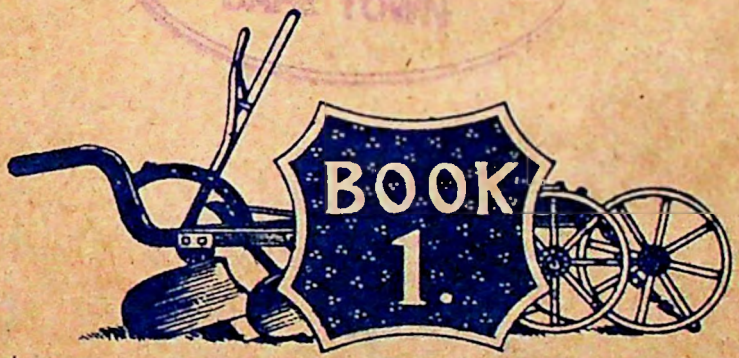
FARMING
FOR
SOUTH AFRICAN SCHOOLS



EDITED BY
REV. W. G. DOWSLEY
B.A., R.U.I.

Farming,
for South African Schools.

EDITED,

UNDER THE AUSPICES OF THE

DEPARTMENT OF AGRICULTURE, UNION OF SOUTH AFRICA.

by

The Rev. W. G. DOWSLEY, B.A., R.U.I.,

Author of "Ostrich Foods and Feeding".
"Farm Accounts", "South African Farmers' Bookkeeping", etc.

Master-in-Charge, Modern Side, S. Andrew's College, Grahamstown.

ILLUSTRATIONS BY E. BEVERLEY CLARENCE
AND V. A. GARNETT.

BOOK. I.

Printed and Published by: DE NATIONALE PERS, BEPERKT.
30 Keerom Street, CAPE TOWN,
BLOEMFONTEIN and PIETERMARITZBURG.
1920

HIGH VELD, GRASSLAND.

The Veld in Winter.
Phot. I. B. Pole Evans.

The Veld in Summer.
Phot. I. B. Pole Evans.

PART I.

Introduction to Agriculture.

THE SOIL.
TILLAGE AND IMPLEMENTS.
ADDITIONS TO THE SOIL.

By the Editor, assisted by H. J. du Toit, Dry Land Agronomist, and A. Stead, B.Sc., School of Agriculture, Grootfontein.

FRUIT TREES.

By R. A. Davis, Chief, Division of Horticulture.

PRUNING.

By H. B Terry, F.R.H.S., School of Agriculture, Potchefstroom.

FOREST TREES.

By H. B Terry, F.R.H.S., School of Agriculture, Potchefstroom.

VEGETABLES.

By the Editor, assisted by J. J. Kotzé, B.A., B.Sc., of the Department of Forestry.

The Contents of the other Books of this Series will be as follows:

BOOK II.

THE LIFE OF FARM PLANTS. By the Editor, assisted by A. O. D. Mogg, B.A., Botanist attached to the Division of Veterinary Research, and Others.

INSECTS. By C. P. Lounsbury, M.Sc., Chief, Division of Entomology.

BEEKEEPING. By H. B. Terry, F.R.H.S., School of Agriculture, Potchefstroom.

INTESTINAL PARASITES. Compiled by John Hewitt, B.A., Director of the Albany Museum.

BOOK III.

ANIMAL HUSBANDRY.
HORSES.
ASSES AND MULES.
CATTLE.
} By P. J. v. d. H. Schreuder, B.A., Ph.D., Vice-Principal and Lecturer in Animal Husbandry, School of Agriculture, Potchefstroom.

THE DAIRY. Compilation approved by the Division of Dairying.

SHEEP AND WOOL. Compilation approved by the Division of Sheep and Goats.

GOATS AND MOHAIR. Compilation approved by the Division of Sheep and Goats.

PIGS. By P. J. v. d. H. Schreuder, B.A., Ph.D.

OSTRICHES. By Professor J. E. Duerden, M.Sc., Ph.D., Rhodes University College, Officer in charge, Ostrich Investigations, Grootfontein School of Agriculture.

POULTRY. By R. Bourlay, Poultry Instructor, School of Agriculture, Potchefstroom.

DUCKS, GEESE AND TURKEYS. By T. B. Cross, Poultry Instructor, School of Agriculture, Cedara.

DISEASES OF STOCK. By H. H. Curson, M.R.C.V.S., and J. A. Quinlan, M.R.C.V.S., both of the Department of Agriculture.

PREFACE.

The aim of this work is to set out, in words so simple that he who runs may read, the plain facts that help the man on the farm to make the best of his land and to do his duty by his crops and his stock. The writing of it has been a three years' work and though little may seem to have been done by me, I have been able to do as much as I have done only by the help and the patience of those experts on South African farming whose names appear in the List of Contents. All who will find this series useful owe thanks to them.

A work such as this must be simple and entirely trustworthy. The Union Department of Agriculture has supplied me with the facts. My task has been to put them into words that while plain are none the less exact, and then in every instance to send them back again to the experts to be verified. Certain contributions have been backward and forward between experts and editor many times. As far as I am aware this is the most comprehensive work with weight of expert knowledge behind every word of it that has ever been issued under the auspices of any Department of Agriculture. It is simple enough to be put into the hands of the average boy in the upper standards of the Primary School, and yet has system and substance enough to suit advanced students who are referred, when necessary, to publications containing exhaustive treatment of the subject under consideration. Special care has been taken to lay stress upon and to illustrate fully a few principles which, when understood and practised, have power to revolutionise South African Agriculture and bring about the permanent prosperity of the farmer and the State.

Agriculture is a most teachable subject, and as presented in this work will present no difficulty to teachers unfamiliar with farming practice. The author has borne in mind that experiments must be limited to the resources of small farm schools. If school work be combined with observation exercises on the farm, the children will show intense interest in learning the reasons for farming operations and in the explanations of the phenomena which accompany them. The

study of the things which have to do with the life and surroundings of the child stimulates the mind to activity in a way that no other study is found to do. So are readily learned the truths which open the doors of Nature, through which is the only escape from ignorance of the things that matter and from the hopeless drudgery that has too often driven the farm lad from the country to the town.

I desire to thank especially the Secretary for Agriculture, Mr. F. B. Smith, who instructed the experts of the Department to aid in the compilation; to Mr. Alex. Holm, Under Secretary for Agricultural Education, and to Mr. E. J. McMillan, Principal of the School of Agriculture, Potchefstroom, who allocated the subjects to the several experts; to Mr. P. J. du Toit, Under Secretary for Agriculture, who was one of the first to interest himself warmly in the project. I am also grateful for the encouragement extended to it by Mr. J. E. Adamson, Director of Education, Transvaal, and by Dr. W. J. Viljoen, when Director of Education for the Orange Free State.

Space does not permit me to thank all who have helped me in addition to those mentioned in the List of Contents and on the Title Page, but it gives me great pleasure to acknowledge the aid given by the following: Brigadier-General B. Enslin, and Major Currie, Chief and Acting Chief, respectively, of the Division of Sheep and Goats, and other experts of the same Division; Mr. C. E. Gray, M.R.C.V.S., Chief of the Division of Veterinary Research, and Mr. J. D. Borthwick, M.R.C.V.S., Assistant Chief of the same Division; Dr. Pole Evans, Chief of the Division of Botany, and Dr. Doidge of the same Division; Mr. C. P. Lounsbury, M.Sc., Chief of the Division of Entomology, Mr. J. C. Faure, and Mr. C. K. Brain of the same Division; Mr. C. E. Legat, Chief of the Department of Forestry; Professor E. Anderson, Ph.D., of the Transvaal University College; Mr. A. W. B. Murray, and Staff of the Government Printing Works; Mr. E. D. Challis, Superintendent of the Division of Dairying; Mr. R. C. Holmes, Kendrew; Miss K. Jefferies Davis, B.Sc., Dr. S. Schonland and Miss L. Britten, B.A., Professor of Botany and Lecturer in Botany, respectively, of Rhodes University College; Professor Schwarz of the same College; Colonel du Toit, and Mr. H. C. Gore, Lecturer in Animal Husbandry, Grootfontein School of Agriculture, and the late Mr. W. Robertson, M.R.C.V.S.

I am also much indebted to Mr. P. J. S. Ribbink, Librarian, Union Buildings, and his Staff.

I also have pleasure in acknowledging the use of blocks and illustrations kindly supplied by the following firms:— Messrs. Ransomes, Sims and Jefferies, Ltd., Messrs. G. North and Son, Messrs. William Cooper and Nephews, Messrs. Mangold Brothers, and Messrs. Spratts Patents, Ltd.

Besides the many publications of the Agricultural and Forestry Departments, the following works have been freely consulted in the compilation:—

Man and His Work, by Herbertson.
Soil and Plant Life, by Cunningham and Lancelot.
Stephens' Book of the Farm.
School Agriculture, by Milo N. Wood.
The Living Plant, by Knight and Staples.
Elements of Agriculture, Southern and Western States.
Agriculture for Young Folks, by Wilson.
Agriculture through the Laboratory and School Garden, by Jackson and Dougherty.
Rural School Agriculture, by C. W. Davis.
Botany for Beginners, by Bailey.
Agriculture for Southern Schools, by Duggar.
First Principles of Agriculture, by Goff and Mayne.
Tillage and Implements, by Malden.
The Young Farmer, by T. F. Hunt.
Experiments with Plants, by Osterhout.
Agriculture for Beginners, by Burkett, Stevens and Hill.
First Studies of Plant Life, by Atkinson and Wood.
Elementary Exercises in Agriculture.
Bulletins of the Department of Agriculture of United States of America.
The Pastoral Review.
Insect Pests of Farm, Garden and Orchard, by Sanderson.
Judging Live Stock, by Craig.
Elementary Botany for South Africa, by Edmonds and Marloth.
Romance of Plant Life, by Elliot, and many others.

CONTENTS.

THE SOIL.

TILLAGE AND IMPLEMENTS.

ADDITIONS TO THE SOIL.

FRUIT TREES.

FOREST TREES.

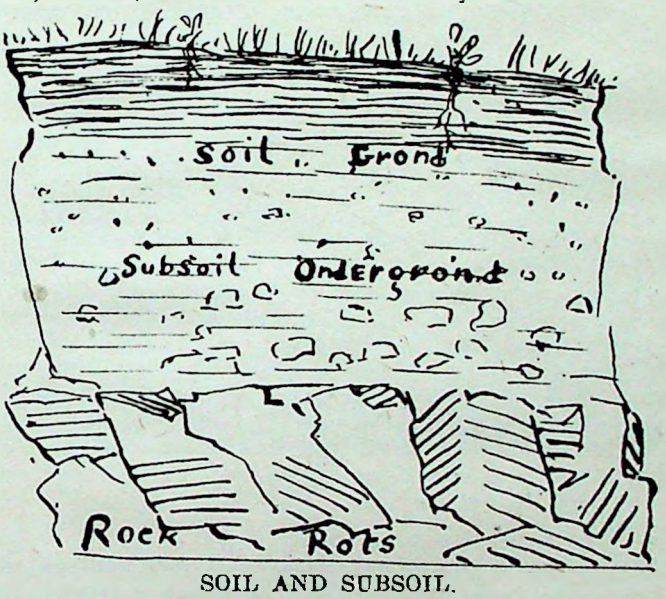
VEGETABLES.

Farming for South African Schools.

THE SOIL.

ITS ORIGIN.

1. The face of the earth was once upon a time solid rock. For long, long ages it lay exposed to all weathers. The rain dropping upon it over and over again wore away the stone and crept into the holes it made. The burning sun beat upon it, making it so hot that one could hardly bear to touch it. Then followed the sudden cooling wind (or rain) which, much in the same way as a cold draught



SOIL AND SUBSOIL.

cracks the heated lampglass, caused the rock to break. The rain that crept into the rock, swelling as it changed into ice, continued the work of bursting it apart. The wind beat upon it, the air ate into it as rust eats into iron; as the sharp edges of bricks at the corners of a new house in the course of time become rounded through 'weathering,' so the earth's crust of rock has been 'weathering' from its beginning, and its tiny fragments are to-day known to us as Soil.

2. How shall we begin to learn about Soil? The best way is to dig a hole some feet deep or, if a railway cutting or a deep donga be near, to pay a visit to it. We shall find that Soil is made up of several layers. The top layer, which we know as the surface soil, often changes all at once at a depth of anything from an inch to a few feet to ground of much lighter colour; this is known as SUBSOIL, or under-soil. So sharp is sometimes the change in colour that it is quite easy to tell where the surface soil ends and the subsoil begins. Below this (but often at a great depth) we find gravel and large stones. Then comes rock. Does it not seem, then, as if there may be many steps in the formation of soil? First, the rock broken up into stones; then, these stones split up into gravel; then, this gravel worn away into smaller grains and slowly coming to form what we now call Soil.

3. The change of rocks into clay and sand is not the only change they undergo. Not only are the rocks broken down into 'rock-powder' but the very nature of this 'rock-powder' is changed. Soil is more than just 'rock-powder'. It is 'rock-powder' acted upon by the atmosphere. In the rock are certain minerals which will not dissolve ('melt') in water. The atmosphere so works upon these as to change them into simpler things which water is able to dissolve. Plants cannot grow in 'rock-powder' until it has been so acted upon, and changed into these simpler things, for it is only upon them that plants can feed.

Tillage opens up the 'rock-powder' so that the atmosphere can act upon it, and so hastens the making of plant foods.

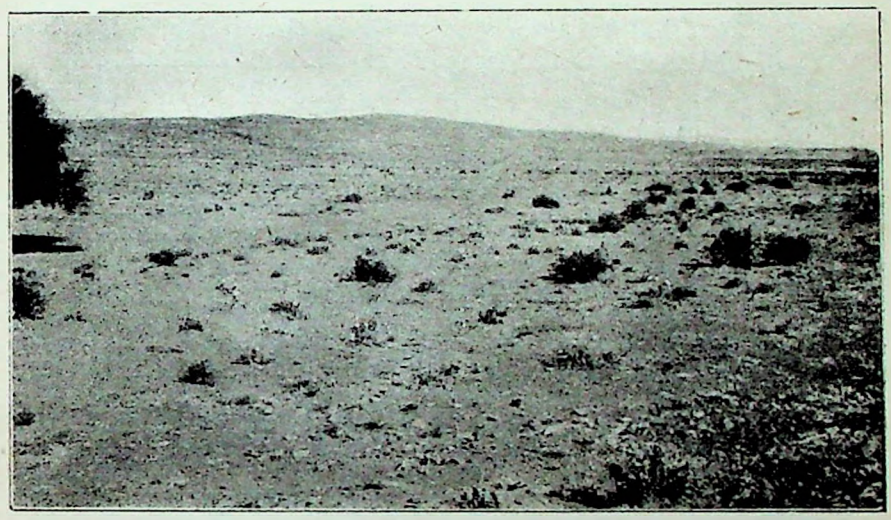
Some soils are more fertile than others owing to the different rocks from which they were broken down, and owing to differences in "weathering."

Soil washed from where it was formed, and left behind later by water flowing over land at a lower level, is called ALLUVIAL soil.

THE SUBSOIL.

4. Our time is mainly to be spent in learning something about the surface soil, for it is in this that plants get their start in life, but, before going on to think about it, we must look carefully at the Subsoil beneath. Notice that the Subsoil, besides being usually of a lighter colour, is generally much more tightly packed together and harder to dig.

If we can manage to dig up a little we may see what will happen if we place some of it in a tin, while in another tin we put some soil taken from the surface. If in these two tins we now sow seeds of some quickly growing plant such as rape or mustard and treat both tins exactly alike, giving them plenty of water, we shall find that the plants grown in soil taken from the surface make better progress than those grown in the Subsoil. A glance at the railway cutting teaches the same lesson. In the upper, darker layer of soil, grass and plants are growing in large numbers; the lower, lighter-coloured layer of Subsoil has few plants or none.



BUSHVELD. *Phot. I. B. Pole Evans.*

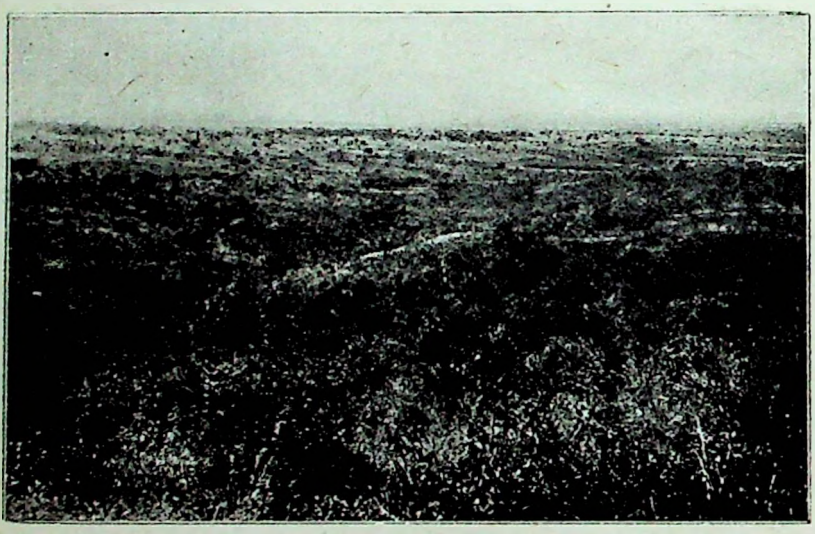
Why is this? It is because in the Subsoil there are often certain things which poison plants; these poisons are driven away by opening up the Subsoil to light and air. Even then they usually do not leave it all at once. Until it has been for a long time lying bare to the sun and the air it cannot grow plants. For this reason the farmer, while glad to break up the Subsoil with his plough, is careful not to bring it up to the surface where the poisons in it may damage his crops. (*)

(*) In very dry (arid) parts of the country the conditions are different and the farmer can often bring up subsoil to the surface without harming the crops.

THE SURFACE SOIL.

5. Let us now try another experiment by which we may find out the different things of which Surface Soil is made up.

Take a handful of earth and rub it up well in water to form a paste. Place it in a fruit jar; fill the jar with water; fasten the cover; shake the jar well for some time, and then allow it to stand until the soil settles to the bottom. There will be found floating on the top of the water a little vegetable matter. Skim this off. Now look carefully at the soil. The coarse material on the bottom is SAND; above this is finer matter called SILT. If the water has been allowed to stand until it be clear there will be found above this a



ARID SOIL. *Phot. I. B. Pole Evans.*

layer of soft and greasy CLAY. Rubbed between the fingers and thumb and compared with the sand and silt it will be found to be made up of very fine particles. Leave all three to dry. The sand will then be found loose and open, however much we may have pressed it together, as any boy who has digged sand-castles knows very well; while, if the clay has been kneaded into shape, it will set hard on drying.

Look very carefully at the vegetable matter skimmed from the top of the jar. You will find in it scraps of dead roots, stems and leaves of plants. These rot down into what is known as HUMUS.

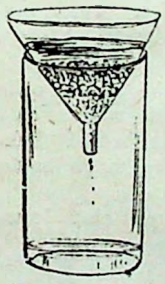
HUMUS.

6. Humus makes soil fertile. It is because it is found in the soil as far as the roots go down that the surface soil is daker in colour than the subsoil. The more Humus, the darker is the soil. It is forming from year to year wherever plants and grasses ripen and die. From it plants draw much of the food which they get out of the ground.

SAND AND CLAY.

7. Though neither Sand nor Clay is food for plants we have much to learn about them and the ways in which they differ.

In a funnel (if possible a glass one) place a plug of cotton wool or a little plate of tin in which holes have been drilled. Cover this over with a layer of Clay, pressing this well to the side. Now pour water into the funnel. The water passes through very slowly or not at all.



Now put some Sand into the funnel in place of the Clay. Pour in water. It will be found to pass through freely and in greater quantity. Less water will be stored up by the Sand than by the Clay. CLAY HINDERS THE PASSING OF AIR AND WATER, WHILE SAND DOES NOT.

8. Soil that is made up chiefly of Clay holds water tightly and is slow in drying. As it dries it cakes and may crack. Its grains are so closely packed together that air cannot enter easily; and, since seeds and roots need air, any seeds sown in wet Clay (if this Clay be kept so moist that it does not crack) will not sprout, while those sown in moist sand will do so.

9. Clay soil is often allowed to remain in grass because it is so difficult to work it. It is slippery in wet weather and dries very slowly; it sticks to the spade and resists the plough, and is said to be HEAVY. (*)

(*) See Sections 92 and 104.

10. Sandy soil is LIGHT or easy to work. It can be dug at any time. Unlike Clay it dries quickly, and when dry becomes powdery, not hard.(*) It needs watering often, as water drains through with ease. This is its chief fault, for, as the water drains aways, it carries away too, dissolved in it, many things which, if they stayed behind, could be used by plants for food. But so open is the Sand that it cannot hold them back. Where but little rain falls there is less chance of plant foods being carried away, so that sandy soils in the drier regions of South Africa are often found lacking in water only. Where there is plenty of moisture sandy soil, although it needs lots of manure, is a useful soil for men such as market gardeners who wish to grow special and early crops, as plants grown upon it ripen much earlier than upon Clay.

11. LOAM is the mixture of clay and sand. All soils are such mixtures. There are Sandy Loams and Clay Loams, so named according to the amount of clay contained in them. Sandy Loam is the best for general farming.

> "A great deal can be done in the way of making farming a success by growing crops which naturally fit the soil and climate of any given farm or district. Some farm crops like stiff, some like medium and some like light soils. Clay land suits wheat, oats, beans and cabbages best. Barley likes a loamy soil, while rye is the "corn" of light, sandy districts. Among "root" crops, mangolds thrive best in the stiffer soils, while a "turnip soil" is one of a loamy nature, and carrots thrive best in the lighter sandy variety. Potatoes do not thrive equally well in every soil, some soils suiting them much better than others." (†)
>
> Potatoes like a loamy soil. Oats do best on clay loam; mealies on sandy loam; lucerne does well on limy soil.
>
> Alluvial soil is very productive.

