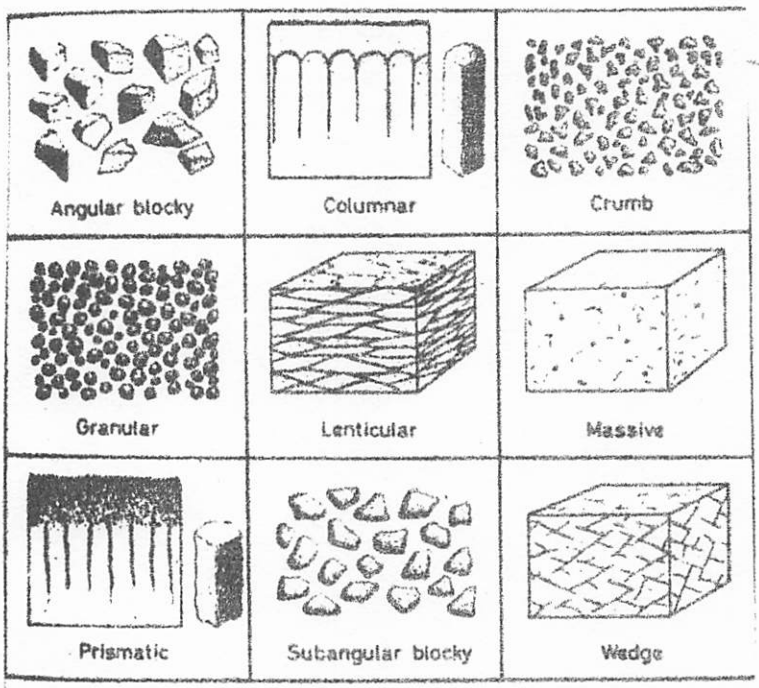


Some of the wide range of life in the soil

1. Earthworm casts
2. Earthworms and their passages
3. Mole hills
4. Moles and their burrows
5. Snail
6. Nematodes
7. Bacteria
8. Fungal mycelium and actinomycetes
9. Algae
10. Protozoa
11. Insect and other larvae
12. Beetles and other arthropods
13. Millipedes
14. Centipedes
15. Lizard's eggs
16. Dead tree trunk with termite passages and fungal growths
17. Termitarium
18. Termite passages

Figure 7. Contour strip cropping in U.S.A. One way of controlling the flow of water in agricultural land on slopes is to plant crops ins strips on the contour and to leave the area in between in pasture.

b.	Clay Loam	20 - 35% clay
c.	Loam	Mixture of grains
d.	Sand or Silt	According to the feel of the soil, but with less then 20% clay.



Some types of soil structure

SOIL STRUCTURE.

17. In addition to considering the texture, the structure of the soil is most important. Structure refers to the arrangement of soil particles. A well structured soil has particles grouped together into blocks of various sizes, that is groups of soil particles which cling to each other to make larger soil units. Such larger units are not easily blown by wind or moved by water and they also allow better penetration of rain into the soil. It is obvious that small particles which are not grouped will clog the surface pores of the soil to form a hard crust, whereas a well-structured soil has large air pores between the blocks of soil & this allows water to enter more easily.

5(a)

SOIL EROSION PREVENTION BY TERRACES.

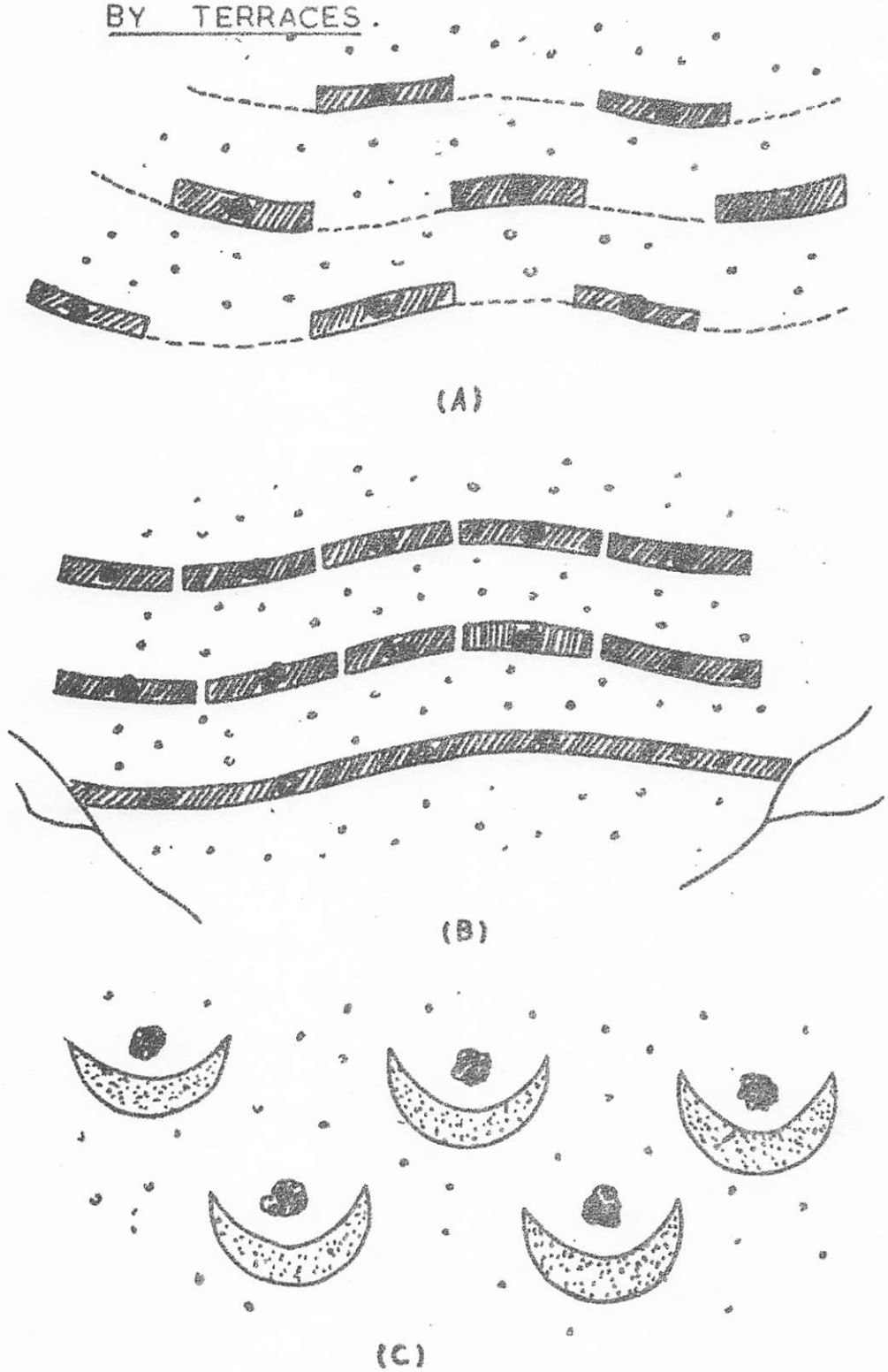


Figure 24: (A) Short terraces of 3 - 6 m long; (B) Longer terraces need a waterway or cross-berms across the terraces to separate them; note that very long terraces would need waterways; (D) In deep but gullied soils crescent-shaped terraces are useful.

18. A cause of a good structure is the amount of clay in a soil. Clay particles are rather like glue & they have the quality of binding other particles together. Clay also absorbs water and can hold nutrients in the soil. As a mix with sands, etc. it is valuable 1/. Another valuable constituent of soil which helps to make good structure is decompsed organic matter such as old leaves, grasses, crop resiues and animal manure. The regular movement of animal night fencing is a most efficient way of improving soil, and particularly so if plant debris has been added as bedding. Reclamation of sheet erosion around watering points can be achieved by this method.

PRESERVATION OF SOIL STRUCTURE.