PLANT FOOD IN THE SOIL.

12. If one were to ask a hundred people where plants got their food at least ninety would reply that the greater part comes from the soil. Yet a little thought would show that this cannot be so. For how does it happen that the soil in which a forest of huge trees is growing never seems to get any less, or that a large plant can be grown in a small flowerpot without the soil being added to?

(*) But soils containing *much fine* sand often dry hard and crust.
(†) McConnell's "Complete Farmer" (adapted).

13. Where then do plants get most of their food if they do not get it from the ground? They can only get it from the air. We shall soon come to see more clearly that this is so. By far the greater part of the plant's food is drawn in from the air. Yet there are certain foods which plants can only get from the soil and without which they cannot grow.

14. If we dry a plant and burn it the greater part vanishes into the air, only a small quantity remaining behind as the 'ash.' Roughly speaking this 'ash' is all that came from the soil. The rest of the plant came from the air and from the water. But although the plant got so little of its food from the soil, yet there were some foods which it wanted and could only get from the ground.

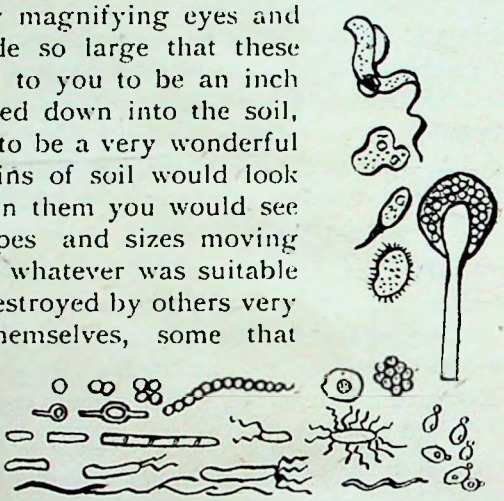
The soil is a great storehouse of this part of the plant's food. But, just as, in a great city warehouse, tea and sugar and cocoa are stored away in cases and have to be unpacked as they are needed, so by far the greater part of the store of various kinds of plant foods contained in the soil is 'locked up' too!

And is it not a good thing for us that it has been 'locked up'? Why, if it had not been, it might all have been used up long ago! But happily only a very little is made fit for use every year, and that little is generally enough for plants. They do not take in their food in chunks. Just as we make use of tea, sugar and cocoa dissolved in water, so they can only feed upon their food when it is dissolved in water and made ready for them. However rich a soil may be in their food substances only a very small part of all these is at any one time ready to be taken away. It has to be made ready before the plant can use it.

LIVING CREATURES IN THE SOIL.

15. But who is there to make this "locked up" food ready for the plants? There are plenty of workmen in the city warehouse to unpack our tea, sugar and cocoa. Are there any living things underneath the ground willing to help the plants in such a way? Indeed there are—millions of little helpers who work without wages!

16. The air, the rain, the earthworms and insects, the roots of the plants themselves—and plants are living things! —all help to get ready the foods stored up in the soil so that the plants can carry them away dissolved in water. But there are also tiny living creatures, far too small for our eyes to see, who will, if we make it possible for them, do this work for us without ceasing. We call them BACTERIA.

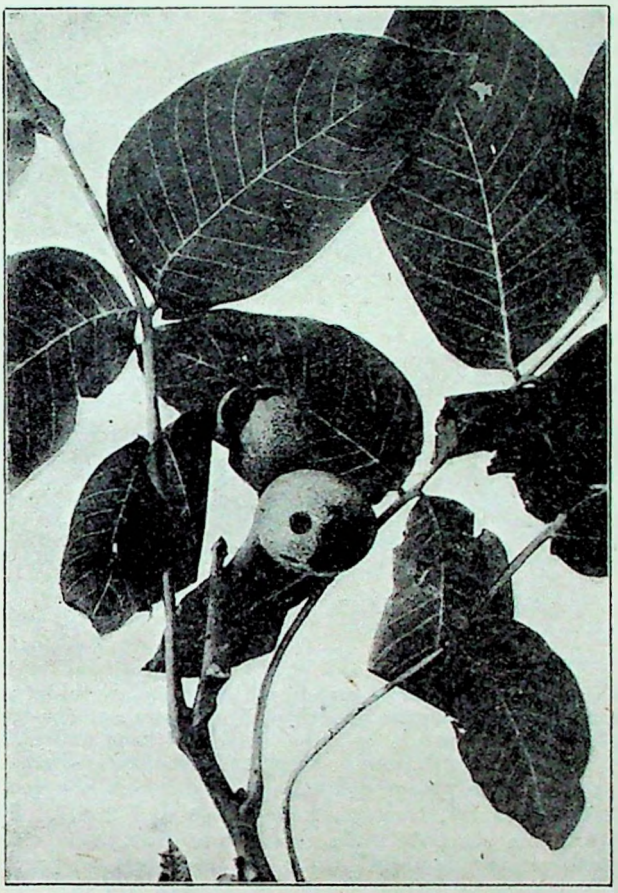


Bacteria, and other Micro-organisms.

"If you had very magnifying eyes and could see things made so large that these little creatures seemed to you to be an inch long, and if you looked down into the soil, it would seem to you to be a very wonderful place. The little grains of soil would look like great rocks and on them you would see creatures of all shapes and sizes moving about, and feeding on whatever was suitable to them, some being destroyed by others very much larger than themselves, some that look as though they were dead or asleep, yet waking up whenever it becomes warmer or when there is a little more moisture. You would see them change useless dead roots and leaves into very valuable plant food; indeed it is they that bring about the changes which make humus such good food for the plants. Now and then you would see a very strange sight indeed—a great snake-like creature, over three miles long and nearly half a mile round would rush along eating up everything before it and leave behind it a great tunnel down which a mighty river could suddenly pour, and what do you think it would be? What you now call an earthworm and know to be about four inches long going through the soil, leaving its burrow along which a drop of water trickles. This shows how tiny these little soil creatures are.

"These busy little creatures are called MICRO-ORGANISMS because of their size. They are not all useful. Some can turn milk bad, and therefore all jugs and dishes must be kept clean lest any of them should be present. Others can cause disease. It has happened that a child who has cut

his finger and has got some soil into the cut, and not washed it out at once, has been made very ill." (*) The bacteria



Bacteria, also, give diseases to fruit trees. The Walnuts in this picture have a disease known as Walnut Blight.

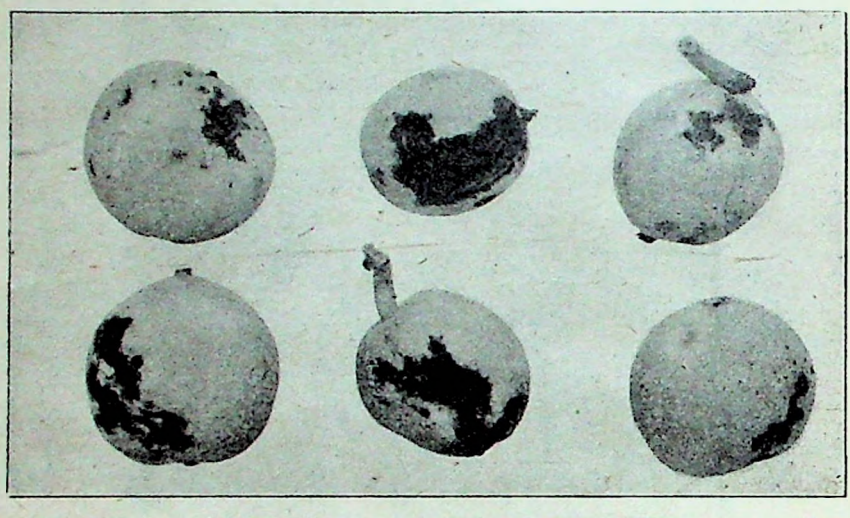
causing the dreadful disease lockjaw live in rich cultivated lands. Care should be taken of the slightest scratch.

THE USEFUL BACTERIA.

17. Let us think for the present of those which are useful to us and not of those which are harmful. These tiny workers are, if we make it easy for them, all the time busily

(*) From "Lessons on Soil," by E. J. Russell, Cambridge University Press.

setting free, little by little, from the cases which contain them, foods that can be taken up, dissolved in water, by the plant's roots. Do they not set the farmer a good example in working as hard as they do?



Walnut Blight.(*) A Bacterial Disease.

"Their work in the soil is to prepare the food for the plants. When we eat a piece of bread and butter or anything, we have to chew it in our mouths and then digest it in our stomachs before our bodies can use it to make blood and bone and muscle. The bacteria in the soil digest the plant food that is there, and make it so that the plants can take it in through the root hairs to make leaves and branches and flowers and fruits. So you see that, if the plants in the garden are to grow their best, we must encourage the bacteria in the soil to digest or prepare plenty of food for the plants to take in. If they are to prepare plenty of food for the plants we must put plenty of food, such as manures or fertilizers, into the soil for them to work on. Then, as the soil bacteria like plenty of air, we must keep the soil well worked up with the hoe and cultivator, for this enables air to get into the soil. They also require moisture so we must not let the garden get too much dried out. In a teaspoonful of good garden soil there are several millions of soil bacteria. The richer the soil is the more bacteria there are, and so the more plant food is prepared for the plants that are growing in it, causing them to grow larger and better than plants growing in a poorer soil."

(*) See the Department of Agriculture's Bulletin, No. 14/1918, "Walnut Blight."

ROOTS OF LUCERNE.
The little wart-like tubercles are the homes of the friendly bacteria.

"Bacteria want warmth, air, moisture, and vegetable or animal matter on which to work. If we neglect to cultivate and allow the ground to be trodden down hard or to be choked with water, our little friends must cease work or may die: and other bacteria—who have to do with rotting and nasty smells—which thrive only where there is no fresh air and are our worst enemies, will be enabled to foul and sour the soil and do it other harm. We have thus friends and enemies in the soil which we may help or hinder at will. Of this we may be certain:—*the soil we neglect or tread hard will not be the same when we again try to cultivate.* It will be poorer and less fertile, and its water- and air-containing power will be reduced." (*)

18. Fungi are tiny plants which abound in most soils that are rich in humus and live on rotting vegetation as bacteria do. Some of them are enemies and cause diseases in plants, some of them are friendly and can even become partners of certain 'grown up' plants, doing certain things for them that root-hairs did for them in their youth! (†)

In soil, too, there is a teeming race of tiny animals which graze (just as cows graze on grass) upon these fungi and bacteria. They are known as Protozoa. If there be too many of them, as is sometimes the case in soil which has been manured much too much (such as that in market gardens), the 'cows' eat down so many of these fungi and bacteria that there are not enough of them left to make the plant food in the soil ready for plants' roots. Clever men, however, have now discovered ways of destroying such tiny animals without harming the useful bacteria.

(*) Adapted from Bulletin 243, Ontario Department of Education.
(†) Adapted from "Soils and Manures," by W. Williams, "School Nature Study Union," Publication 43.

19. One great family of bacteria can steal food from the air itself. Though we cannot see the tiny creatures, we are able to see the little houses in which they live.

Take up carefully the roots of a lucerne, clover or bean plant or any other plant that has pods, and search carefully upon them for little whitish growths like warts. Usually these are quite small, but on a bean they may reach the size of a pigeon's egg. These are the homes of these friendly little creatures and the factories in which they make food out of the nitrogen (*) stolen from the air—food not only for the plant upon whose roots they live, but for other plants as well.

Now, just as the workmen in the great city warehouse need proper air, warmth, food and drink, so all the little workers in the earth's storehouse of food need food, drink, air and warmth. Just as we feel lazy and want to sleep in very hot weather, so they go to sleep when it is very cold, and they are also likely, too, to stop working in very hot weather.

WARMTH IN THE SOIL.

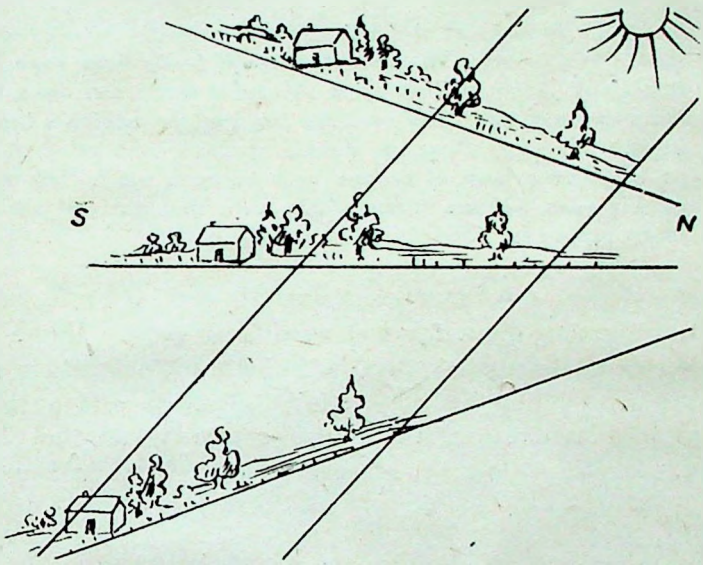
20. Whether soil be warm or cold depends a great deal on whether it lies facing the sun or away from it. If ground slopes to the south the sun's rays do not strike it directly, and it may receive one third less sunshine than ground facing the north. Such soil is cool, and in South Africa it may be good for soil to be cool.

21. Whether soils be warm or cool depends, too, partly upon their colour. You feel much warmer on a sunny day when dressed in a dark suit than in a white one, because the dark colour lets the heat through to your body, while the light colour throws it off. Just so, a soil that is dark is much more likely to be warm than one which is light-coloured.

22. Now we have seen that vegetable matter, which we call humus, makes the soil dark. It also gives off heat as it decays. For these two reasons then humus soil is likely to be warm, and in such soil, if not *too* hot, the friendly little helpers can work well.

(*) Four out of every five parts of air consist of this gas, Nitrogen.

23. Whether a soil be warm or cold depends too upon whether the grains be loose or tightly packed together. Earthworms with their burrows make the soil like a sponge and so let in the air and the rainwater; the latter, as it passes



This shows how land facing the sun receives more sunshine than land lying away from it. The rays that fall on the land facing north are spread over half the space of those falling on the land facing south.

through the air, is warmed and so adds to the heat of the ground. We, too, may make the soil like a sponge when with spade, plough, hoe, harrow and cultivator we let in air, warmth and water. (*)

AIR IN THE SOIL.

24. Air and water are needed not only by the bacteria but by the plants themselves. Plants, too, are living things, living and breathing in every part, roots as well as leaves. They grow not in earth alone but in earth, air and water. All their life long they need air to breathe and water to drink. If air or water be crowded out a plant must die. The soil must at all stages of a plant's growth be loose and open.

(*) See also Sections 51, 52 and 53.

25. A proper seed bed gives a plant a good start in life. When growing small seeds the soil should be very finely tilled to admit a great deal of air, and to touch the seeds on all sides so as to bring water to them.

> "The fineness of the soil should vary with the size of the seed. For instance, if some very small seeds were sown in a rough and lumpy soil, many of the seeds would run down from lump to lump, until they sank far too deep for making a healthy growth. We may liken the sinking of these seeds to small shot poured over a heap of cannon balls between which they would quickly pass. Hence farmers take care that the soil shall be finely broken up when the seeds are small." (*)

26. Roots, too, must be able to grow out in every direction as they hunt for air, water and food. If the soil be tough and hard they find it difficult to make their way through it. When we have made soil loose and open by tillage and cultivation, the roots of plants can seek food easily. Sandy soils may, however, be *too* loose and open.

TRENCHING.

> 27. A plan (often made use of by gardeners) of opening up the soil so that it may readily let in air and water. This is done by bringing up fresh soil to the surface,—by making the lower and upper soil change places.
>
> It is best done by hand and only in deep, rich soil. Great care must be taken lest good soil be buried and unkindly soil brought up in its place. If the subsoil be stirred or broken up so that air and water can mix with it and so change hurtful things into harmless ones, a little subsoil may often be taken up without any harm being done, but it is safer not to do this in wet climates

28. If the soil be turned over by the plough it will be seen to have spread out and to take up more room than it did before. Can you guess the cause of this? Air has been mixed with it, and there are now little passages between the tiny grains—air canals here, there and everywhere. (†)

(*) Adapted from "Elementary School Readings on the Principles of Agriculture," by H. Tanner.

(†) See also Sections 50-61.

HOW RAIN BRINGS PLANT FOOD TO THE SOIL.

29. Soil turned up thus is like a sponge ready to receive any water that comes to it. But sponges differ. So do soils, some taking in more water than others. Which do you think will be able to take in most water, clay or sandy soils?

30. When Rain falls upon a ploughed field it flushes all the little canals and soaks down into the dry ground below. But this is far from being all the good done to the soil by a shower of Rain.

THE VELD. Phot. I. B. Pole Evans.

We have already learned that plants get most of their food from the air, and that some plants—do you remember what kind?—have upon their roots the houses of tiny creatures busy making plant food from the nitrogen in the air. But all plants are not so fortunate as to have these little bacteria living upon their roots and helping them, and yet every plant needs the food that can only be made from nitrogen. The need is mainly supplied by the bacteria that unlock for the plants' use the nitrogen stored in the humus; but a further supply is brought to plants by Rain.

Rain, as it passes through the air, catches in its fall, not only air itself but some of this nitrogen, (*) and carries this with it as it enters into the spongy soil.

31. But the soil is not only like a sponge. We may think of it, too, as a kind of filter. Have you ever seen a filter through which water is passed to make it fit for drinking? It purifies the water by taking from it, as it passes through, anything that might do us harm. The soil acts like a filter as the Rain passes through it, but it takes from the Rain things which plants may use for food.

Just as a net catches fish while letting the water pass by, so soil catches from the Rain much of the plant food brought by it. The Rain itself passes through, but some of the plant food is left behind, especially compounds containing nitrogen, upon which plants can feed.

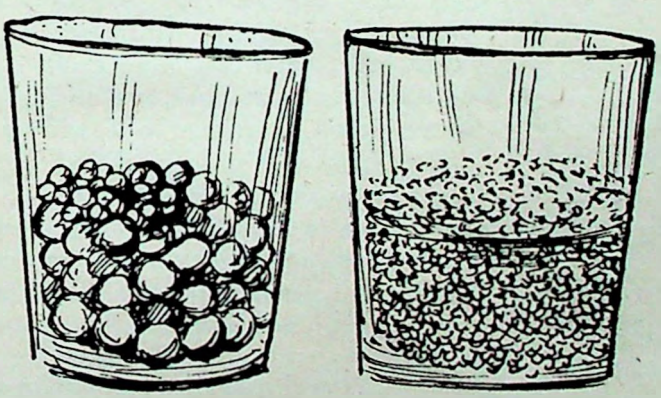
WATER IN THE SOIL.

32. Water is at all times needed in the soil, but not too much of it. Anybody who grows plants in pots soon learns that they very easily perish if watered too often. One of the first lessons a young gardener learns is 'to keep his watering can quiet.' It is only a foolish gardener who fancies he can help his plants to grow by drowning them several times a week. He is killing them with mistaken kindness.

33. We must not water a pot plant by the bucketful, as we water a horse, for the soil in which a plant thrives best is not wet soil, but soil which only just feels damp to the touch. If the soil be properly tilled so that it be broken up into very little grains, and not left in chunks, we help it to keep enough water for the plants growing in it.

(*) In the forms of Nitrate and of Ammonia, which latter is composed of fourteen parts of nitrogen and three parts of hydrogen, another gas forming part of water.

Here is a tumbler with some marbles in it. Put water in until it reaches the height of the marbles. Now suppose the marbles are broken up, and ground into sand, and put into another tumbler. Pour water into this tumbler until it reaches the height of the sand. The total amount of water in each tumbler is shown by the tubes. The weight of sand in the one tumbler is the same as the weight of marbles in the other, yet the tumbler of sand holds three times as much water as the tumbler of marbles. (*) This is because we get more space by breaking up coarse lumps into fine grains. Soil that is carelessly tilled and left in large clods holds far less water and far less air than soil which is thoroughly tilled and broken up into fine particles.



34. Dip a marble in water. When you take it out notice how it is coated with a film of water. In the spaces between tiny grains of soil there will be found little films of water clinging closely to them. They may be so small that you cannot see them, but they are there all the same, unless the soil has been baked through and through by the rays of the sun, or unless they have been drunk up by the roots of plants which, seeking them out, flatten themselves against

(*) "Cornell Reading Course for Farmers," Lesson 2.

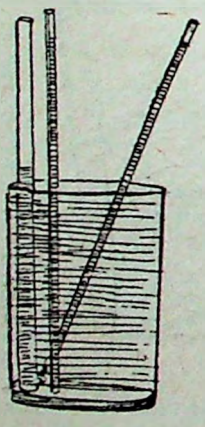
the grains of soil in order that they may gather up the water they need. (*)

HOW WATER MOVES IN THE SOIL.

35. Water so held in these tiny spaces or pores of the soil does not at first sight seem to obey that great law of Nature known as the Law of Gravity, in obedience to which heavy things drop to the ground. Colour some water with red ink and pour some of it out of a tumbler. Of course it will fall to the ground at once. If, however, you stand a glass tube of very narrow bore in the tumbler you will see the water rise up in the glass tube until it is higher than the level of the water in the tumbler. Why does the water rise like this?

1. Level of water in tube.
2. Level of water in tumbler.

BECAUSE IT IS IN A TINY TUBE. The narrower the tube, the higher the water will rise. Such tubes are known as CAPILLARY (or 'hair') TUBES. If you stand two tubes in the tumbler, one slightly narrower than the other, the water will rise more quickly in the broad one, but not so high; the water in the narrower one will in time catch it up and pass it. Now hold the tubes at a slant. The water will move on a greater distance in each, and RISE TO THE SAME HEIGHTS AS BEFORE. If the tubes be wide enough, the water will not seem to rise at all.

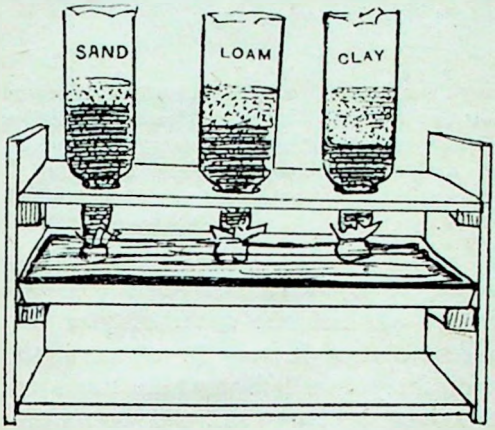


Notice that the water rises to the same height in the smaller tubes, both of which have the same bore.

36. Stand a lump of sugar in water, and the water, in spite of its weight, spreads up into the rest of the lump. Why? Because the lump has tiny tubes running through it in every direction. In the same way the pores of the soil, branching in every direction, act as tubes that connect with each other, with the water below and the surface above. Water can (by moving over the grains of soil and from one grain to another) travel

(*) See Sections 50-61, 65, 109.

in any direction through these tubes from wet to dry. Water travelling in this way through the soil is called CAPILLARY WATER.



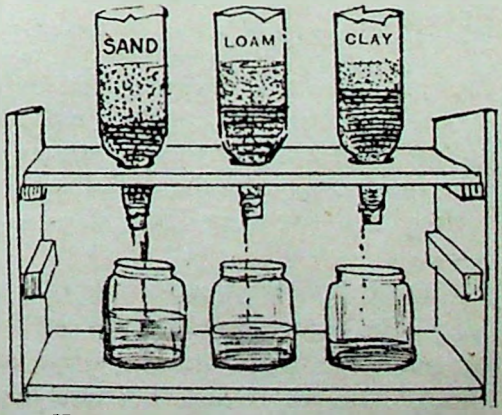
How to find out in which kind of soil water rises most quickly.

37. When the top layer of soil has had any of its water turned into vapour and stolen away by the rays of the sun and by the wind, capillary water rises from below to take its place, just as oil rises between the threads of a lamp wick to take the place of oil burned away by the flame.

38. Stand a lamp chimney on blotting paper in a saucer and fill it with dry soil. Fill the saucer with water and observe the water rising in the chimney.

Cover one end of some lamp chimneys (or bottles from which the tops and bottoms have been broken) with blotting paper. Fill them two-thirds full with different kinds of soils packed with the same pressure, and stand them, covered end downwards, in a pan of water. Watch the water rise in each. Why does it rise? In which soil does it rise more quickly? Which kind of soil, clay, sand, or loam, can draw most water from below by capillarity?

39. Water rises most rapidly, and stops soonest, in coarse sand; it rises more slowly, but in the end higher, in heavy clay. Remember how the water rose more quickly, but not so high in the broader tube. Sandy soil, because of the large spaces between its particles, has a poor lifting power, while water can move



How to find out how different soils retain water.

but slowly through clay because of its very tiny passages. The grains of loam are fine enough to lift, but not to interfere with, the free movement of soil water; the same free movement is also aided by vegetable matter which separates the grains.

> Now fill the chimneys (or bottles) as above, and stand them in a frame, covered side downwards, with a glass tumbler under each. Pour the same amount of water into each. Note which takes in water fastest, and which slowest. Note the time it takes for water to drop out at the bottom of each, and which holds most water.

40. If you raise a large stone which has for some time been lying with its flat side against the ground, you will find that, although the ground near it may be dry, yet the soil below is damp. No doubt you will find there too some insects that have sought cover because of the moisture. Where did this moisture come from?

It is capillary water which has risen thus far and, because of the stone, can rise no further, while the stone, too, hinders the sun's rays from stealing it away.

41. Some gardeners, who are aware of this, cover up their strawberry beds with straw. This straw not only protects the fruit but, like the stone, prevents water being stolen away from the soil below, so that the roots of the plants have enough for their needs. The water drunk in by the roots is made good from below. This plan is known as MULCHING.

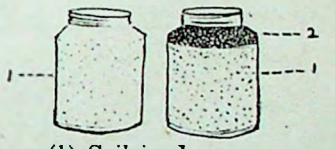
42. But straw may be eaten by white ants, or there may be no straw to get. Is there no other way? Yes, there is another and a better way by which farmers may check water that has sunk into the soil from coming up again to the surface and so being lost.

43. Put a lump of sugar into water coloured with red ink. The water rises to the top of the lump. Upon the top put some finely crushed sugar and over this put another lump. The water does not rise beyond the crushed sugar. Why not?

Sugar Lumps, with "Mulch" of Powdered Sugar between.

44. The two lumps of sugar are now a little like a lamp wick that has been cut in two between the oil and the flame. The water cannot pass across the powdered sugar. It can only creep from one grain to another when the grains are so near together that they touch one another very closely. This is so in the lump. But in the powdered sugar above it the grains are spread so far apart that the water cannot work its way up from one grain to another. Remember how if tubes be wide enough, water will not appear to rise in them at all.

45. Just as we can use a blanket of powdered sugar to stop the water from leaving the sugar below it, so we can use powdered soil to stop water from leaving the soil below it. What the gardener has been able to do in a small way over a few square yards with a MULCH of straw the farmer can do nearly as well by making a mulch of his own powdery soil.



(1) Soil in Jar.
(2) Fine Gravel.

"The effect of a soil mulch may be shown by filling two cans with soil and planting mealies. When the plants are 3 inches high cover the soil in one pot with a layer of coarse sand or granular dry soil to the depth of 1 inch. Place in the window and observe which plants first show the need of water." (*)

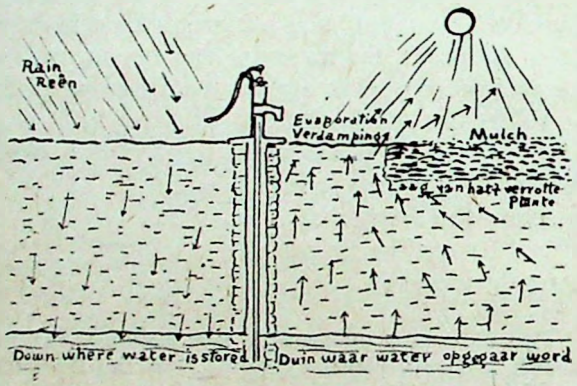
Place soil (1) in two jars filling one to the top, the other to within an inch of the top. Pour water into both until the soil is moist throughout. Then fill the vacant space at the top of the second jar with very fine gravel (2), but do not press this down. Weigh both jars, and go on weighing them week by week. The jar with the gravel at top will lose water less rapidly than the other. This experiment shows the use of a mulch and the value of hoeing.

46. Stirring the top soil of a field spreads the grains so far apart that the water cannot pass from one grain to another. A layer of loose dry soil forms a 'ground-blanket' which acts as does a mulch of straw, stopping the water so

(*) United States Department of Agriculture, Bulletin No. 653, "Lessons on Corn."

that it cannot reach the surface. Since it is only at the surface that the sun's rays can steal it away, the water is saved. It cannot rise through the loose mulch and is kept below for the use of the plants in dry weather.

47. After a downpour of rain this powdery blanket of soil may skin over into a close crust. Through this the moisture below now finds no difficulty in making its way to the surface. Have you not noticed that a shower of rain during a dry time, or watering a garden unless it be done very thoroughly, dries up the soil more than ever. It forms this close crust where the soil was loose before and so makes it easy for the water to get to the surface. As soon as the



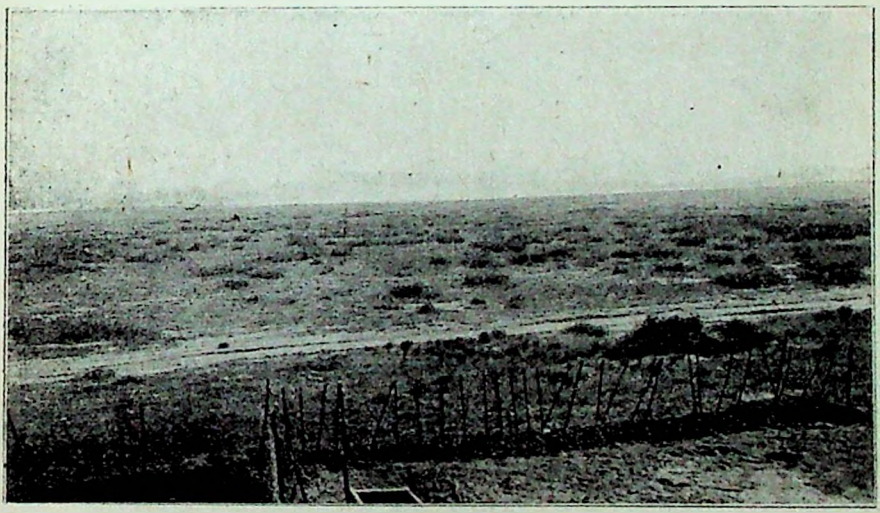
How water moves in the soil.

ground is dry enough to be worked this crust must be broken up again into a mulch which, because of its looseness, will not only prevent the water below from rising, but will drink in more readily any rain that may fall upon it later. A wise American says, "Water your garden with a rake." (*) Once water has entered the ground it can be stored there by means of a mulch. However sunsmitten and dry the mulch may become, so long as it remains powdery, the soil below, where the plants' roots feed, will be damp. By means of a mulch the farmer stores water in his soil just as water is stored in his dam; the sun and the wind cannot steal the water from his mulched soil as they steal it from his dam.

(*) See Sections 87-89

DRY FARMING.

48. The future of farming in South Africa depends upon the use of the mulch. Very little of the land here can ever have water brought to it from rivers and dams. The farmer who cannot cause rain to fall when he wishes for it, must learn to store what he needs in the soil. It will be hidden there. He will not be able to see it; but he will see its effects. Even in those parts where very little rain falls, if what little there is be treated as a precious thing, if the ground be made ready to receive it, and it be carefully prevented rising to the outer air ever greedy and eager to suck it up, more so than ever in times of drought, it will enable the farmer to grow paying crops where they cannot be got to grow in any other way.



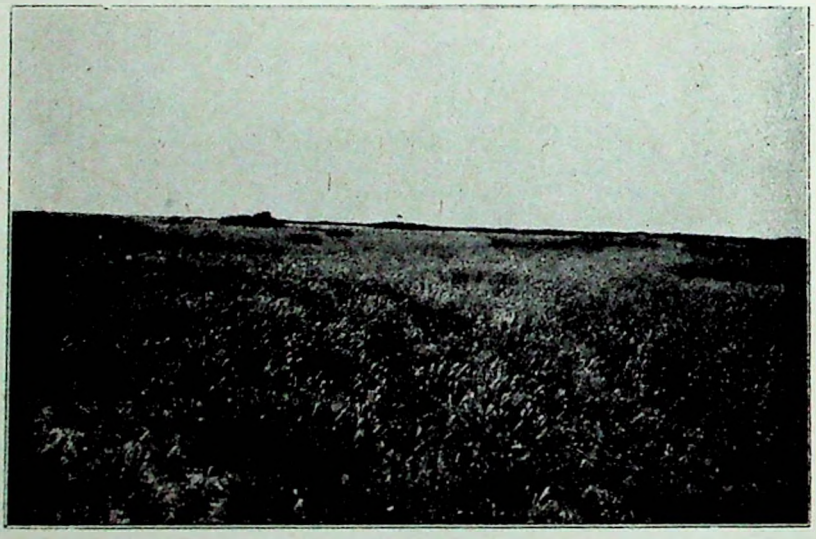
ARID REGION. Phot. I. B. Pole Evans.
General appearance of veld in winter.

49. This plan of growing crops is called Dry-Farming. Of course Dry-Farming does not mean that we can farm without water, for that would be quite impossible. It simply means that we can grow crops on land that appears to be dry and that has not had rain fall upon it for quite a long time. Land that is ploughed and made fine to a good depth, if constantly kept covered with a mulch will go on drinking in moisture from the rain and storing it up throughout the

whole year until next year's sowing season comes. Then the plants' roots will begin to draw upon it, and may need no further moisture. If enough has been stored a crop can ripen without any rain ever falling upon it. We cannot judge by the eye how much water is stored up in soil. One morgen of land can contain hundreds of tons' weight of water in the top inches of soil and yet not look wet. (*)

DRAINAGE.

50. While we remember that plants need water we must not forget that they need air too. (†) We should make certain that the rainwater does pass down into the soil and so



ARID REGION.
General appearance of veld in summer.

make room for air. Water is indeed at all times needed in the soil, but not too much. It is possible to have too much of a good thing.

51. Wet soils are cold and we have seen already that warmth is helpful to plant life. Many barrels of water can

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletins: T.B.F. 96, "What is Dry-Farming?" and T.B.F. 130, "Dry Farming."

(†) See Sections 24-28.

be standing on a morgen of wet ground and not be noticed. Such water, as it is gradually changed into vapour at the surface, chills the soil.

52. Wet one of your hands and then hold both hands out. Why does the wet one cool at once? Because the water upon it is robbing your hand of heat to enable it to change into vapour. Just so, water standing in the soil steals away heat from that soil. The warmth of the sun's rays is carried down very slowly into soil when it is wet, since it takes much more heat to warm water than it does to warm the same amount of soil. Run about on a sunny day with bare feet. The dry sand will burn your feet, while the moist sand feels cool.

53. Suppose you burn beneath a pot enough wood to evaporate a barrel of water. Every barrel of water that goes off in vapour from the surface of the soil draws out from the ground as much heat as is contained in the wood under the pot. The soil and plants are chilled for want of that heat. The bacteria, too, may have to cease working for lack of it. (*)

54. If soil is so wet that, when you dig a hole, water collects in it above the depth to which the plants' roots go down, why then these roots will be drowned—just as you would be drowned if you were to have your mouth under water for a time! The water has driven out the air, and if the air be kept out, the roots will die.

Plants can no more do without the small quantity of air they need than animals can do without the large amount necessary to them.

55. Not only is it important that water should pass into the soil from above; it is just as important that water should pass away as soon as it has done its work. The farmer's proverb is, "Soon on and soon off."

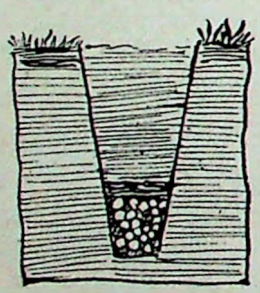
56. There is a place in the ground where the water stands. We can find it in damp soils by digging a hole. The level to which the water collects in this hole is known as the WATER-TABLE.

(*) While all this is so it must be remembered that cold soil is sometimes an advantage in our hot South African Summer. The bacteria which cease working for lack of warmth also cease working when it gets *too* hot.

57. From this water-table, if it be not too far down, water rises and is continually supplied to plants. (Why will water rise from a lower water-table in *clay* than in *sand*?) Since the water-table sends up moisture to the soil above it, it is useful and necessary; but it must not be too high, for roots of farm plants do not thrive in standing water. We can lower the water-table by Drainage.

58. Drainage prevents water from doing mischief. It draws air into the soil so that plants' roots and bacteria can live. It makes the soil fit for early ploughing and for growing early crops.

59. Drainage, too, helps plants to bear up against drought. In drained land roots go deep into the soil in search of what they need, and so have a wider depth for feeding. Such plants can withstand drought better than plants growing upon undrained soil, whose roots lie close to the surface and there for a time get the water they need; but when this upper layer of soil becomes so dry that they can no longer obtain water they must die, while those whose roots lie deep still get enough water to keep them going. Drained soil is drier in a wet time, and moister in a dry time, than undrained.



V-Shaped Drain.

60. The simplest form of drain is an open one, but no wise farmer wishes to have an open drain upon land that he cares for. It is a waste of so much space; and its sides sometimes become a garden of weeds.

A better plan is the V-shaped drain cut into the subsoil down along the main slope of the land. The bottom may be filled with rounded river pebbles to a depth of about nine inches. Upon the top of these is put a layer of brushwood well pressed down to prevent soil dropping through it into the pebble-bed. The soil is then filled in.

A much better plan is the drain made of unglazed earthenware pipes, into which the water finds its way through small openings.

61. When the rock underneath allows water to soak into it, the soil above does not need draining. It is drained naturally.

IRRIGATION.

62. In South Africa, wherever there is not enough rainfall to supply growing crops with water, the practice is to dam running streams and rivers and, turning their water aside, to conduct it to the fields, where, divided into smaller rills, it spreads over the surface of the ground.

CROWN ROT OF LUCERNE.

Plants wilt and rot at crown. Remove and burn infected stools. Attend to the drainage and apply a dressing of quicklime.

63. Before we irrigate land we must make certain either that it can be drained, or that it is naturally drained so that any water brought to it sinks without delay to a lower level than the roots of the plants we grow. If this be not so, Irrigation may hinder the plants' growth instead of helping. Have we not seen that water standing idle on the surface, or in the top layer of the soil, gradually drives out the air which plant roots need, and ends by drowning them. If mealie lands be flooded for two or three days in summer time the plants will turn yellow and die.

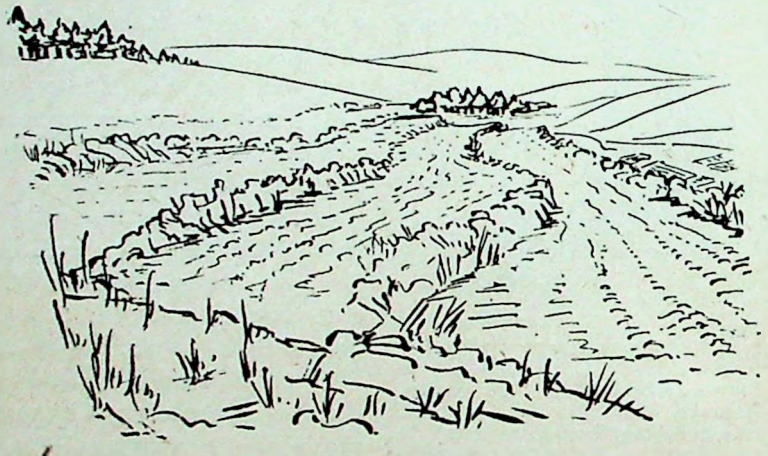
64. Where rain falls but seldom Irrigation is the simplest way of giving the roots the water they need, but we should not send more water on land than it needs, and we should take care that water which is not needed can be carried away speedily. It is better still to use only the amount of water that is needed.

65. Water brought to land in this way softens the ground and makes it easy for roots of plants and for air to spread through; it brings from a distance plant food, part of which may be left behind upon the surface as the water settles and sinks into the ground. It carries the rest dissolved down into the soil, and as this passes beside and

among the roots, they feed upon it. The soil does not let such dissolved plant food pass freely through it, as water passes through a sieve. It takes hold of some of it as a filter does and keeps it for future use.(*)

TERRACING.

66. When we wish to irrigate land on the slope of a hillside we have to make it possible for the water to stay upon it long enough to soak in. A TERRACE is a bank of almost level land winding round a hillside. Its slope has to be the very gentlest, so that rain falling upon it or water carried to it by irrigation may spread over it in a very thin



TERRACES.

sheet and move so slowly that it is not likely to tear gaps through which the water may turn and quickly flow off downhill. Terracing, too, prevents soil washed out by rains from being carried down the slope and so finding its way into the sea; if the wall of the terrace be strong enough it stops beautiful, sloping, fertile fields from turning into horrid-looking dongas.

Terraces are often sown with lucerne or with some other plant having long roots which bind the soil together and

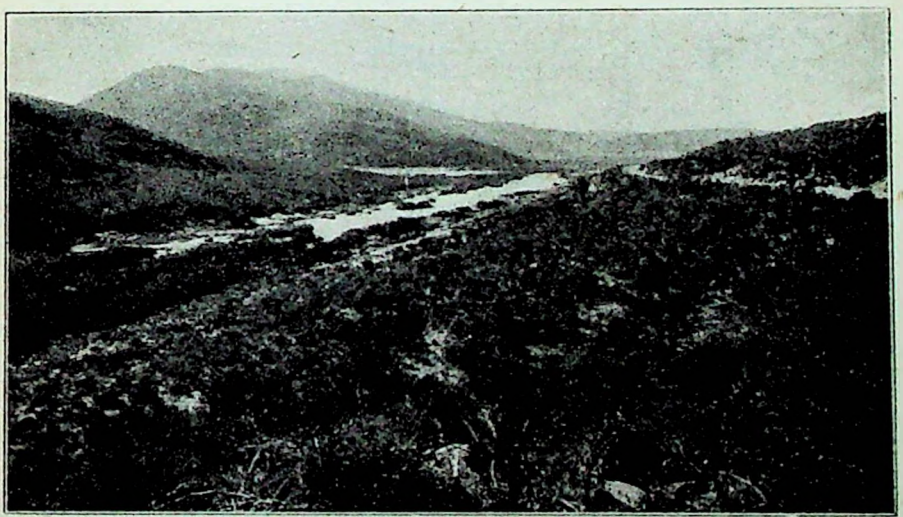
(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletins: U.R. 14/1914, "The Drainage of Irrigated Lands"; U.R. 59/1913, "Laying out Lands for Irrigation"; Nos. 9 and 16, 1913, "The Distribution of Water"; No. 9, 1914, "Irrigation Engineering"; No. 51/1913, and C.G.H. 5/1897, "Brakland, etc."

strengthen it. Breaks in terraces should be mended without delay with soil taken from below. Furrows ploughed in them should never run 'up and down hill,' lest they should serve as channels to carry the water to a lower level.