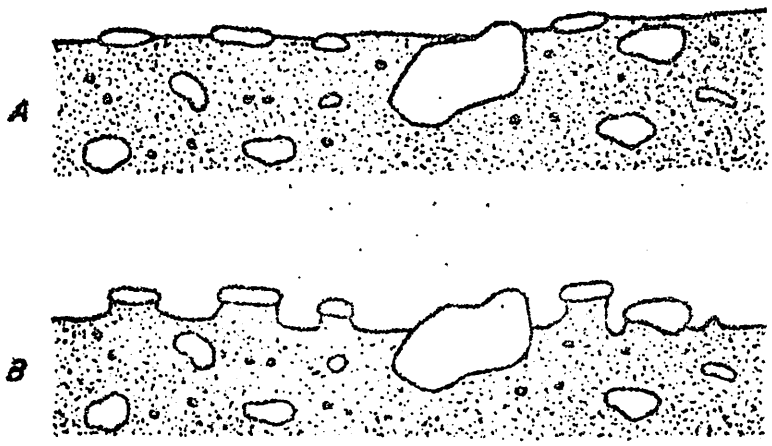
19. The structure of soil is important, and therefore the structure needs to be preserved. Structure can be destroyed by ploughing soil when it is too wet, or by trampling on it (This means by allowing livestock to trample on it). When it dries it will set hard and will not reform its structure. Structure can also be lost by allowing the organic matter to fall below the minimum needed. Since most of the organic matter is held in the topsoil, the erosion of the topsoil is a major cause of soil degradation.

20. In a report published in the East African Journal of Agriculture (October 1950). Dr. P.E.Glover says about part of Somalia "On the plateau, soil erosion due to overstocking and tree destruction has become a very serious menace. One of the most striking features of the ghastly "forests" of dead trees to be found in many parts of the country is the fact that in almost every instance the roots of the dead trees stand out well above the level of the present soil surface. Often the soil has been eroded down to rock level.

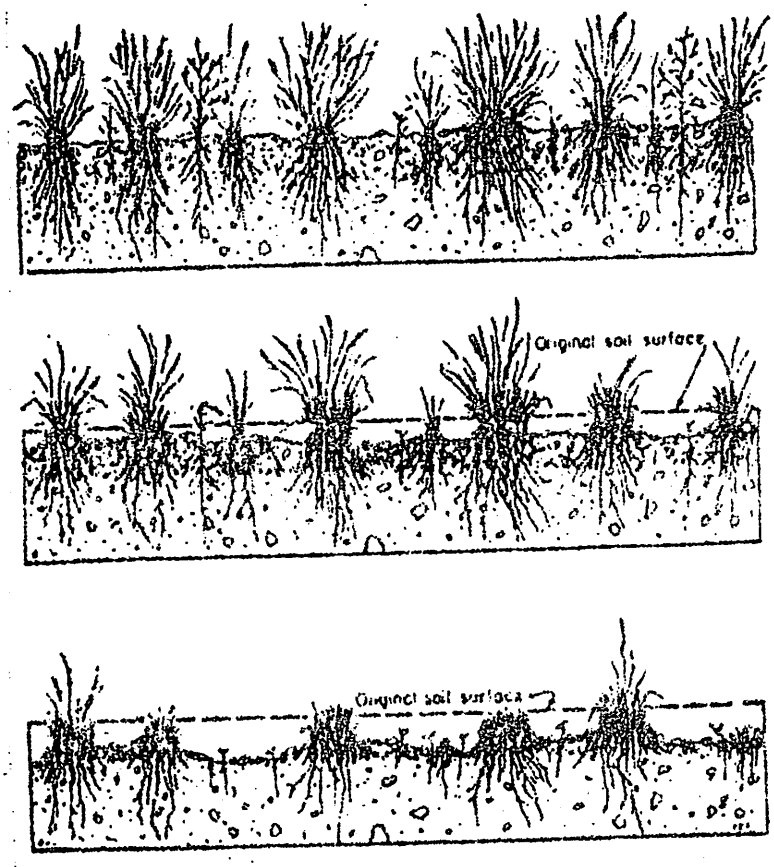
21. As is known, the topsoil in many parts has been taken away by the combined action of trampling, wind and water. A further report on soil erosion and water supplies in Uganda states. "The topsoil contains most of the organic colloidal material (that is the material which holds the organic content) with which is associated all the biological activities and the granular structure of a fertile soil. On the removal of the natural vegetation or on any degree of slope the fine soil fractions are dissociated from the crumbs by pounding of the rain, some to be carried into the soil mass and block the capillaries to form an impacted layer, the remainder to set off down the slope. Structure is gradually destroyed and the soil is left to the mercy of wind and water.