WEEDS.

67. Weeds are Plants growing out of place. They harm crops by overcrowding them, by stealing away the air and sunlight, and the food and water that by right are meant for them. We should keep soil quite free from weeds, and take care that the seed we sow does not have seeds of weeds mixed with it.

68. The more we learn about weeds the better we shall be able to fight against them. They may be divided into three classes.



Phot. I. B. Pole Evans.
Rhenoster Bush, a weed that is fast destroying much of the grass veld.

ANNUALS are plants that last one year only. We can get rid of such weeds by pulling them up, or by cutting them off below the surface before seeding.

BIENNIALS are plants which live for two years, usually ripening their seeds during the second season. Weeds of this kind are hard to destroy during their first season, as

they grow up again after being cut down. If cut down just before seeding time in their second year they generally die easily. We must keep them from seeding and so prevent them from spreading.

PERENNIALS are plants that live on from year to year. Such weeds are hard to destroy as they generally spring from underground buds as well as from seed. We can pull out the roots by hand, or grub them out, or gradually starve them by destroying leaves and stem. Some are best fought by growing crops such as Teff Grass, which choke and smother them, or by planting the land with quickly growing crops such as Lucerne, and frequently mowing.

69. Cultivated crops well taken care of will rid land soonest of weeds. With crops of Mealies, Mangolds, Onions, or other plants which require clean cultivation, we may rid land of weeds of all kinds. (*)

TILLAGE AND IMPLEMENTS.

70. Jethro Tull, an English farmer who lived two hundred years ago, has been called the 'Father of Tillage.' He found that his land when well tilled yielded far better crops than when this was not done, and he tried to teach other farmers that it was worth their while to till land well too. Before his day farmers had ploughed their soil without care and sown seeds anyhow. At first his neighbours laughed at him, but later when some of them tried his plan, they found out that he was right, and so in time by word and example Jethro Tull taught England and the world the value of good Tillage, and farmers ever since have given much more time and care to it, though even to this day some till very carelessly, and wonder why their crops are small.

Jethro Tull did not himself know, as we do now, why his crops were so good, and how Tillage improved them. He only knew that it was so, and he explained it by saying

(*) See Sections 80, 111, 115.
For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletins: L.S. 35, "Malta Thistle"; L.S. 36, "Burweed"; L.S. 37, "Mexican Poppy"; L.S. 38, "Dwarf Marigold"; L.S. 73, "Khaki Weed"; C.G.H. 12/1908, "Jointed Cactus"; U.R. 35/1914, "Slangkop" or "Poison Bulb"; T.B.F. 90, "Prickly Pear and Spineless Cactus"; U.R 40/1913. "Witchweed"; etc.

that "Tillage is Manure." Yet it is amazing that people should not have tilled carefully before his time, for he was not the first man to teach other men its value. Farmers had learned about it long years earlier, but had let it drop out of their minds. A Roman farmer, Stercutius, found out, two thousand years ago, how Tillage and Manuring improved the ground, and for this his countrymen declared him a god!

Some hundreds of years earlier still, a story was told which taught the value of Tillage—a story which has come down to our day. The storyteller was Æsop, who is thought to have been a negro slave from our own continent of Africa.

"A dying father left a piece of ground to his three sons. At the point of death he called them to him and whispered, 'On no account sell it. A great treasure lies hidden there. Dig and plough it up; leave no inch unturned and you must find it.'

"Every day in eager search they ploughed and dug, hoping to find great riches. But treasure of gold there was none to find; and at last they gave up the search in despair.

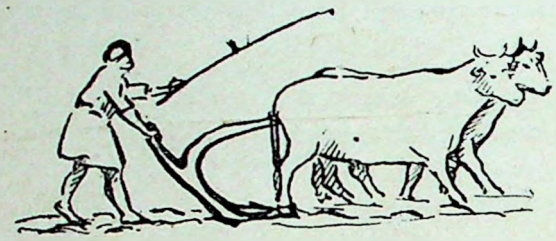
" 'Now that we have the land all tilled,' said the eldest, 'let us not waste all our labour. Let us sow some seed!' This they did; and when autumn brought an abundant harvest, they found that their father had indeed spoken truly. Treasure was to be found by digging the soil. Tilling had made it fertile."

The spade is the chief implement used in tilling, and there is none better than it for working the land. By it the soil is made thoroughly ready for sowing and planting, and dug shallow or deep at the will of the user. It is slower than the fork, which, however, does not break up the soil into as small particles. With the fork we dig potatoes and do other work for which the spade is not so good.

The spade, however, is fit only for small plots of ground; the farmer who works land on a large scale must use the plough.

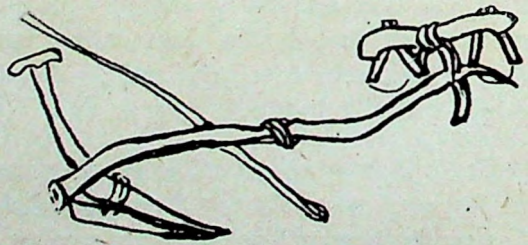
PLOUGHS AND PLOUGHING.

71. Man got the idea of ploughing from the pig, whose way of pushing over the soil with his snout when searching for juicy roots the farmer thought would serve also to cover seeds.



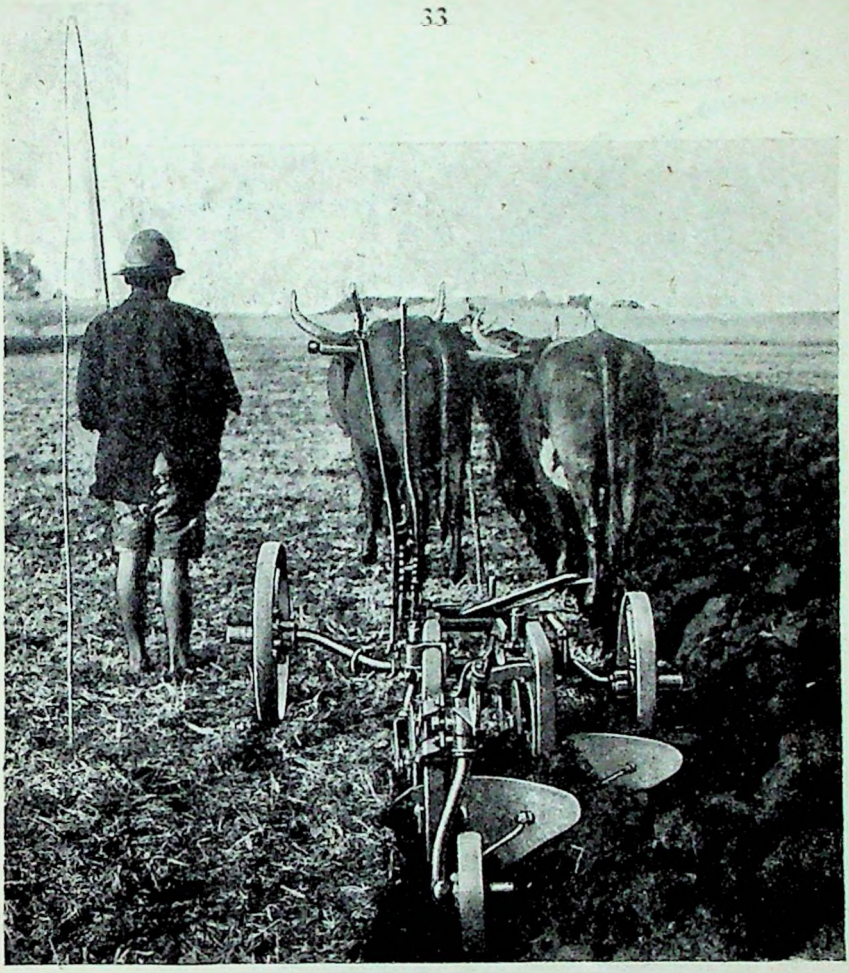
THE FIRST PLOUGH.

The first attempt to copy the animal was made with the trunk of a tree pointed at one end like a pig's snout, and, trimmed so that two branches were left opposite each other. One of these served as a handle; the other was fastened, by willow or wattle branches plaited together, to the tail of an ox. When the farmer held this rude implement steady and pressed hard upon the handle it pierced into and tore its way through the ground. The farmer's sons followed him breaking up the clods with heavy sticks. Later on, when Acts of Parliament were passed forbidding the plough to be fastened to an animal's tail, a kind of harness was used.



AN OLD PLOUGH IN A MUSEUM.

With such poor ploughs men grew but very poor crops. They but scratched the top of the soil, and, instead of turning over weeds and smothering them, helped them to grow better. Such wooden ploughs wore out quickly, and some farmers began to place iron on the parts that gave way first. Their neighbours at first refused to do this, believing that iron poisoned the ground so that no crops would grow at all!



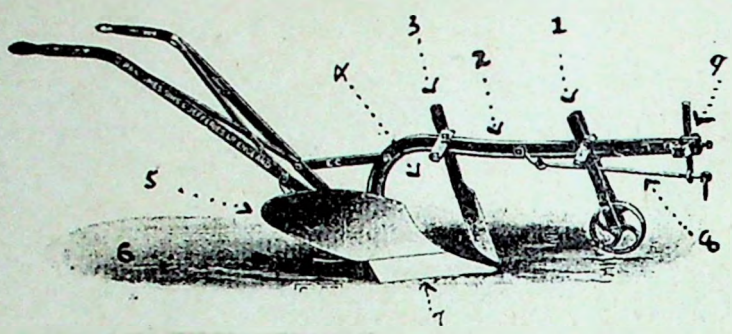
Messrs. Ransomes, Sims & Jefferies, Ltd.

PLOUGHING: Two furrows at a time.

To-day ploughs are made principally of steel, and serve the farmer for every purpose for which the spade serves the gardener.

To understand the plough and how it works, needs just as much thought and study as anything a boy learns at school.

72. We should know the various parts of the plough and why each is shaped so: why, for example, the long mouldboard is used to turn the soil over without breaking it; while the short one with a sharp turn is used to break up soil into fine particles.



Messrs. Ransomes, Sims & Jefferies, Ltd.

A PLOUGH.

PARTS: (1) Trunk or Wheel, (2) Beam, (3) Coulter, (4) Throat, (5) Mouldboard or Breast, (6) Landside, (7) Share, (8) Draught Rod, (9) Clevis or Bridle.

73. PRINCIPAL PARTS OF PLOUGH.

BEAM.—The body to which the other parts are fixed.

COULTER.—The knife that cuts the furrow-slice from the land. A disc instead of a knife is useful in turning weeds over. Another form, the Jointer, skims grass and stubble from the soil.

SHARE.—Cuts the bottom of the furrow-slice.

MOULDBOARD or BREAST.—Turns and breaks the furrow-slice.

TRUCK or WHEEL.—Steadies the plough, and regulates depth to which the plough goes.

DRAUGHT ROD.—By raising or lowering this bar the plough is made to run deep or shallow.

LANDSIDE or SIDECAP.—The part of the plough that wears out soonest.

THROAT.—Ploughs high in the throat are the best for dirty land and do not 'choke.'

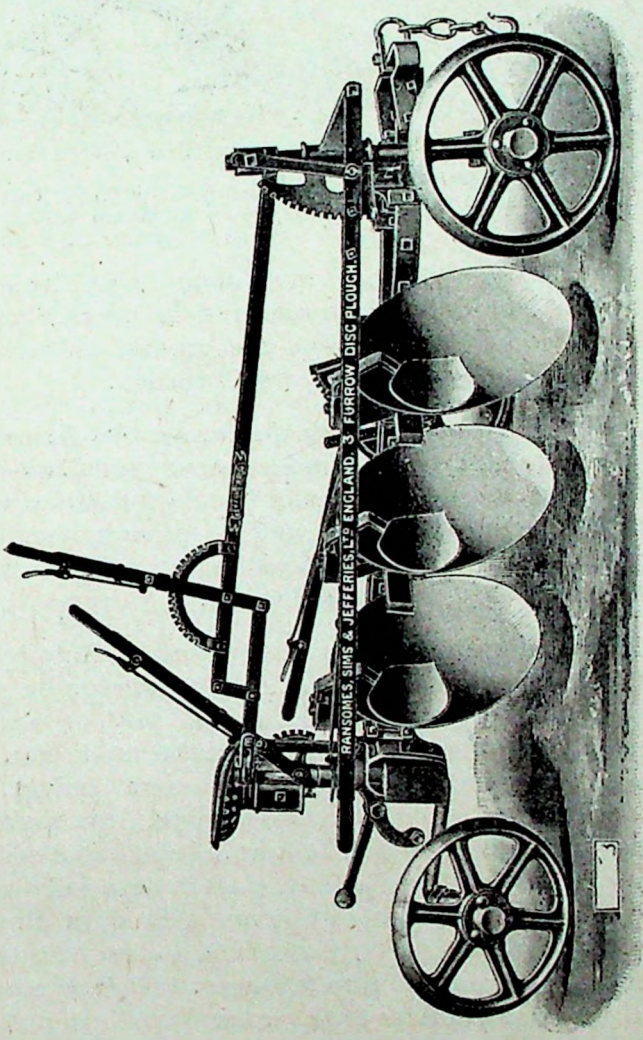
HEELPIECE.—Carries the weight of the plough.

74. We should know something of the different ploughs in use and when they are used. Just as there are many kinds of carts so there are many kinds of ploughs. A farmer would not bring his corn to market in his cape cart, but in his wagon. Just so the kind of plough a farmer uses depends upon the work he is doing.

75. The plough's chief work is to break up raw earth, to bury surface rubbish and weeds, and let in the air that plants need. As soils differ so do ploughs, and only experience can teach which kind of plough to use. If the

work be light the plough should be suited to it; if the work be heavy the plough must be strongly built.

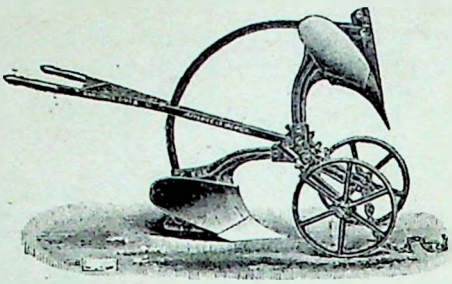
Land may need a Disc Plough.



A THREE FURROW DISC PLOUGH.

76. This plough is specially useful for ploughing up new lands. It crumbles up the soil and gives a seedbed at once. As its saucer-like plate turns round, the fine edge cuts a way and as it turns throws the cut soil aside. This kind of plough should not be used for heavy, sticky soil in a wet state, nor for any stony ground.

77. If steep land is to be ploughed across, the farmer should know of the 'Turn-wrest Plough,' which only throws the furrow one way—downhill.



Messrs. Ransomes, Sims & Jefferies, Ltd.

ONE-WAY or TURN-WREST PLOUGH.
A Reversible Plough with two bottoms, only one of which is in use at a time.

78. Sometimes the farmer will need to break up the hard pan which has formed at the bottom of the furrow; or to loosen the subsoil, so as to give more space to roots and to prepare them to withstand drought, or to enable the ground to keep more water. Then a SUBSOILING PLOUGH is needed.

79. When buying a plough the farmer should carefully think out beforehand which kind he most needs and choose it with the greatest care. It should be selected with a view to strength and lasting qualities, and no plough should ever be bought unless spare fittings can be got without delay to replace others if they should be broken.

80. Ploughing itself needs to be learned. Only by close and constant attention to the soil can knowledge be gained when to use any implement on the soil or to leave it alone. Furrows must be straight and run side by side; they should be of the same height, and should lie over at the same angle, to make the work easy for the harrow that follows. In suitable soil deep ploughing is better than shallow, and is especially needed in South Africa where you can expect a drought almost at any time. Plough as deeply as possible and so help the soil to hold more water and to keep it longer. Shallow ploughed lands are the first to suffer from drought and when there is plenty of moisture weeds gain the mastery of the crop.

"Plots ploughed during winter months and cross-ploughed in spring give very good results. Winter ploughing is better than spring because—

(*a*) it gives more time for getting the seedbed ready in spring;

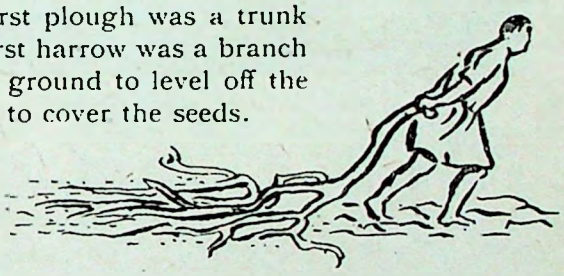
(*b*) the soil gets more good from lying exposed to the effects of weather during the winter months;

(*c*) insect pests are more easily kept in check." (*)

81. The plough has to be cared for and kept in good order. All bolts must be kept in place and tight. Parts that touch the soil must be smooth, bright and clean, so that the soil will not stick to them. If the soil sticks to the mould-board, or if this be rough or imperfect, the plough becomes hard to drive. It saves money to have a good new plough rather than to work for long with one that is worn out.(†)

THE HARROW AND THE CULTIVATOR.

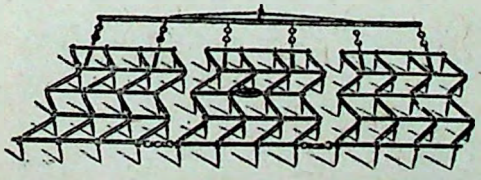
82. As the first plough was a trunk of a tree, so the first harrow was a branch dragged over the ground to level off the rough places and to cover the seeds.



THE FIRST HARROW.

To-day the harrow is used to break up further the slices cut by the plough, to kill weeds, and to form a mulch.

" Like many other things, there is a time to harrow and a time to leave off. There is no use trying to do it when the land is wet." Clods cut out by the plough must, if wet, be left to dry before the harrow can mix them with air. When the ground is fairly dry and where water is precious, the ground should be harrowed the same day that it is ploughed.



Messrs. Ransomes, Sims & Jefferies, Ltd.

HARROW.

(*) Union Department of Agriculture's Bulletin, Local Series, No. 8.
(†) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin L.S. No. 56, "The Plough."

DISC HARROWING.

Messrs. Ransomes, Sims & Jefferies, Ltd.

This crushes surface lumps, smooths and levels the soil.

A DISC HARROW BEING FOLDED FOR MOVING.

Messrs. Ransomes, Sims & Jefferies, Ltd.

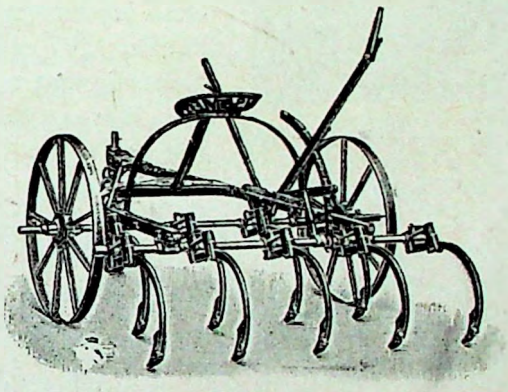
83. There are several kinds of harrows, each having its own special use.

The spring-tooth harrow lifts and tears the soil and kills weeds. Its teeth dance about so that they shake up the soil without becoming clogged.

The disc-harrow thoroughly powders the turned-over soil and forms a good mulch.

84. Crops can be harrowed when over ground with little harm and with much good result, but this should not be done in the early morning when the stems of plants are brittle.

85. As the hand hoe follows the spade so the Cultivator follows the plough.



Messrs. Ransomes, Sims & Jefferies, Ltd.

A CULTIVATOR & HORSE HOE.

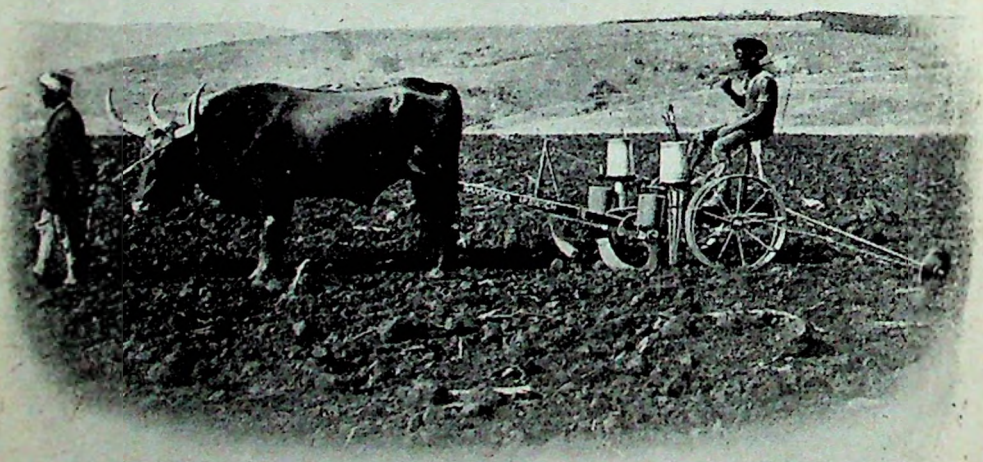
It carries on the work of the Harrow at a later stage, tearing up the soil and opening it up without doing away with its evenness, scuffling between several rows at a time and forming a thin layer of fine top soil. The farmer should find out how near the roots of his crops are to the surface and fix the teeth of the Cultivator so as to avoid hurting these. Hurting the roots hurts the plant.

THE DRILL.

86. Another very useful implement which saves the farmer much expense is the Seed Drill, by which seeds are placed in the ground in rows, at an even depth and covered. Broadcasting seed is a very wasteful way of sowing, for by it much seed is lost, being left uncovered and taken by birds, or washed away by rain. Much, too, of that covered by the harrow and lying deep, may not grow if the soil be heavy and wet, while that lying near the surface in light

G. North & Son.
Broadcast Seeding with a Hand Machine.

dry soil will fail if the soil around it dries out. In a dry season seed that has been drilled has a very much better chance of growing than if it has been scattered over the ground, for with the Drill we can plant seed at any depth we wish. Seeds planted at the same depth sprout at the same time and plants grow and ripen more evenly; less seed is needed, and the yield is larger. We should try the experiment of planting some rows of seeds at different depths and note the results.



PLANTING MEALIES.

Drills are sold which sow more than one row of seeds at a time, and which, as they drop the seed into the furrow, drop manure with it. Even potatoes can be planted in this way.

> "On light soil mealies may be planted to a depth of five inches, but on heavy soil this is too deep, as the seedlings very often have trouble in getting to the surface.
>
> "A good distance apart for mealies in average soils is 3 feet between rows and 18 inches between plants in row. Under a good rainfall and on fertile soil, the seed may be planted closer, but, under average conditions, it is safer to plant too thinly than too thickly." (*)

THE ROLLER.

87. Remember how water is stored below the surface by making a loose mulch or 'ground blanket,' and how it rises and fades away in the form of water vapour when the surface is 'tightened.'(†) This is why ground keeps moist much longer when trodden down—the WATER KEEPS ON RISING.

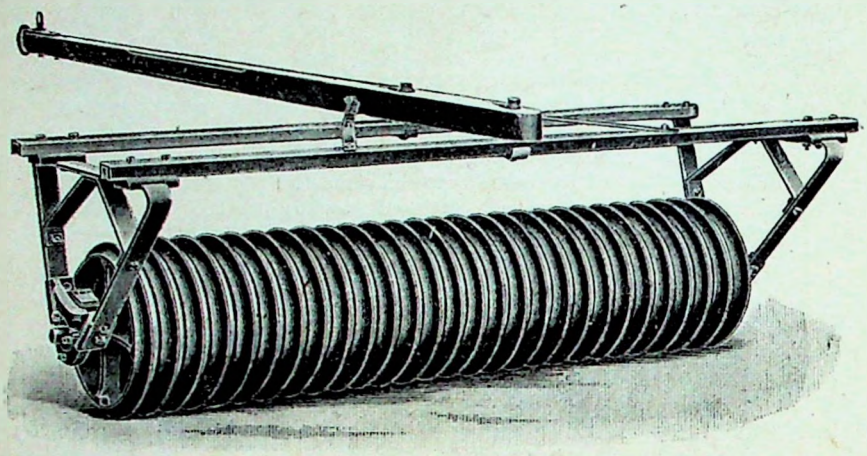
How seeds sprout where the feet have trodden.

88. Now small seeds sprout in the top layer of soil, and this must be kept damp until they have done so. This explains why the gardener treads ground solid on sowing such tiny seeds as those of the onion. It is his way of preventing the top layer of soil from drying out, for he knows that moisture comes more readily to the top when the ground has been pressed, and that the seed gets damp sooner, keeps more moist, and sprouts more quickly. Later on he takes care to loosen and crumble the top, and to keep it loose by raking it.

89. When shallow-rooted field crops must be supplied with water at any cost, the farmer must do with the Roller what the gardener does with his feet. The Roller keeps the soil moist from the surface downwards. As soon as ever the roots get down harrowing should begin.

(*) Union Department of Agriculture Bulletin. Local Series No. 8.
(†) See Section 47.

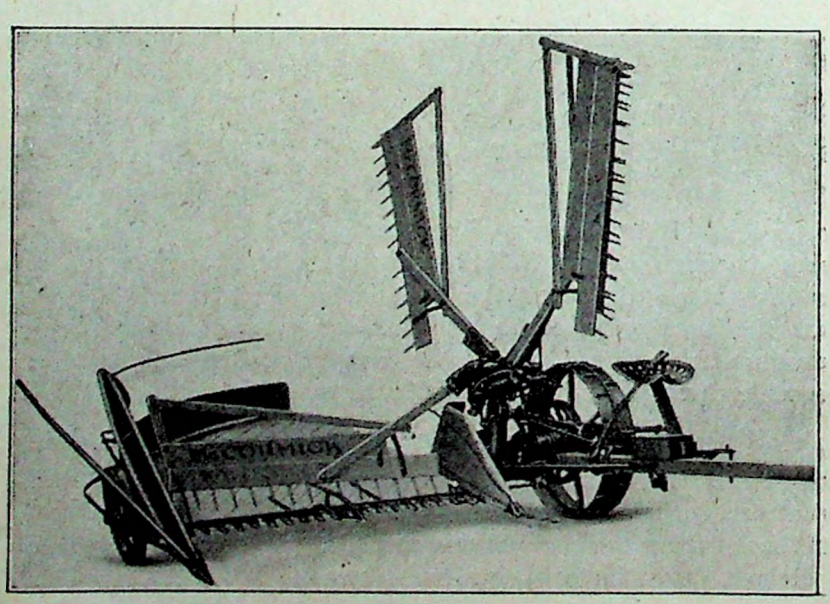
The Roller, too, is used to crush clods. "By its use in rolling young wheat and spring corn, the mischief done by



Messrs. G. North & Son.

A LAND ROLLER.

the wire-worm and grub is prevented, and it is useful in resetting crops made light by frost."

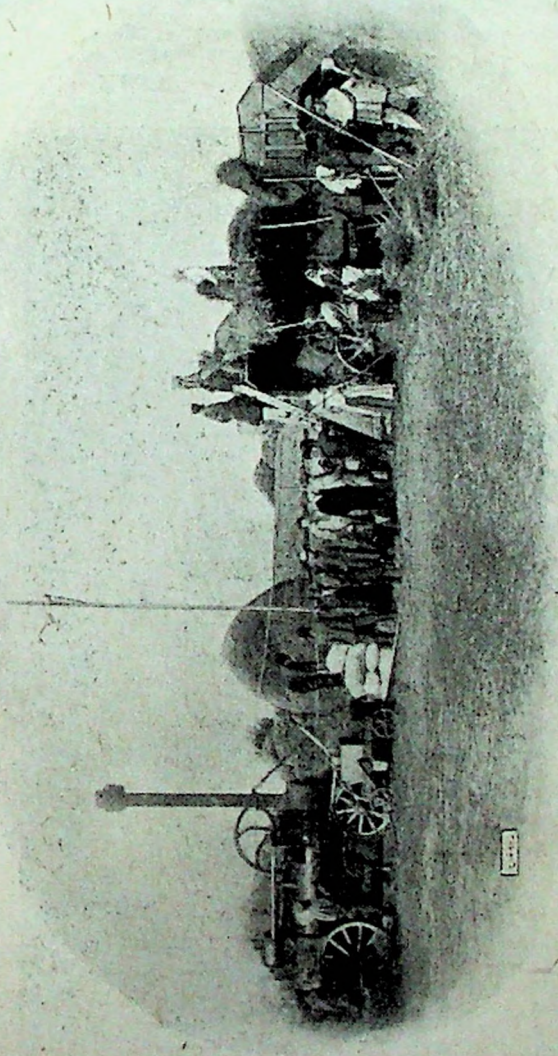


Messrs. G. North & Son.

A REAPER.

HARVESTING.

90. Harvesting is best done with the aid of machinery. Delay in the harvest field may mean the loss of a crop, so mowers, reapers, swathe-turners, binders and other machines

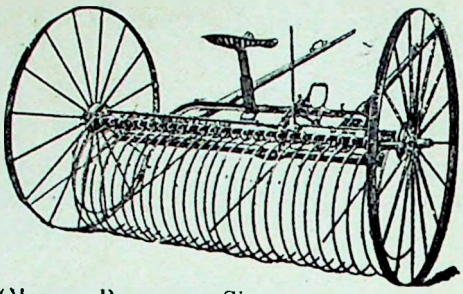


HARVESTING WITH STEAM POWER.

(Messrs. Ransomes, Sims & Jefferies, Ltd.)

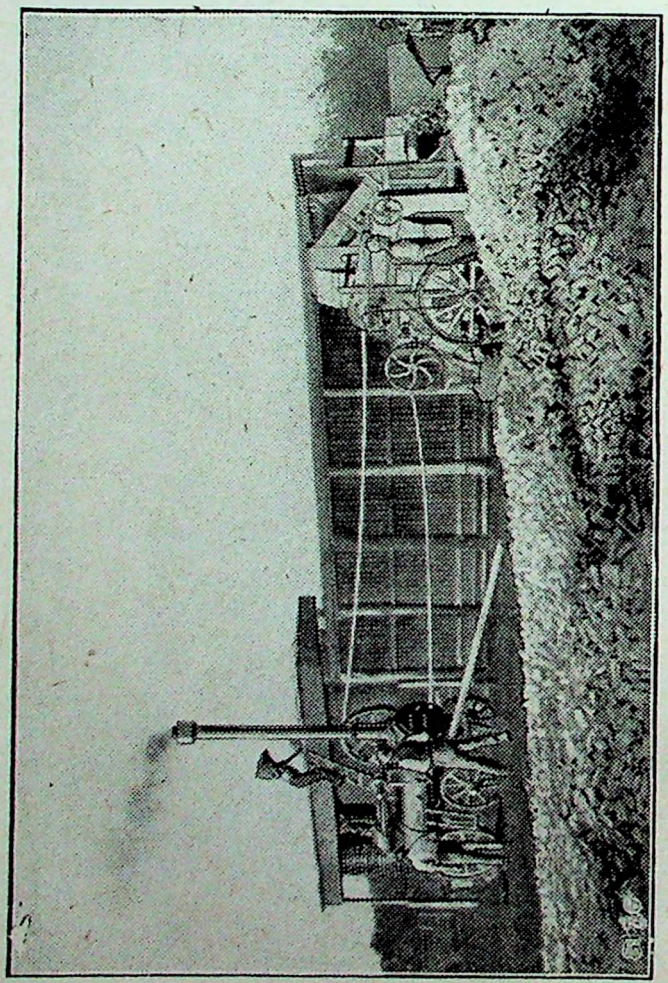
are now used instead of the sickle and hook, by wise farmers, who can so get through much more work in a shorter time.

The giant strength of steam is now being used for all kinds of hard work on the farm, especially for machines used in harvesting.



(Messrs. Ransomes, Sims & Jefferies, Ltd.)

RAKE.



SHELLING MEALIES.

(Messrs. Ransomes, Sims & Jefferies, Ltd.)

THE CARE OF IMPLEMENTS.

91. Care must be taken of every implement upon the farm. Each one should be kept in good order, well oiled before using and while being used, and never left uncovered in the field. The wooden parts of each should be kept well painted to prevent decay. The metal parts should be kept well polished, as polished metal is not nearly so likely to rust as unpolished. Too many implements are ruined by being let lie about.

ADDING TO THE SOIL. (*)

LIME.

92. Certain things are sometimes added to soil by wise farmers. One of these is Lime.

> Read again Sections 7 and 8, and then put into two bottles some fine clay, about half a handful in each. Fill one with water and the other with water to which there has been added enough Lime to make it milky. Shake both bottles thoroughly and then watch them carefully. The particles of clay in the bottle containing lime water will stick together in clots too heavy to be held up in the water, and will sink to the bottom long before those in the other bottle, leaving an almost clear liquid behind.
>
> Now in the funnel (mentioned in Section 7) let us scatter some Lime upon the caked clay which refuses to let water through, and then add water. We shall find that the clay is no longer able to hold back the water.

Lime causes the tiny particles of clay to cluster together in such a way that large spaces are left through which air and water can pass readily. It is because of this that we can, by adding Lime to them, improve clay soils: Limed land is drier, warmer, much less sticky and more easily tilled.

Lime is said by farmers ' to sweeten the soil.' This it does by putting out of action certain acids which are hurtful to plants. It makes the soil a more pleasant home for the friendly bacteria that work unseen in it, and in this way frees food for plants. (†)

Lime frees ' locked-up ' food. It ' whips ' the land into doing more work and may, unless we supply plant food

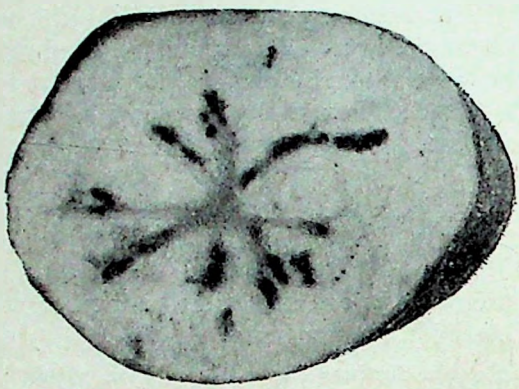
---

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin U.R. 81/1915, "The Manuring of Land."

(†) See Bulletin L.S. 39, "Lime for the Land."

along with it in the shape of manures or fertilizers, leave the land exhausted afterwards. A farmer's rhyme runs:—

"Lime and lime without manure
Will make both land and farmer poor."



INTERNAL BROWN FLECK.

A troublesome potato disease, particularly on the high veld. The brown parts remain hard when the potato is boiled and can be picked out from the soft part.

The disease is the result of poor soil. If the soil be heavily dressed with Lime (and phosphates, if wanting in these) it will probably not occur.

PLANT FOODS. (*)

93. Every wise farmer seeks to put back into his soil the Plant Foods that have been taken out of it by former crops, and without which future ones cannot fully succeed. If we make land work hard year after year by growing crops to cart away from the farm and sell, some one or other of the things which the plants need becomes used up. Large crops are really loans made to us by the soil—loans which we should pay back again.

We must, to begin with, know what it is that we borrow from the soil so as to be able to pay it back. Now in ordinary land there are but three Plant Foods ever likely to be wanting, so that these three are the only ones (except Lime) which farmers need add to their soils.

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin T.B.F. 53, "Food of Plants."

These are :—

COMPOUNDS OF NITROGEN.

POTASH.

PHOSPHATES.

If one of these be wanting in the soil, plants will fail, just as if all were absent.

Let us learn something about each of these.

COMPOUNDS OF NITROGEN.

94. We have learned(*) that the air is chiefly made up of Nitrogen, a gas which does not look in any way different from air. In spite, however, of it being so plentiful plants are not able to use it in its pure form. They can only take it when it is joined with other substances. The saltpetre which we use in curing bacon is one of such compounds and is called Potassium Nitrate. Sodium Nitrate is another and can be used in providing Nitrogen for plants.

These Compounds of Nitrogen, though so useful, have one great drawback : they dissolve very easily indeed, and if there be no plants ready to feed upon them they may be LEACHED, that is, washed out of the soil, and lost.

In South Africa, because our climate is so dry, the losses from this cause are small, and it is owing to this and other reasons that South African soils are not so often wanting in Nitrogen as are the soils in wet countries.

95. We have learned also(†) that Nitrogen forms the greater part of AMMONIA, and that Ammonia is brought to the soil by rain ; also (§) that bacteria which live upon roots of legumes (plants with pods, such as beans and lucerne) can draw it from the air, and pass it into the roots of the plant on which they live.

Here then are two ways in which the farmer gets Nitrogen without having to pay for it.

(*) See Section 19.
(†) See Section 30.
(§) See Section 19.

POTASH.

96. Long ago before coal was used and when all fires were made of wood, its ashes, scattered on the land, were found by farmers to improve the growth of their crops. When such ashes were left standing in pots of water the substance which helped plants to grow was found to dissolve in the water and, when the water dried up, lay at the bottom of the pot in the form of powder. Such powder became known as Potash. A great deal of vegetable matter is now burnt to make Potash for the farmer's use. Household wood-fires give a small but continual supply of ashes containing Potash. These should all be kept and made use of.

Many minerals are found which contain Potash, so to-day we have another way besides burning wood, of getting the plant food which is needed especially by fruit crops and tobacco plants.

PHOSPHATES.

97. Put the bone from a leg of mutton in the fire. Soon it will be a red mass. When taken out and cooled, it will be found to have lost about one third of its weight. All the animal part will have been burnt away, the earthy or mineral part which is left readily crumbling into a powder.

This powder is Phosphate of Lime, that is, a compound of Phosphoric Acid and Lime. Phosphoric Acid will also join with Potash to make Phosphate of Potash. Phosphates are very valuable plant foods, especially in South Africa where the average soil may contain but little.(*)

THE ACTION OF THESE PLANT FOODS.

98. Nitrogen and Potash keep back, while Phosphoric Acid hastens the ripening of the crop.

Nitrogen, if there be too much of it, causes a rank growth, which is very subject to attacks by insects and disease. It is largely owing to too much Nitrogen in the soil that the disease Rust makes wheat-growing impossible in some districts of South Africa.

(*) See Section 108.

Lime and Phosphoric Acid have an opposite effect to that of Nitrogen: they produce a sturdy, healthy growth.

Phosphoric Acid gives strength during the early growth of a plant by increasing its root-growth, giving it the benefit of a good start in life.

Plants growing on Lime soils are noted for their sturdy and vigorous character; while fruit grown on such soil has a delicious flavour. (*)

Every plant needs all three plant foods, and when crops are sold off the land the supply of one or more of the three plant foods will run short sooner or later. The proverb says that ' the strength of a chain depends on its weakest link ' for, if one link be weak, the whole chain gives way. Just so with our soil. If one plant food run short the crop needing it fails, even though there be plenty of other plant foods in the soil. The one plant food needed must be given or the plant will not grow as it ought.

THE GREAT NEED IN SOUTH AFRICA.

99. Now which of these four elements, Lime, Nitrogen, Phosphoric Acid and Potash is likely to be found wanting in South African soils? In Europe the greatest lack is Nitrogen, but the average South African soil, if there be enough humus in it, can be counted on to furnish plants with enough Nitrogen for their needs. Our soil is much more likely to be wanting in

PHOSPHORIC ACID AND LIME.

South African soil generally contains more Nitrogen than Phosphorus. If we add yet more Nitrogen without at the same time increasing the Phosphorus, this latter becomes the ' weak link in the chain ' and we run the risk of doing harm rather than good. Our great need then is likely to be

PHOSPHATE.

FARM MANURE.

100. The use of Manure from the stable, the farmyard and the kraal is the natural way of paying back to the soil the plant foods borrowed from it. Sheep give us the richest Manure. Dung from kraals is very rich and should not be used as fuel.

(*) Abridged from "The Soil and its Study," by A. Stead.

All living things, animals and plants, contain Compounds of Nitrogen, Potash and Phosphorus, and when such living things decay these three are set free and by degrees fitted again for use by plants. If we give back to the land any part of a crop, we are paying back a part of the loan that the land made to us. Straw given back to the soil makes other straw, yet how many farmers burn theirs!

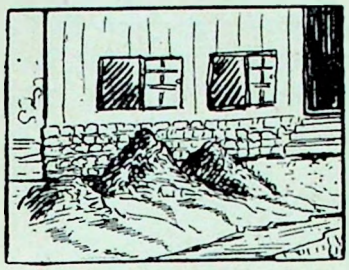
101. Dung serves best as Manure when it has rotted down into a brown mass. Usually not till then is it suitable for the soil. It has to be saved until it becomes fit for use, and it takes from six to twelve months to do so. While,

Messrs. G. North & Son.

A KRAAL-MANURE SPREADER.

however, most crops (especially vegetables) need well-rotted manure, in some cases it is best to use fresh manure, which can be spread from a Manure Spreader, the manure being pitched directly from the stable on to this and so spread evenly, finely and thinly. Manure so spread dries quickly and does not serve as a breeding place for houseflies.

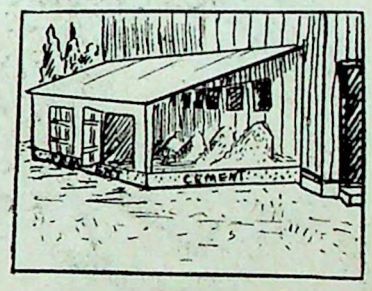
A great deal is lost on account of the poor way in which Manure is often handled. Every man who wishes to act fairly by his land will see to it that his Manure is covered up from rain and sun so that the plant foods in it are neither washed out by the one nor dried up by the other.



How NOT to store manure.

102. The liquid part is most valuable where the soil needs Nitrogen, and should not be allowed to escape. Black streams should never be allowed to run away from a farmyard; such streams contain much Potash and Ammonia. This liquid might be drained off and applied to the land later, mixed with two or three times its weight of water. Unmixed it is apt to produce a burning effect.

103. Ammonia, remember once again, is a Compound of Nitrogen and Hydrogen. It has a sharp, biting smell. Whenever this smell is noticed we know that Ammonia is escaping into the air. What can we do to prevent this loss? We can keep our manure in moist, closely-packed heaps, or in pits. If it should get too dry, water may be added. A layer of soil should be put over each day's manure after it has been put on the heap or in the pit.



How to store manure.

104. Clayey soil is much improved by adding Farm Manure, becoming easier to dig, plough and harrow, especially if such manure has plenty of straw in it. (*)

COMMERCIAL FERTILIZERS. (†)

105. If the farmer cannot get enough manure for his land from the farmyard, the stable and the kraal, he must

(*) See Sections 8, 9 and 92; and obtain from the Librarian, Department of Agriculture, Pretoria, Bulletins L.S. 94, "Farm Manures."

(†) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin L.S. 60, "Artificial Manures and their Special Uses."

buy it from the shop, but before spending money on Fertilizers he should find out what his soil needs.

He has to ask the question: "What is the weak link

ROOT-KNOT OF TOBACCO, CAUSED BY GALLWORMS.
Fertilize and cultivate well, and the plant may outgrow the trouble.

in my chain?" The best way to get the right answer to this question is to ask for advice from the nearest Agricultural Experiment Station. The farmer will there be told what

he should buy. If he buy Fertilizers without such advice he is very likely to get something that his soil does not need, and so go to the expense for nothing. He may even get Fertilizers that will harm his soil instead of doing it good. He must never trust the glowing advertisements of the man who sells them. There is no sense in buying a Fertilizer which his soil does not need, and in failing to get one which it does.