1/. (But see later remarks about clay soils in semi-desert conditions, para. 31).

5(a)



IN PLACES WHERE THE SOIL ACCUMULATES ALONE THE RAIN STREAMING WASHES OUT CARRYING THE TOPSOIL AND LEAVING OUT THE STONES. IN SUCH PLACES A SMALL ISLAND IS FORMED. (SEE FIGURE "B" ABOVE).



WHEN THE ROCKS AND PLANTS ARE LEFT ALONE (SEE THE FIGURE ABOVE) AND THE RAIN COMES PLANTS BECOME WEAK BECAUSE OF THE SOIL WHICH IS BEING WASHED OUT. THE ROOTS CAME OUT ON THE SURFACE AND PLANTS BECOME LIABLE TO DEATH. A SMALL ISLAND IS ALSO FORMED.

22. The above explanation indicates why roots are found exposed for 2 - 3 feet (600 - 90cm) above the present soil level in flatter areas also, where gully erosion is not always seen.

SOIL WATER NEEDS.

23. The microscopic soil organisms, as with all living organisms, need to be supplied with water. The roots of pasture plants in the soil also need a constant water supply. This need for soil water is related to the following :-

a. Photosynthesis in the leaves of plants etc. because water is, together with carbon dioxide, necessary for this process.

b. To provide a movement of water through the plant which is evaporated from the leaves. This evaporation cools the leaves.

c. To carry nutrients from the soil up to the plant tissues. Nutrients can only be taken into the plants when they are in solution with water. Most plants use over 200 kgm of water to make 1 kgm of dry plant material.