106. Once the farmer knows the weak spot in his soil, he can get, in the shape of Commercial Fertilizers, any food that his plants need. These Fertilizers can be bought wherever seeds are for sale, the merchant who sells them being bound by law to supply the buyer with a true statement of what each contains and how much of it.

107. The farmer must suit his Fertilizers not only to his crops, but also to his soil. He must find out not only what plant food his soil needs but also the form of Fertilizer that will suit it.

108. Phosphate, for example, is the plant food most needed in South Africa. One form in which the farmer can buy this is SUPERPHOSPHATE. This is made either from bones, or from rock rich in phosphate of lime ground into powder and mixed with sulphuric acid. But if the farmer's soil be already too acid, this 'Acid Sulphate,' (as Superphosphate is sometimes called, because it has so much acid in it) will add still more and harm it. He will have to apply Phosphate in some other form such as BASIC SLAG, a substance made from what is left over after the manufacture of steel. But if the farmer's soil be ALKALINE (the opposite to sour), Superphosphate is just what he needs.(*) The Agricultural Experiment Station will tell him which to use. He must bear in mind that much depends upon the FORM IN WHICH FERTILIZERS ARE APPLIED.

(*) Write to the Librarian, Department of Agriculture, Pretoria, for Bulletin on "Brakland," No. 14/1914.

SOME FORMS IN WHICH PLANT FOODS ARE SOLD.

Compounds of Nitrogen.	Compounds of Potash.	Compounds of Phosphate.	Containing Nitrogen and Phosphate.
Sulphate of Ammonia. Nitrate of Soda.	Sulphate of Potash, Muriate of Potash.	Superphosphate, Basic Slag.	Meat Meal Bones and Bone Meal.

109. Unless there be moisture in the soil to dissolve Fertilizers and make them available to the plant, they cannot have the desired effect.

GUANO.

110. Guano, like farmyard manure, usually contains all three plant foods, but its composition is much more variable. It always contains Phosphate. It is dung of seabirds and that sold in South Africa is obtained from islands off the coast of the Cape Province; it needs to be used with great caution in South Africa if it contains even a fair amount of Nitrogen. (*)

GREEN MANURING.

111. Cultivation, in a dry country like ours, has one drawback: it brings about the rapid destruction of rotted vegetable matter, which, you will remember, we called HUMUS. When soil specially needs humus farmers somtimes sow quickly-growing crops, such as mustard and rape, and just as these reach the flowering stage, plough them under for the sake of enriching the soil. Weeds, of course, will do just as well and should be ploughed in, not burned. This plan of ploughing under unharvested crops is known as GREEN MANURING. The plants are not wasted since they furnish food for the next crop that goes in. Any plants whose roots go deep gather plant food from the subsoil, and the crop sown after they are ploughed under is more easily able to get its supply. In Europe legumes—the great family of plants that bear their fruit in pods and to which the bean, pea, lucerne and clover belong—are generally sown because they gather Nitrogen from the air and, turning it into the plant, save the farmer the cost of buying a fresh

(*) Write to the Librarian, Department of Agriculture, Pretoria, for Bulletins: U.R. 27/1913, "Guano," and No. 15, 1918, "Bat Guano."

supply. In South Africa, however, Nitrogen is seldom ' the weak link in the chain,' so there is usually no special reason for a leguminous " soiling crop " as the ploughed-under crop is called.

112. South African soils into which crops are ploughed should usually be fertilized, at the same time, with phosphate. (*)

OTHER PLANS TO KEEP THE SOIL FERTILE.

113. The wise farmer knows that, while all crops need the same plant foods, some varieties of plants require more of one kind than of another, so that while one variety of crop may fail because it is unable to obtain its food in a soil, yet a crop of another variety may prosper. He makes plans to use his food supply to better advantage, and to make it last longer.

114. But first he has to learn how much of each plant food each crop takes from the soil.

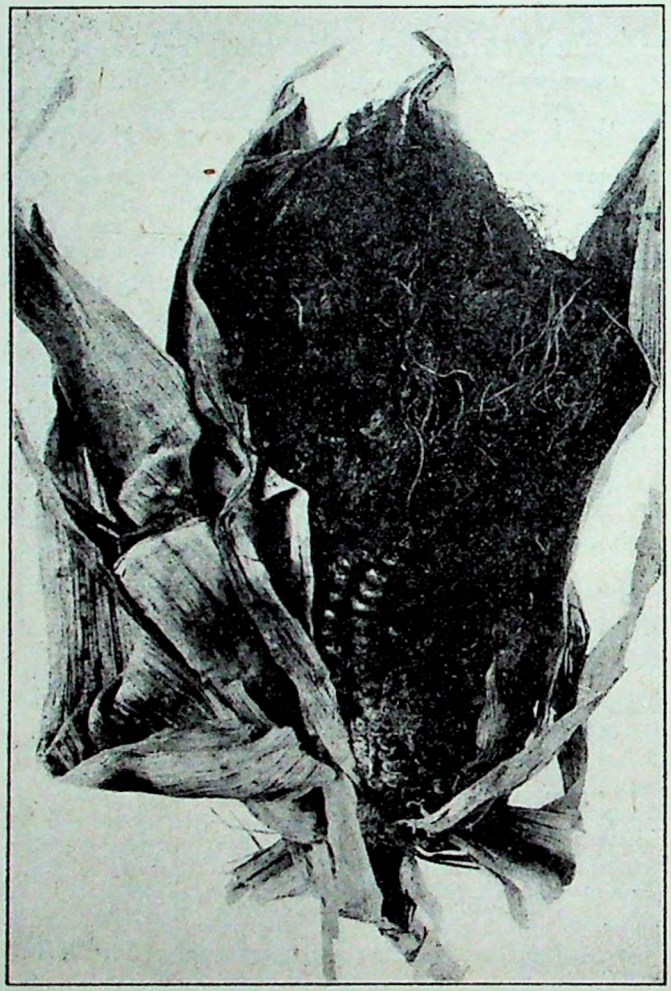
TABLE OF LBS. PER MORGEN REMOVED BY GOOD CROPS FROM SOIL.

	Nitrogen.	Potash.	Phosphoric
Mealies	97	81	40
Wheat	108	65	47
Barley	108	80	47
Oats	124	104	43
Mangolds	310	677	119
Potatoes (tubers)	103	172	48
Beans	182	88	56
Lucerne	339	364	174

As will be seen, the amount of each plant food taken from the soil varies. For example, a crop of mangolds takes away no less than 10 times the amount of Potash that a crop of wheat does. It is clearly unwise to grow potash-loving crops one after another. Instead they should be grown turn about with plants such as mealies.

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin U.R. 6/1917, "The Effects of Green Manuring and Fertilizers on Crop Production," and obtain Industries Bulletin, No. 19, "Fertilizers."

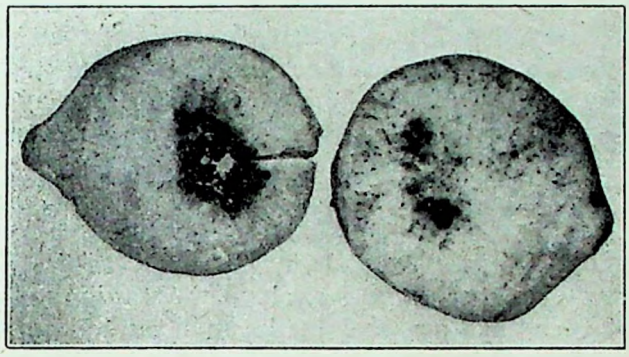
115. With this knowledge the farmer can "arrange the cropping of his fields so as to suit their weak points and their strong ones." "Turn about is fair play," says the



MEALIE SMUT.
To keep clear of this disease rotate your crops.

proverb, and changing crops about has other good effects besides using up plant food to the best advantage. When the same crop is grown year after year certain weeds, certain insects and certain diseases come to trouble the farmer. Changing crops about, or "Rotation of Crops," as it is

called, keeps these weeds, insect pests and diseases in check and also compels the farmer to feed stock and manure his land. (*) A system of Rotation of Crops should take into account the peculiarities of the plants, the length of time



BLACK ROT IN TURNIPS.

Discoloration of veins and gradual dropping of leaves. The veins get discoloured and the leaves gradually drop off. To prevent this disease rotate crops and disinfect the seed with Corrosive Sublimate (K). Watch seed beds and destroy diseased seedlings.

each occupies the ground, the season during which it grows, whether its roots be shallow or deep, and the wants of the farm. (†)

116. While, however, a suitable system of Rotation can do much, it must not be thought that it can save any land from at last losing its food supply. It cannot do so because each crop carries some away, and no soil can go on supplying it for ever. The best plan is the use of suitable manures.

117. Another plan for keeping soil fertile is to use it for a time as pasture ground, or to let it lie FALLOW, that is, without a crop, for a season. Though we speak of such land 'resting,' there is much change going on in it—especially if we keep it awake by tilling.

(*) See Sections 119-127.
(†) See Appendix, FUNGICIDES, K.
For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin U.R. 48/1914, "Fertilizers and Crop Rotation."

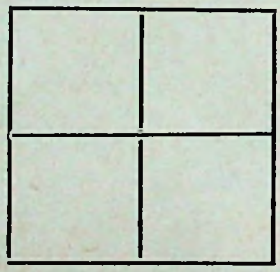
Just as a good boy comes back to school after the holidays refreshed and ready to work hard again, so the soil, after a time of rest, is full of new energy. If we keep it ploughed, it does not go to sleep any more than does the boy in holiday time. There are changes going on in it by which much of its sleeping matter is being roused from sleep and being made into useful plant food. This plan of keeping land fertile is a very ancient one; we read in the Bible that the Children of Israel were bidden, on entering Canaan, to give their land a ' sabbath of rest ' every seventh year. (*)

WISDOM FARM.

118. Now, let me tell you how a farmer, named Mr. Wisdom, found out much in books, about these things of which you have been reading, and made up his mind to see for himself if they were true.

His books had taught that he could not always go on growing one kind of crop on the same land, so he made up his mind first to grow one kind of crop, and then another kind. (†)

119. He divided is farm like this :—



Year after year he changed his crops about, while at the same time he used (as advised by the Agricultural Experiment Station) fertilizers to supply the place of the plant foods the crops had taken from the soil.(§) No field grew the same

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin U.R. 4/1914, "Some Conditions which Affect Soil Fertility."

(†) See Section 116.

(§) See Section 114.

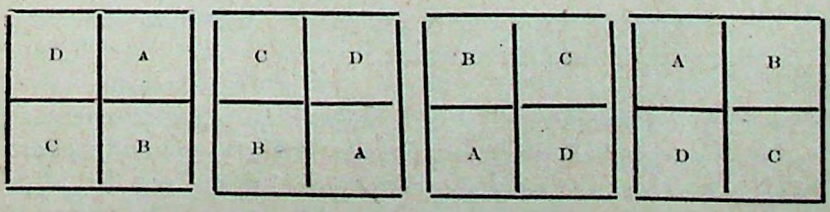
crop two years running. In this way he learned that fields really did yield better when crops were changed about than when one field bore the same crop for many years together.

120. He told his neighbours about this. One of them did not see the use of it. "I plough, sow and reap," said he. "Providence does the rest."

"Your soil at present is producing good crops without manuring," answered Mr. Wisdom, "because during long ages it has been stored with plant foods, but, however rich it now is, it will wear out sooner or later. (*) Without the knowledge of how to prevent this a farmer becomes a mere sowing and reaping machine unable to make progress. Without the knowledge clever men have now gained, a farmer is at the mercy of bad seasons and crop diseases. Why should the farmer alone of all manufacturers leave his results to fortune? Other manufacturers make themselves so skilful in their business that they know almost exactly what their preparations will bring them. Why, in farming, the foundation of all other trades, should so much be left to chance?"

121. "But I could not change my crops about," said another farmer, "for I like to grow the same crops year after year."

"So do I," said Mr. Wisdom, "and I *do* grow the same crops every year too!" He explained to his neighbour that, though each field was bearing a different crop from that borne last year, yet the farm was growing just the same produce year after year. Every year one field was in Crop A, one in Crop B, one in Crop C, and one in Crop D. He had changed his crops about so that B always followed after A, C after B, D after C, and A after D.

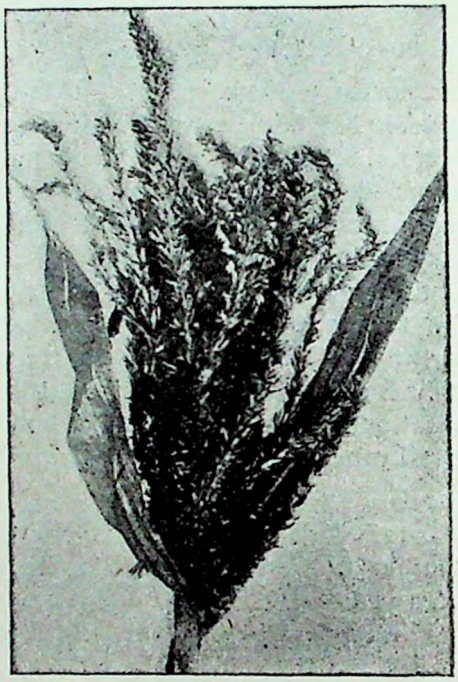


(*) See Section 116.

His neighbours said that he made his farm ' rotate' like a wheel, so he called his plan Rotation of Crops.

By and by, for Mr. Wisdom was eager to know why his plan worked so well, he read more books and learned of some differences between plants that accounted for his success.

122. He found that some plants having short roots, feed near the surface, while others with long roots feed deep down; and that all plants have not the same needs, one kind requiring more of a certain plant food than another kind. (*) While the plants with short roots occupied the soil, the sub-soil was having a holiday and plant food was slowly collecting there; after such plants he sowed others which sent their roots deep down taking the foods they wanted from far below. While these were growing the top-soil was having its holiday and was ready to work again when its time came to supply short-rooted plants with plant food.



MEALIE SMUT.

To keep land free from this disease rotate your crops.

His neighbours came together to hear him tell how his plan worked out in practice.

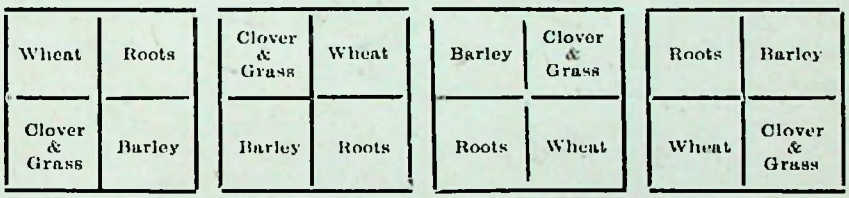
123. " I cannot tell you," he began, " of any one plan which you may all work on, because, when you have heard all I have to say, you will understand that a Crop Rotation which will suit one farm may be quite out of the question

(*) See Section 114.

for another. Only the farmer himself can decide what Rotation is best for his farm. But let me tell you of a plan, known as the Norfolk 4-Course Rotation, which has for many years been found successful in one part of England. Follow it out with me right through, and let me tell you some of its good points. This may help you to think out plans to suit your own farms and requirements."

He drew a figure on the blackboard representing the Rotation :—

First Year : Roots (manured with farmyard manure and partly fed to stock on land).
Second Year : Barley.
Third Year : Clover and Grass.
Fourth Year : Wheat.



124. " One advantage of this plan," Mr. Wisdom explained to his neighbours, " is that there is an equal amount of work throughout the year, and that the farmer can do with but little plant and few working animals."

" It gives him, too, plenty of food for his stock, and grain to sell. The straw comes in useful for bedding and so becomes manure."

125. " If all the corn and fattened cattle be sold off the land the soil will, it is true, become poor in time, in spite of the fact that much plant food is restored to it in the manure produced by feeding the cattle with the hay and root crops. But the farmer usually feeds his cattle also upon oats, cotton-seed cake, etc. These are bought when the corn is sold, so that wagons taking corn to market come back laden. The oats and cake so bought, when fed to animals, add to the plant food in the soil.

" A Norfolk farmer who feeds oats and cake in addition to the roots and hay grown on the farm, and who uses all

his straw for food or bedding, and returns all the manure to the land, is actually enriching the soil year by year, although he sells off all his barley, fattened cattle, sheep and wool.

126. " Another benefit of this plan is the cleaning of the land. The root crop is not sown until late in the season, giving plenty of time for ploughings and harrowings. Throughout the growing period of this crop it is kept clean by constant hoeing. This crop is a gross feeder and that is why most of the manure is given to it. Another reason is that the following crop requires a rich but mellow soil and one in good tilth, especially on account of the fine seeds (clover and grasses) that are sown soon after the barley is up.

" Sheep are often ' folded ' on the lighter soils to eat off the whole or part of the root crop. This manures the land for the next crop and also does it good by ' tightening ' it.

" The clover and grass crop provides hay for stock."

127. Mr. Wisdom went on to explain how, by learning of this Crop Rotation, he had come to see the folly of selling all his crops. Now he saved some for the winter, fed stock upon them, selling such fattened stock next spring. This he called " carrying his crops to market on four feet." Much of the food produced by the farm was thus left upon the land in the form of manure, and this manure kept the soil in good condition and made splendid seed beds.

Now, Mr. Wisdom seemed to his neighbours to be quickly becoming rich, while they were no better off than before. And yet they had laughed at him for trusting so much to book-knowledge!

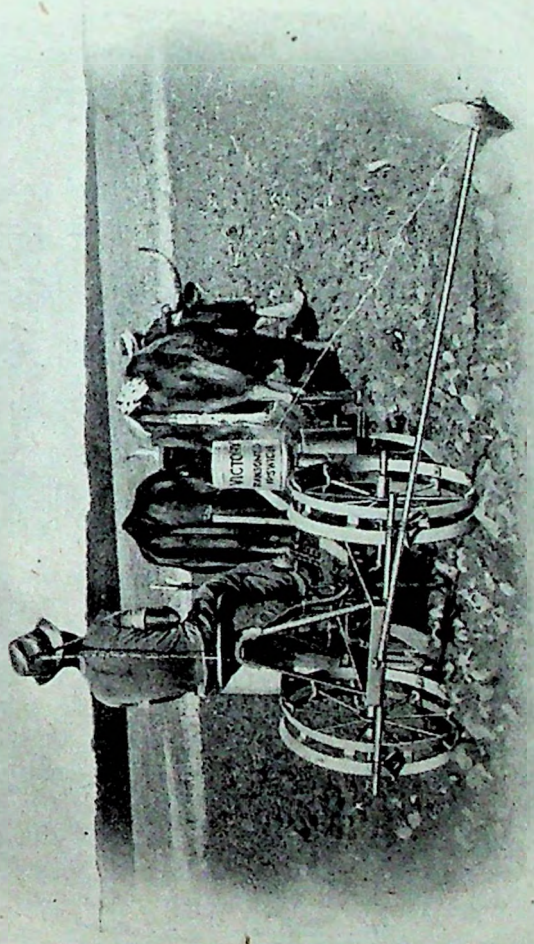
128. " How is it that you are doing so well?" one of them asked him. " Your wages bill must be bigger than mine."

" True," said he, " but my bill for seeds is less, for I use a drill, while you still believe in broadcasting." (*)

(*) See Section 86.

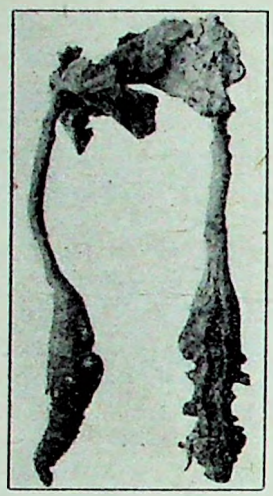
Mr. Wisdom's crops were so much better than his neighbours' that they could not answer him.

But how could it be that he had made a profit while they had little or none? It must be that he was favoured by fortune, for when their crops (which grew in the same fields from year to year) were attacked by disease and nothing they



could do made matters better, Mr. Wisdom's crops were free from disease!

129. "How is it?" asked one, "that your turnips have no "club root"? Our fields are full of disease."



Club Root of Cabbage and Turnip.
Roots become swollen and badly formed; plants are stunted.
Remove and burn affected plants; apply lime to soil, 30 bags to acre.
Practice crop rotation.

" The little soil creatures (called FUNGI) that cause such diseases, can only live upon certain root plants, and since turnips grew upon each field of mine only once in every four years, these creatures died of starvation in the years between. I read, too," he went on, " that such fungi can only thrive in acid soil, so I put on a dressing of lime to make certain that they should not live." (*)

130. " But why," said another neighbour, " is your wheat so free from weeds this season? My field is full of wild mustard."

" I cleaned the land," said he. " Growing mangolds and mealies gave me a chance of killing the weeds by cultivating between the rows. That is the reason, too, why my wheat is so good. I have not allowed weeds to take the plant food intended for it." (†)

131. " Why did you buy that?" said another, pointing to Mr. Wisdom's roller.

" I read a story," said he, " of an English peasant whose wheatfield was trampled by his landlord's horses and hounds while hunting foxes. The angry tenant asked for, and got, payment for the damage done. But at harvest time he paid the money back again. No damage had been done at all! The trampled land had borne twice as much wheat as the rest. Now I," added Mr. Wisdom, " have bought a roller to ' trample in ' my wheat seed." (§)

132. In addition to the land upon which Mr. Wisdom rotated his crops, he had some veld upon which he grazed his cattle. Year by year he ploughed and sowed more and more of this until at last he had it laid down in pasture

(*) See Sections 18, 92.
(†) See Section 67.
(§) See Sections 87-89.

grasses that grew on from year to year and which he knew throve in that district.

133. His neighbours each spring burned their veld, while Mr. Wisdom never burned his. Gradually his farm began to support more stock, while theirs came to support less.

Messrs. W. North & Son.

The Tooth Cultivator thoroughly stirs the soil and uproots weeds.

"Why don't you burn your grass?" one asked him.

"There are two classes of grass in the veld," he said. "coarse and fine." Burning the veld every year kills off the finest and best, but leaves the coarse. I thought it better to plant my pasture with fine grass and now I do not need to burn it at all."

134. One afternoon while I was on Mr. Wisdom's farm, he was harrowing mealies. They were quite half a foot high and the harrow was pulling up some of them. One of his neighbours passed by and drew up his horses and joked with him. He had never seen mealies harrowed when they were as high as that! Why did Mr. Wisdom harrow mealies half a foot high?

"Did you never hear?" said he, "the old farmers' saying: Good harrowing is half farming?"

Just then there was a great drought, and of all the mealies in that part of the country only Mr. Wisdom's lived. His harrowing had kept in the soil a supply of water for their needs. The very man who had joked with him came himself to buy seed for his next year's sowing.

Fruit Trees.

300. If one reads the Bible it is easy to see that fruit trees and vines were planted and cared for in the very earliest times. Adam and Eve were supposed to live in the Garden of Eden, and if there had been no fruit trees there, Eve could not have given Adam that apple we all know about, and so we might have been quite a different lot of people to-day.

I am not quite sure after all that it was an apple that Adam ate, but it was fruit of some kind, and we are told that it was good for food and pleasant to the eye. I don't think we shall ever know what kind of fruit it really was, but as we are told that the Lord God planted a Garden Eastward in Eden we should know that all the fruit thereof was good. We read that Adam and Eve sewed fig leaves together and made themselves aprons, so that this tree proved useful in more than one way. Then we may also read, in that Book of Books, of vines and pomegranates, but not of pears and peaches and plums and apricots. If you ask the reason for that, the answer is that in those days such fruits, as we have them to-day, were unknown; but, although this was the case, there must have been present somewhere or other wild types of these fruits which were the parents of the beautiful kinds we now enjoy so much.

It is believed that all our nice apples have come from the sour crab apples of Northern Europe, and that the almond is the parent of the peach and nectarine. This may quite easily be the case, but one can only guess because nothing is really known.

What we do know is that the first fruit trees bore fruit, that some of this dropped to the ground and rotted, that young trees grew from the seeds of the fruit, and that for thousands of years these trees just grew up in this way. We, nowadays, call fruit trees which are grown from seed,

"Seedlings," so in the old days all fruit was grown on "Seedling" trees.

301. One thing to notice in a seedling tree is that it does not bear exactly the same fruit that its parent did. There may be a great resemblance, a sort of family likeness, but one can nearly always find some difference, and so you can see that fruit borne on trees to-day may be quite different to that which the parents of those trees bore 500 years ago.

One must also remember that most people like nice fruit, and when an unusually nice peach or apple or pear was found you may be sure everyone else wanted some like it, and so, many hundreds of years before Christ came, people knew how to bud and graft trees in order that they might get more of the kinds that bore the best fruit. No one knows who found out how to do these things, but an old Roman gentleman named Columella, who used to write books on Agriculture about 50 years B.C., says in one of them that grafting was taught and practised by the "Ancients," so that it must have been thousands of years ago.

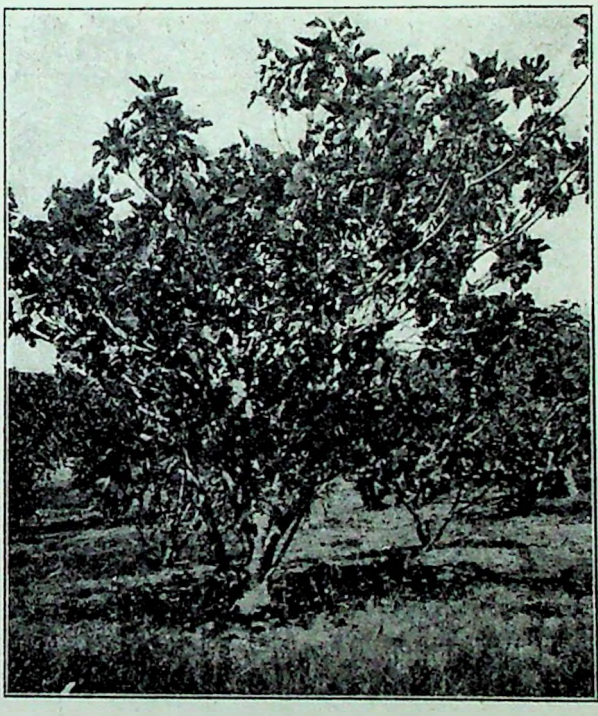
302. Fruit was, and is, a very important food amongst the Arabs and the people of Northern Africa, Persia and India and the countries bordering on the Mediterranean Sea. Dried figs, plums and apricots are largely eaten, but by far the most important of all fruits there, is the date. There are many millions of date palms in Northern Africa, Persia and Arabia, and if it were not for the fruit of these beautiful trees thousands of Arabs would die of starvation, because the date is their chief article of food.

Just as dried fruit has been a chief food of these people, so canned fruit also was used but not so much. The fruit was not put up in cans, because they had no cans in those days, but they used stone and earthenware jars with stone lids which were fastened on with a special cement.

About 1866 a party of men were digging amongst the ruins of Pompeii in Italy, one of the two cities which were buried in ashes in the year 79 A.D. owing to the eruption of Mount Vesuvius, when they found some of these jars of fruit; they opened them and found some figs which were

still good and sweet after many hundreds of years. The figs had not been kept or canned in sugar because there was none in those days, but honey had done just as well. It is interesting to know that finding these figs made people try to can fruit and other things, with the result that food of many kinds—such as meat, fish, vegetables and fruit—is now sent from one country to another all over the world.

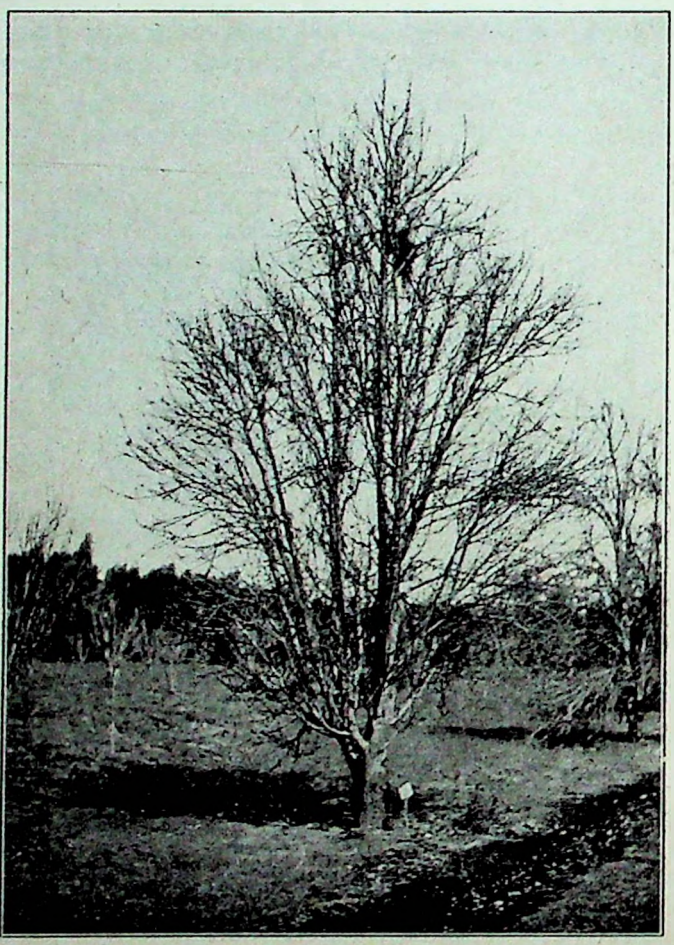
This is what we know about fruit in the past. Let us now look and see what one can find to say about fruit trees in South Africa.



A WALNUT TREE.

303. Firstly, you must remember that the different fruits want different conditions, that oranges, lemons, bananas, pineapples, pawpaws, mangoes, etc., need a warm climate, where there is little or no frost and where there is a good supply of water for irrigation when needed. Such fruits as apples and pears delight in a cold climate, whilst peaches, apricots and plums grow best where it is neither

too hot nor too cold. It is easy to see, when you think of this, that one cannot grow the best oranges and also the best apples in the same garden or orchard—if the climate were cold then the apple trees would thrive and the orange



A Pear Tree (variety "Douglas") never pruned. Much of its fruit was lost in wind storms and eaten by birds.

trees most likely would die; on the other hand, if the climate were too warm the oranges would thrive and the apples—though they would not die—would not produce such good fruit as they would have borne if the trees had been planted in the right climate.

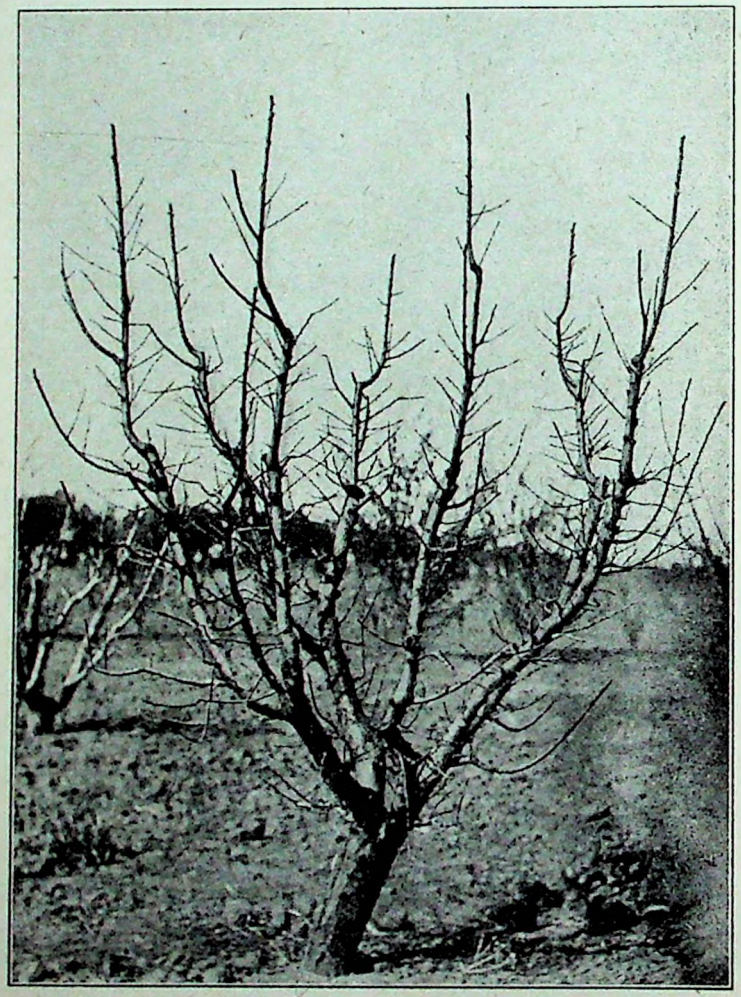
304. Then there are parts of the country where there is little or no rainfall; these are called "arid," and many people would think that no fruit would grow in such places. The Creator in His great purpose, however, gave us the date

The same Tree shortened back and its head opened. It produced a fine crop.

palms, and these beautiful trees delight in spots such as no others would grow in.

Again, one may find along the Eastern coasts of our continent beautiful groves of cocoa-nut palms, and these love to be as near to the water as possible.

It can, therefore, be seen that some fruit or other can be grown over the whole of the Union of South Africa from the coast to the highest points inland and in the wettest as well as the driest places.



A Peach Tree regularly pruned throughout its lifetime.

Tropical fruits, such as those we first spoke about, are usually found growing best in the low veld and bush veld and in the lower hill-country near the sea coast. Stone fruits, apples and pears do better in the higher parts of the

country, such as the high veld, or, in the case of stone fruits, in those parts of the Western Province where the rainfall occurs in Winter.

305. Now, there is hardly any fruit of all those we grow to-day in such quantities which is INDIGENOUS to South Africa. (By INDIGENOUS, I mean native to the country.) Pawpaws, dates and cocoa-nuts are the only ones and these have been brought down to the Union from the Northern parts of the continent. All the others are, what is called, EXOTIC, meaning that they have been brought to South Africa from other countries, mostly from Europe.

306. It is wonderful to think that in this beautiful land of ours there are places where almost any kind of fruit tree will thrive, no matter whether it has been brought from the cold Northern climate of Europe or from the torrid regions of this or other countries. Each type of fruit is planted in climates best suited to it and, as these are found at different ALTITUDES (or heights above the level of the sea), it is usual to say that certain kinds of fruits do best at such and such an altitude. It should, however, be remembered that the altitude itself has nothing to do with the success or failure of any plants or trees. Success or failure depends upon the climates found at certain altitudes. As one gets nearer the Equator the sun has greater power, and so there is a difference between the degree of heat at a given altitude there and that found at the same height, say, a thousand or more miles North or South; so that climate must vary even at the same altitude in accordance with the latitude.

KINDS OF FRUIT TREES.

307. Fruit trees are generally spoken of as either CITRUS or DECIDUOUS. By CITRUS we mean all kinds of oranges, lemons, naartjes, etc., and by DECIDUOUS we mean all those fruit and also other kinds of trees which shed their leaves in Winter. Botanists make a good many other classes amongst fruit trees and call apples, pears, quinces and, in fact, all fruits with pips, *Pomaceous* fruits,

that is, fruits "like an apple." Plums, peaches, apricots and all kinds of stone fruits they call *Drupes* or *Drupaceous* fruits, that is, "like an olive"; figs and mulberries, *Moraceous*, that is, "like a mulberry." Then there are nuts of all kinds in another class by themselves, and grapes are also classed as fruit.

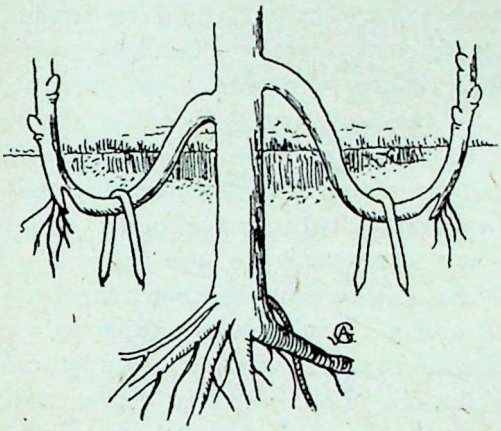
308. Besides the above, all of which may be called "tree fruits," there are others such as currants, raspberries and blackberries and many other berries; these are commonly called "bush fruits."

LAYERING.

309. Fruit trees may be grown from seed, or, in many cases, from cuttings and also by means of "layers." This method has been largely practised in South Africa, but fortunately is not so much depended upon now. The great advantage claimed for layering is that the young tree grown in this way bears fruit the very same as the parent tree and begins to bear almost as soon as it is planted out. The great disadvantage lies in the fact that all trees produced by layering start life with an imperfect root system, as may be easily seen when we show how it is done, and so there is always the chance that disease may attack the roots and cause the death of the tree; this is particularly likely with all kinds of the citrus family. The usual way of growing young trees by layering is to choose the tree from which it is intended to get the young shoot, first of all for its healthy vigorous growth, and next because of the large quantity of fruit it bears. It is no use taking layers from a sick tree, because then the young trees will also grow up sickly or may even not grow at all. When getting fresh trees—whether by this or any other method—one should recollect that "like parent like children" holds good, and that it is just as easy to grow trees of a good bearing kind as of a poor one.

310. In order to go to work the easiest way, the tree chosen should have branches as close to the ground as

possible; those to be layered should be cut half way through with a knife or saw, then partly broken and the branch at that point thrust down into the soil, which should be made to cover it as thoroughly and deeply as possible. One end of the branch is still attached and growing on the tree, the other, or tip end, is slightly above the ground and the broken spot is under the ground. The result is that the broken part of the layer begins to throw out roots and the parent tree still keeps the branch alive through the part which is not quite cut off. As soon as enough roots have been formed to support the young tree, the soil is taken away and the unbroken part of the branch cut. The layer is now a young tree ready to be planted wherever it may be wanted. Its weak spot is the wound made by the breakage of the roots and the fact that these often spread too much in one direction, thus making an unevenly balanced tree. As many as 40 layers may be obtained from one old tree.



LAYERING.

CUTTINGS.

311. In some districts of South Africa, trees are grown quite easily from "cuttings." Figs are often, if not always, grown in that way, as also are quinces and some other fruit trees. Cuttings are taken from a good parent tree and may be any length desired—sometimes fig trees are grown from a single bud on a cutting not two inches long. The best length is from 12 to 18 inches. Cuttings for planting should be taken from the tree when it is without leaves or blossoms.

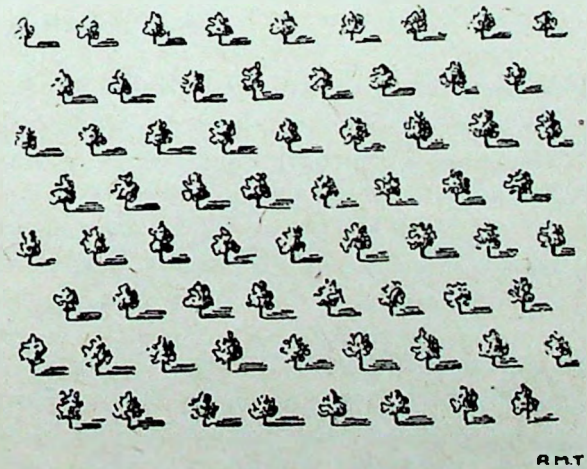
The best time is the close of Winter. The cuttings are placed in the ground, six inches apart, in rows four feet distant from each other. Each cutting is buried two-thirds of its length, so that if it be twelve inches long there will be eight inches under and four inches above the soil. In making cuttings it is usual to cut them so that the bottom end of each slip may have a bud half an inch or so above it. Cuttings made in this way as a rule start more quickly than when they are made in the middle between two buds. They should be kept MOIST BUT NOT WET. As the Spring of the year advances and the soil becomes warmer, the buds above ground will swell and put forth leaves and, later on, young shoots. All which do not grow should be pulled out to make room for those that do. The following Winter they may be taken up and planted out wherever they may be wanted.

GROWING FROM SEED.

312. The growing of trees from seed is the best possible way of going to work. One gets stronger and better trees with healthy and naturally grown roots. It is also the easiest and simplest way, being nature's own and therefore best. All kinds of trees may be grown from seed, but as there are varieties of some kinds of trees, such as the Washington Navel orange, which have no seed, these special kinds must be grown by other means. Apples, pears and quinces are sometimes called "pip" fruits and their seed has to be handled differently to that of peaches and plums. The coating which is round the kernel is hard, and so, if the seeds of these fruits are soaked in cold water for a week before they are planted, they have a much better chance of growing than if they are planted without this being done. Generally such seeds are sown broadcast in the ground, which should be light and sandy rather than heavy, in beds about four feet wide and eight or more in length, according to the quantity one has to sow. At the end of the first year's growth they are taken up and replanted in the same manner as that described for cuttings.

TWO WAYS OF LAYING OUT AN ORCHARD.

Most room is given each tree and most room for cultivating and irrigating by planting trees in squares. At 20 feet apart, trees planted so go 108 to acre; at 22 feet, 90; and at 24 feet, 76.



The hexagonal plan economises space but the land can only be cultivated in three directions, and is not so convenient for irrigating and hauling out a crop of fruit. At 20 feet apart, there are 126 trees to acre; at 22 feet, 103; and at 24 feet, 86.

313. Such fruits as peaches, apricots and plums are called "stone" fruits and the seeds of these should not be allowed to get dried up or they will not sprout the first year after planting and, perhaps, not at all.

314. It is usual to take the seeds from the fruit and to place them in the ground in a shallow pit made for the purpose. Such a hole should be about a foot deep and may be of any size wished for; a layer of sand about an inch deep is spread over the bottom of the pit, and a layer of seeds placed on it; then another layer of sand is put in and another lot of seeds, and so on until the hole is full, when a layer of soil should be put on top and kept covered over with straw or long grass: if this from time to time be sprinkled with water the seeds are kept moist until the time comes to plant them out in rows in the way above described.

315. THE BEST SEASON OF THE YEAR TO PLANT ALL KINDS OF FRUIT TREE SEEDS is just at the close of the Winter months, when one may expect the sun to get a little stronger and so warm up the soil, because without light, air and warmth, growth is hardly possible.

It should not be long before the young shoots push their way through to the surface. They should make their appearance in about from three to nine weeks, the time depending on how well they have been stored. They grow rapidly and at the end of a year are ready for transplanting or to be BUDDED OVER to the varieties needed. Nearly always they are budded.

316. Seeds of orange, lemon and naartje trees of all kinds grow quickly when properly cared for and planted. The seed is taken from ripe fruit and kept moist until it is planted; to keep it moist it is mixed up with damp sand until planting time comes and then it is treated something like the apple and pear seed; the seed beds, however, must be placed in a sheltered place where there is no frost or only a very little, as otherwise the little trees are liable to be killed

by the cold. As soon as the plants are eight to ten inches high they are transplanted into what are called "nursery rows" and placed from nine inches to one foot apart in the row with four feet between rows; then, when they get as thick as a lead pencil, they are ready to be budded, or they may be allowed to go on growing where they stand if they are to be sold or planted as "seedlings."

Very few people, however, plant seedling fruit trees, because there is no certainty about the kind of fruit they are to bear: some may produce fruit something like that of the parent tree, whilst others will give fruit quite different. Because of this uncertainty people "bud" or "graft" their seedlings so that they may be quite sure to get what they want when the tree grows big and bears fruit.

BUDDING.