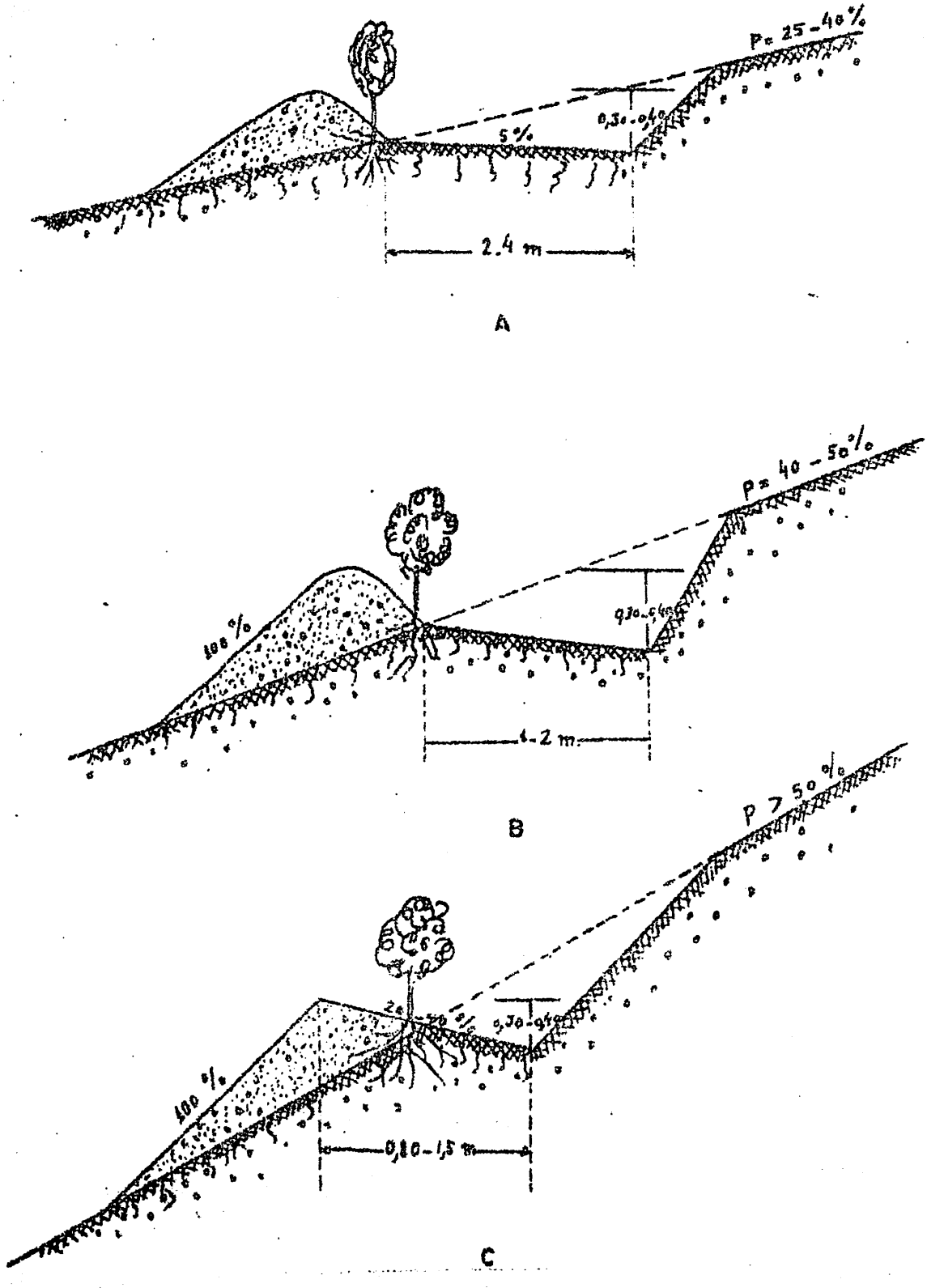
24. When soil-water is low, shallow rooted plants (e.g. millet), may die off completely. Other crops such as maize will drop leaves and fail to develop. Even drought-resistant species will stop growing and become stunted. When rain falls, they do not always recover if they have been hard grazed. Measures to hold water in the soil are therefore an important part of soil care in rangelands.

SOIL WATER TYPES.

25. There are four types of water in soil, these are :-

a. Chemically bound water. This is water which forms part of molecules in the soil and is part of those molecules, firmly integrated. (e.g. Iron oxide $2Fe_2 O_3 3H_2o$). This information is given for interest and accuracy, but it is not important in practical rangeland terms. This water cannot be removed by drying the soil and it is not available to the roots of plants.

7(a)



THE DIAGRAMS ILLUSTRATE DIFFERENT WATER CONSERVATION METHODS.

b. Hygroscopic water. This is the 10 - 25% of water which still remains in a soil after being air-dried. It is held by the soil particles, mainly clay, and it is also not available to the roots of plants.

c. Capillary water. This is water which exists mainly in the corners where soil particles touch one another. It is this soil water which is used by plant roots.

d. Gravitational water. After heavy rain some water will remain in the soil for a short time before draining downwards to join the water table or underground water-flow. Plants can use this water, but most plants do not survive in waterlogged soil. The drainage downwards of surplus water is therefore necessary for most plant life.

SOIL WATER MEASUREMENT.

16. The maximum capacity of a soil would be the total amount of pore spaces which can be filled up with water. However, much of this water would rapidly drain away before the plant roots could use it, so a better measure of soil water is the amount still in the soil two days after heavy rain. At this time all the gravitational water will have drianed away and the amount remaining tells us how much water a soil can hold. This is the field capacity of the soil. Sandy soils have low field capacities and clay soils have high field capacities.

17. The amount of water still left in the soil once plants start to die because of shortage of water is called the wilting point. A good soil should have a high field capacity and a low wilting point in order that it can store large supplies of water for plant growth.

SOIL WATER MANAGEMENT.

18 The aim in rangelands must be to conserve water in the soil so that vegetation production is increased. The basis of this aim must be to increase the entry of water into soils and to hold the water in the soil once it is there.

29. The entry rate of water to the soil is high if there is a good soil structure with a high percentage of large pores in the soil surface. This can be helped by rough cultivated furrows on the contour or by the construction of bunds and terraces on slopes. The fact that rain falls does not mean that it penetrates. Hunt (1945) has stated "in the apparently porous red soils of the Haud, over which water had trickled after heavy thunderstorms on a nearly level surface for 24 hours, the water penetrated only 9 inches (22 cms)". Entry rate of water is reduced if :-

a. The force of the raindrops breaks the surface soil structure.

b. The pores in the soil surface are sealed by pockets of air. Very dry soils are often hard to wet.

c. The soil swells when it becomes wet. This swelling may cause the surface to become sealed over by a layer of wet soil (probably by a thin layer of clay).

30. Water leaves the soil in several ways. The main water loss is through the roots of plants (a productive process). It also evaporates from the soil surface, and this may be increased where the soil is cracked deeply, as in clay soils.

WATER SUPPLY & SOIL TEXTURE.

31. In para 18, a reference was made to soil texture in semi-desert areas. At this point in the pamphlet it is suitable to quote from an article in the Geographical Journal N. 123 1957 P. 465., by J. Greenwood. He says :-

"Of the factors affecting vegetation growth, that of water supply is of paramount importance in the semi-desert conditions over much of Somalia. The amount and distribution of rainfall in relation to perennial plant growth must be evaluated with reference to soil type since the capacity to absorb moisture and to retain it against gravity and against evaporation, as also against the suction of plant roots, varies considerably with the soil. This is well shown in Dr. J. Smith's studies of the distribution of tree species in Sudan from which emerge several facts relevant to the present discussion. This study makes it clear that the minimum moisture requirement of a soil to support a given tree species is related to the clay content of the soil, and that throughout the Sudan a species requiring 3 times "X" inches of rain on clay soils, requires less than 2 times "X" inches of rain on sands.

The statement is made that clay soils in 500 mm of rainfall in the east, carry species which need only 300 mm in the sandy west (of the Sudan). The clay content of the western red sands varies between 5 and 2 percent; in the east, soils with 50 percent clay are common. According to Smith, Acacia mellifera, Benth, a species known to occur in vegetation arcs in Somalia, grew on 20 percent clay soils in rainfall of 250 mm (10 inches), and on 40 percent clay soils in 400 mm of rain (16 inches). In the Sudan, superior vegetation which likes moderate water supply is carried on inselbergs 1/ rather than on the clay plains in which they occur, despite a very high gravitational loss on the higher ground. It is also relevant to note that a given species of tree survives in least rainfall on coarse sands, hillsides, and gritty runnels". The poorer standing of clay soils with respect to their capacity to provide moisture for plant growth is considered to be mainly iue to soil/air evaporation, especially in the case of bare cracked clays. The soil/air surface in such soils is much greater than that in sands or sandy soils.

32. It will therefore be seen that despite the value of clay as a binding agent in soils and as a better storage-medium for water than is sand (para 18), nevertheless in semi-arid, semi-desert areas the most important factor is water percolation into the soil and this is better in sandy soils or grit rather than in clay soils or in soils which have a clay surface layer.

SOIL AIR.

33. The air in soils is contained in the pore-spaces between the soil particles. The total pore space in soils varies from 25% in sands to 50% in clays, but not all this pore space is air. As the water in a soil increase, the soil air decreases and vice-versa.

34. Like the air of the atmosphere, soil air contains about 79% nitrogen gas but it usually has less oxygen and much more carbon dioxide than the atmosphere. The high percentage of carbon dioxide in the soil is caused by the millions of soil organisms which give out this gas as a waste product. The organisms multiply fastest during the rainy season and consequently the carbon dioxide content of the soil is highest at this time.

1/ inselbergs = A steep-sided rise above a plain, often found in the semi-arid regions of tropical countries.

35. Soil bacteria and soil fungi have the job of breaking down organic matter and releasing from it nutrients in the soil. When the carbon dioxide content of a soil is high, this is a sign that the life in the soil is actively growing and working, and the release of nutrients accompanies high carbon dioxide production.

36. Both the soil organisms and the roots of plants need good supplies of oxygen for growth. Normally the oxygen supply in the soil is replenished by transfer into the soil of air from the atmosphere. However in poorly structured soils the oxygen cannot easily enter the soil and carbon dioxide increases. If the oxygen in soil air falls below 10% and the carbon dioxide rises above 10%, then the soil function is reduced and plant growth can be reduced also.

37. In small fields or farms the oxygen can be increased in the soil by cultivation. The new oxygen introduced into the soil by cultivation will stimulate soil organisms to active growth. They begin to attack organic matter and to produce plant nutrients, and this is the time to plant crop or pasture plants.

SOIL COLOUR.

38. The colour of a soil is due mainly to the humus, that is decomposed organic matter, together with the iron compounds contained in the soil. Humus usually darkens the colour of a soil in the surface layer where the humus collects. However, light rainfall areas are mostly lacking in humus and the soils are not dark with humus.

39. The colour of the iron compounds in a soil depends on the amount of air and water available. In poorly drained wet soils the oxygen content is low in the soil air, and the iron forms compounds which are grey in colour. In fairly dry soils the iron compounds are oxydised and are red in colour. In wet soils which are well drained the iron compounds are yellow. Soil colour can be important because it affects the temperature of a soil.

SOIL TEMPERATURE.

40. The temperature of a soil has important effects on the growth of plants. It also determines the rate of plant growth and the ripening time of fruits and seeds.

The growth of the valuable soil bacteria is also controlled by temperature. Soils can be too cold for optimum production, for example, wheat seed well germinate in 3 days at 10 C, whereas it takes 6 days at 5 C. They can also be too hot. Dr. Glover in 1950 wrote "Because of the greater solubility of phosphoric acid, etc. in overheated, rapidly dried soils, it follows that as devastation progresses, and increasing amount of soil is being impoverished by leaching" (that is the taking away of soil chemicals dissolved in water).

41. Russell (1932) also says. "When a soil is dried out and warmed at the same time, changes occur which cannot yet be satisfactorily explained, nor is the relative importance of drying yet known.

1. The solubility of the phosphoric acid, inorganic electrolytes and organic matter is increased both on drying the soil at indoor temperature and on heating a damp soil.

2. The nitrate content tends to decrease on drying or heating. The magnitude of these effects depends on the soil types".

42. Glover continues. "In a country like Somalia where the soil is being denuded of plants at an appalling rate, it means that new expanses of soil which were formerly protected by plants are being continually exposed to overheating and rapid dessication in the process of destruction by man and his stock. Therefore the significance of the chemical changes as outlined by Russel cannot be over-emphasized in denuded arid areas.

43. Soil temperatures on bare land in Somalia have been measured as up to 65 C (150 F) by Glover, just below the surface, and as 30 C (84 F) 30 cms (12 inches) below the surface. Shallow rooted plants and trees are obviously at great risk in these bare areas. In the higher zones, Acacia Bussei is greatly reduced due to trampling of livestock over their shallow, long roots (Glover).

44. Small amounts of heat are produced in soil by the action of bacteria in decomposing organic matter.

45. Soils lose heat when water evaporates from the ground surface. For this reason wet soils are cooler soils. The moisture content of a soil is a large factor in control of soil temperature. It takes more heat to raise the temperature of water by 1 degree than it. Sands which hold less water than clay tend to be warmer or hotter soils.

46. Soil temperature is affected by colour. Dark soil (black or red) absorb more heat from the sun than light yellow soils.

47. The best protection aganist overheating the soil is to encourage a good vegetation cover by all possible means.

SOIL ORGANISMS.

48. The soil is an environment in which water, air and food materials are a part. Many living organisms take advantage of these conditions and live permanently or temporarily in the soil. The animals in the soil are large enough to be seen. These are ants, beetles, earthworms, snails (in wet soil) and centipedes etc. The larger soil fungi may sometimes be seen as masses of fine white threads in the soil.

49. The most important forms of soil life are microscopic, i.e. too small to be seen by eye. These include the fungi and bacteria.

50. Soil life has two main purposes. Some soil organisms are the only forms of life on this earth which can make use of the gas nitrogen. Without them on other life could exist, because all living cells must have proteins which contain nitrogen atoms.

51. Many soil organisms break down or decompose the bodies of other organisms which have become mixed with the soil. Without this activity no dead leaves or stems or fruits, and no dead bodies of insects, mice, sheep etc. would decompose into the soil and eventually all the nitrogen would be locked up in this dead material. The soil decomposers convert the bodies of plants and animals into simple substances which can be used again by plants and animals.

52. Another advantage of these soil organisms is that they have a sticky coating over their cells. These sticky substances help to hold the soil particles together and so make good soil structure.

SOIL ORGANIC MATTER.

53. Organic matter is the dead plant and animal materials in the soil which are in the process of being broken down. The amount of organic matter in soils can vary greatly. Average soils can contain 3% of organic matter, but sandy soils may have 1% or less. Dry, hard soils prevent the entry of much organic matter which is therefore washed to smaller collecting points by rain. This action helps to create the "vegetation arcs" or separated strips of vegetation which have been noted in parts of Somalia, where silt and organic matter are washed into slight depressions, or to level parts of a slope.

54. Most organic matter in the soil comes from decaying plant material, especially roots, leaves and stems. Where vegetation is dense then there is more potential for improvement to the soil. Forest soil is particularly noted for its quality.

55. Organic matter may be at any stage of decomposition. Some of it will consist of plant parts which are freshly settled in the soil. Leaves may still have their original shape and thickness, but within a short time the substances holding the cells together are attacked and decomposed. Soon most of the cell contents are broken down and eventually the whole crumbles into small particles of dark soil humus. The great number of bacterial and fungal cells also die off and become converted into soil humus.

56. During decomposition, nutrients are released from the organic matter. Many of these nutrients will be used by the active soil organisms, but some will be taken in to the roots of plants.

ADVANTAGES OF ORGANIC MATTER.

57. The main value is the supply of nutrients for the use of crop and pasture plants, but in addition, because it is able to cement soil particles together to make a better structure it has the effect of opening up some silt or clay soils and therefore allowing better water percolation.

It also absorbs water itself and thereby increase the water holding capacity overall. At the same time organic matter is able to hold nutrients from the soil and so prevent them from being washed out of the soil by heavy rain.

58. For good land management it is necessary to add organic matter to the soil in places where cultivation of food or animal fodder crops is being done. Organic matter additions are usually animal manure ploughed in or made into compost by rotting down with vegetaion which has been used as bedding. Moveable night bomas are one way of spreading organic matter in areas to be cultivated and this method can be usefull in improving areas around watering points as we have previously said. Where grasses are planted it is desirable to add legumes to the mix because these are more beneficial to the soil.

59. In large rangeland areas the only practicable way of maintaining the supply of organic matter in the soil is by rotational resting of large areas to allow vegetation regeneration, and careful use afterwards to stabilize the soil and prevent unnecessary erosion by wind and water.

60. Essential nutrients in the soil, for good plant growth are nitrogens, phosphorous, potassium, sulphur, and trace elements (i.e small amounts) of boron, copper, zinc, cobalt etc. In farmed areas with good rainfall it is often of advantage to add these nutrients in the form of fertilizers which have been manufactured in industrial factories. However, in the rangelands the use of fertilizers can not be economic except perhaps to assist the establishment of new pasture, in strips, for seed production.

FOOTNOTE :-

From the World Bank Staff newssheet of May 1980 the following is quoted "As fuelwood supplies become exhausted, people are compelled to burn manure and agricultural residues". It is estimated that the amount of manure now being burned (in the World) would have been enough to supply organic matter to have produced 20 million tons of foodgrain annually.