317. Budding is one of the easiest operations, and is done like this: a "bud" is taken from the tree from which it is desired to grow others, and is put into a slit made in the bark of the seedling in such a way that the exposed cut surface, showing the inner bark of the bud, should touch the growing wood of the STOCK (or stem into which the bud is inserted). The cut bark must then be wrapped in something in order to make sure that the two shall join and to prevent the drying out of the bud, which will happen if this be not done.

Figure I.
A BUDDING KNIFE.

It is usual for a budder at the beginning of his work to get a number of cuttings of the kinds needed for getting young trees and to cut all the leaves off them.

The bud sticks, as they are called, should be kept fresh and moist by wrapping in a damp cloth. Figure I. shows a proper budding knife, without which it is not wise to begin the work, and it may be

Figure II.
A BUD STICK.

noted here that this knife must be kept as sharp as possible. The blade is used for making the T shaped cut needed, and the ivory haft is for opening up the bark if it does not " slip " easily.

Figure II. shows a bud stick, as carried by the "budder," ready for use.

The work of budding is begun by the gardener, who has everything ready, taking the seedling in hand and making a cut lengthwise down the wood through the bark at a spot some 5 inches above the ground. Then he makes a straight cut across it towards the top of the first cut with the blade of the knife held slightly downwards (A, Figure III). In withdrawing the blade a slight turn outwards leaves the top of the first cut open and ready to receive the bud (B, Figure III). If not open wide enough he takes the thin end of his knift handle and lifts the bark at the top enough to admit the bud easily. Next he takes a bud, cut, as shown in Figure IV, from the back

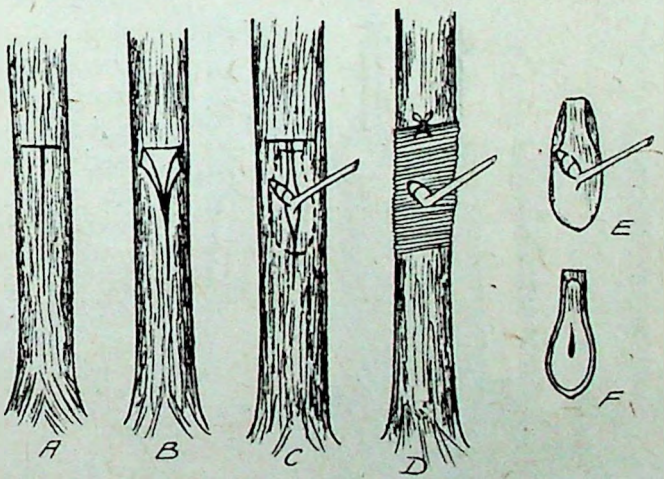


Figure III.—BUDDING

A—An upright and a cross cut made in the bark = T.
B—The bark opened, "lifted," to receive the bud.
C—Bud inserted, ready to tie.
D—Wound tied up, enclosing bud, but leaving the "eye" clear.
E, F—Front and back view of a bud.

Figure IV. Cutting a bud from the Bud Stick.

part frontwards, pushes the point into the opening made for it and gently forces it down until it is in the position shown in Figure III, C. Lastly, he has to firmly tie the bud in its place. This should be done so as to keep out all air, and needs to be tight enough to keep the bud close up to the growing woody part of the stock, but not so tight as to cut into the bark (Figure III, D). Some ten days after the work is finished the bindings should be looked over and, when necessary, loosened, as the growth of the stock will sometimes cause the stuff used to cut into the bark, thus pushing away the buds and making the work of no use. Nurserymen generally use "raffia grass" to tie in buds, as it is cheap and thoroughly answers the purpose. Strips of calico, tape, etc., may also be used, in fact, anything in the way of strips of bark or fibre which will stand hard pulling. String is sometimes resorted to, but this is not advised on account of its tendency to cut into the bark.

Figure V. A Seedling "budded up."

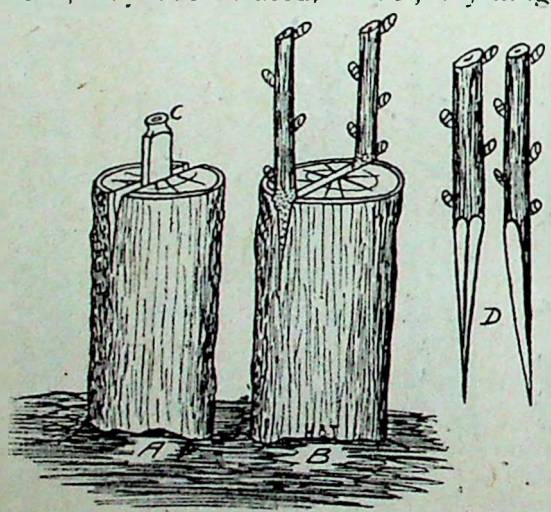


Figure VI.—CLEFT GRAFTING.

A—Stock headed back, cleft open by small wedge.
B—Scions inserted in cleft (wedge withdrawn).
C—Small wedge to hold cleft open.
D—Showing scions cut wedge shape.

Figure V represents the first cuts of almost the same bud, with the difference that it is turned upside down in order to allow the bud to be pushed upwards instead of downwards. This change in the manner of working is

necessary because too much moisture is likely to gather round the tying material during our wet weather, and, if it gets into the cut the seed may decay, especially in working such trees as orange, lemon and naartje. The custom of "BUDDING UP" is looked upon as the best one for the working of all kinds of trees of the citrus family.

Possibly nine-tenths of all trees sold in nurseries in South Africa are produced by the use of one or other of the above ways of budding.

GRAFTING.

318. Grafting of nursery stock, at one time the usual way of increasing trees, has now been almost entirely given up in favour of budding, the latter method being just as good and far more quickly done. Seedlings to be grafted must complete at least the first year's growth from the pit, and if not then large enough may be left for another year.

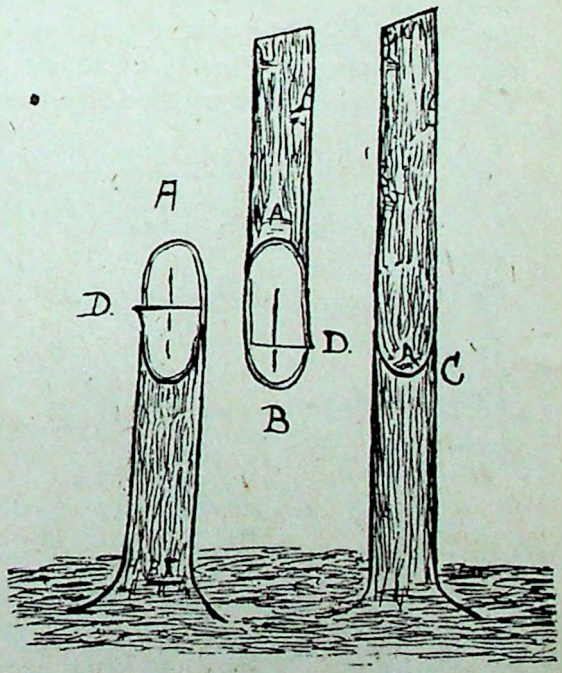


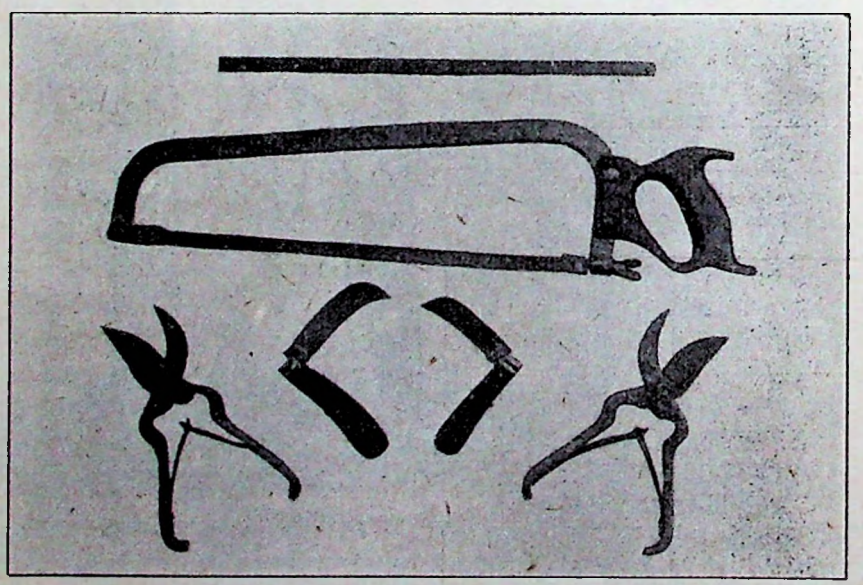
Figure VII.—WHIP OR TONGUE-GRAFTING.
A—Stock cut back and prepared for scion.
B—Scion prepared to fit stock.
C—Stock and scion united, ready for tying and waxing over.
D, D—Showing tongues made to hold grafts in position for tying.

Grafting must be done as late in the Winter as possible, and may be carried out either in the nursery rows in which the seedlings have been planted, or the STOCKS (stems in which the grafts are to be placed) may be taken out of the soil and worked in

any convenient place. The way of doing the work is the same in both cases. There is little need of removing the stocks in this country, so that the method of grafting in nursery rows need only be spoken about.

The kind of graft to be used will depend largely on the sizes of the stocks to be worked. If they are unequal as to size and measure, from ½ to 1 inch in diameter, the CLEFT GRAFT is the better way, as shown in Figure VI. When the stocks are smaller and of a size somewhat near that of the SCIONS or slips for grafting, the WHIP or TONGUE GRAFT may be used (Figure VII).

In either case the stock is cut off a little above the crown of the roots, and as this spot is usually below the surface of the ground the soil may be removed along each row, allowing the crown roots to be seen before the work begins. Usually scions are put in with three or four buds tied with raffia, which together with the tip of the scion is then painted over



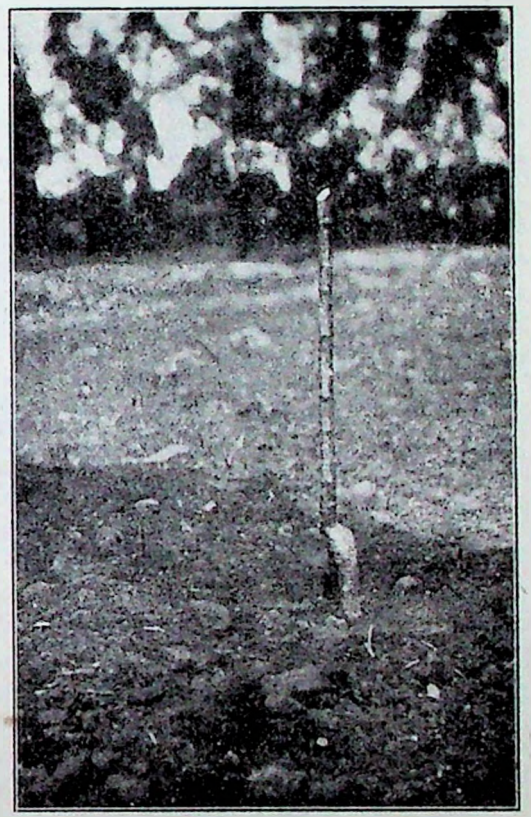
PRUNING TOOLS.

with warm wax and the earth brought back along the whole row, just high enough to allow the two top buds to be seen. (*)

PRUNING.

319. Trees need pruning year after year, and those which drop their leaves in Winter are pruned during the time they are without them.

FOR THE FIRST FOUR YEARS A TREE IS PRUNED TO ENCOURAGE ITS GROWTH; TO BUILD UP STRONG LIMBS, AND TO GIVE IT A GOOD SHAPE.



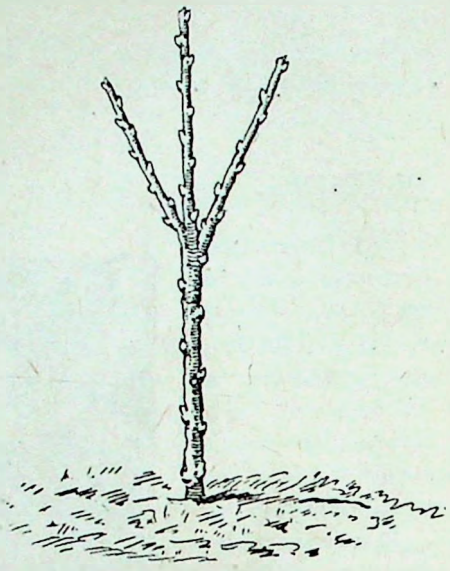
"Heading back."

The best shape is the "goblet" or "vase" form. To obtain this the year-old tree is HEADED BACK to the height of one's knee, so as to bring about a low head built on short sturdy arms which will bear heavy crops of fruit without breaking. A tree with a low head is easily sprayed and pruned and its fruit easily picked.

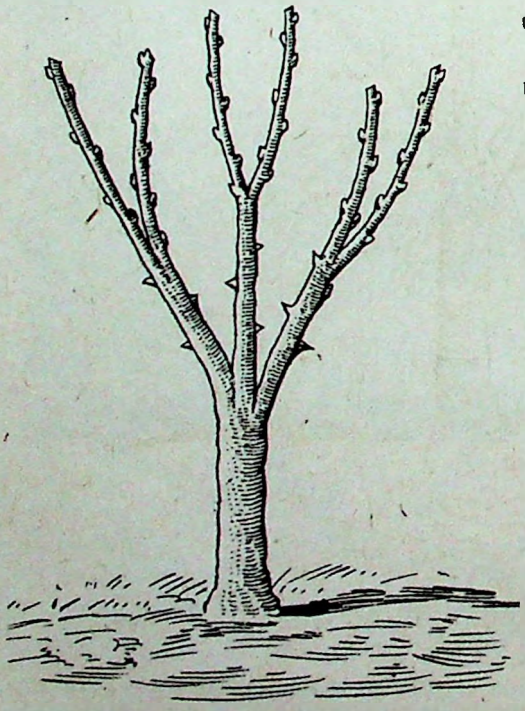
(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for the following Bulletins: L.S. 19, "Propagation of Fruit Trees"; L.S. 53, "Practical Directions for the Fruit Grower"; Farmers' Bulletin No. 131, "Fruit Growing in the Transvaal"; L.S. 7, "Budding and Grafting of Citrus Trees."

Three shoots (*which must not start from the stem too close together*) are then chosen to form the principal arms, and during the following Winter these arms are cut back to 9 or 12 inches from where they start, all other growth being cut away close to branches or stem.

Next Winter two "leaders" on each of these arms should be cut back 12 to 15 inches from where their growth began, all side shoots being cut off. In the third Winter after planting, the tree should have at least 12 strong evenly-shaped growths.



"What a tree should be like after the first winter's pruning."



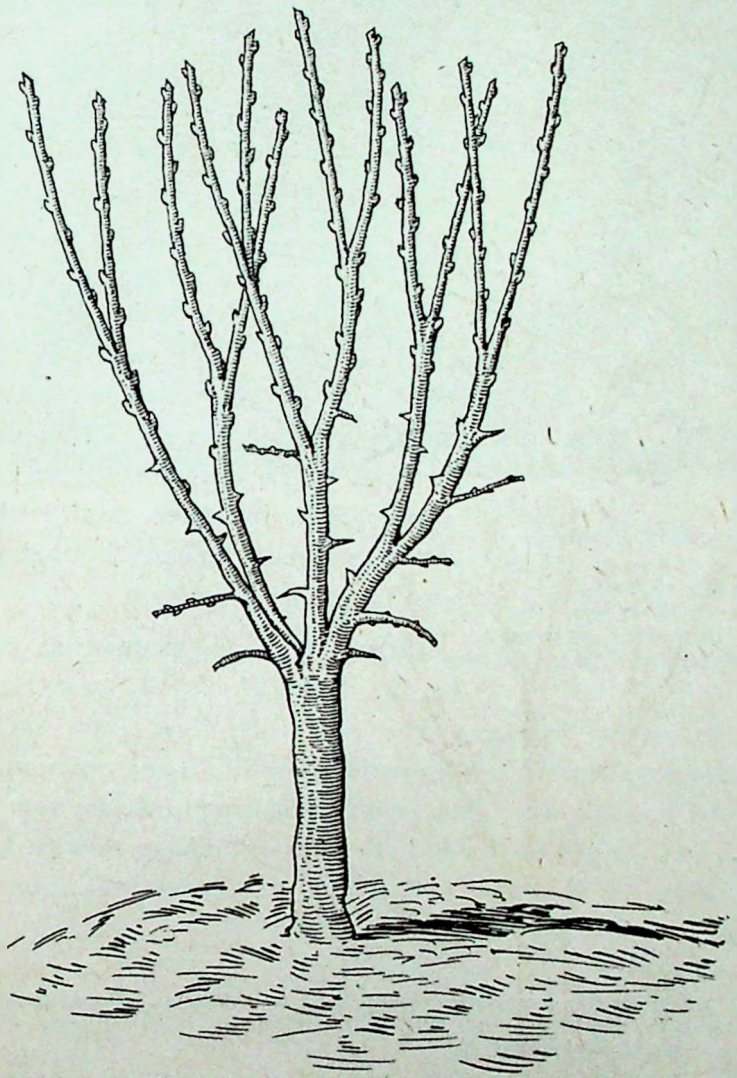
"What a tree should be like after the second winter's pruning."

WHEN REGULAR CROPS MAY BE EXPECTED THE OBJECT OF PRUNING IS TO KEEP THE TREES IN HEALTHY GROWTH, TO PREVENT LOSS OF SHAPE AND OVERCROWDING OF BRANCHES, AND TO ENCOURAGE THE GROWTH OF FRUIT-BEARING WOOD.

New wood produces more fruit than old, so that old and barren shoots can be removed to force new growth.

Fruit poor in size

and colour is due to lack of light and to overcrowding. Pruning should enable the light to find its way to every part of the tree. The fewer fruit there are



"What a tree should be like after the third winter's pruning."

on a tree the better the size and quality will be, so at pruning time the amount of fruit-bearing wood can be reduced. Later on, when the crop is 'set,' it can be 'thinned.' The

fruit will then get the full benefit of the tree's nourishment.(*)

320. *Citrus Trees.*—THE ORANGE AND OTHER CITRUS TREES ARE PRUNED IN A DIFFERENT WAY. Their fruit is borne on the tips of the new wood, and to keep the trees bearing year after year they must be kept growing steadily. All dead and weak wood should be cut out so that the fruiting wood inside the tree may grow strong and ripen.

Suggested Pruning: Leave two of these growths (c and d): remove centre one, (b), and the piece of wood with the fruit scar, (a).

Always cut off the piece of wood which carries the fruit; immediately behind this point will be seen two, three or four new growths; if there be space for two allow them to remain and remove the others. This gives strength to the tree, size to the fruit, allows light to enter, and enables wood to ripen. Watershoots should also be cut away.

Citrus trees are pruned as soon as the fruit is off the trees, that is, in early Spring. The sun then has not much burning power and new growths soon fill up any open spaces caused by pruning. The lower branches should be kept cut back to a height of two feet from the ground to prevent fruit dragging on the soil, and insects or disease harming the stem.†

(*) For further particulars apply to the Librarian, Department of Agriculture, Pretoria, for Bulletin: "Pruning of Deciduous Fruit Trees," Local Series No. 16.

(†) For information concerning the Picking, Sorting, Grading, Wrapping, Packing and Exporting of Citrus Fruit, write to the Librarian, Department of Agriculture, Pretoria, for "Citrus Growing in South Africa," by R. A. Davis.

CITRUS CANKER OF LEMONS.

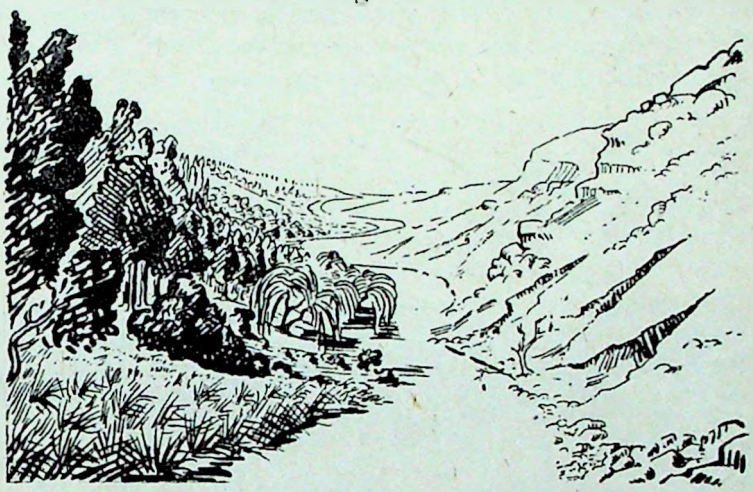
(The worst disease of citrus trees.)

Raised corky spots on leaves, twigs, and fruits; spreads very fast in warm, moist weather.

Suspected outbreaks should be reported and specimens sent for examination to the Chief, Division of Botany, P.O. Box 994, Pretoria.

Forest Trees.

351. Before us is a long valley lying between two ranges of hills. A river flows down the middle of it, and divides the country into two very different scenes. Indeed two landscapes more unlike each other could scarcely be found than those which lie to the right and to the left.



THE LONG VALLEY.

ON THE RIGHT rises a naked hill crowned with rocks. Below these, where yet there is soil, it is slit up by dongas—great cracks gape in the ground as if it were thirsty, as indeed it is.

ON THE LEFT rises a hill crowned with forest which creeps down until the greenness of its foliage is exchanged for the long stretches of cool, green grass upon which cattle are feeding greedily. No dongas here to carry the rich soil into the river below. No thirsty cracks here, for there is plenty of moisture all round.

Yet once upon a time, and that not so very long ago, there was no such great unlikeness between the two landscapes. The hill on the right that now is naked was clothed with trees; the rocks that now rise above it were covered with soil; the river bank below was smooth, green and even. Then the river was more full of water, and the cattle that

fed on the now barren side stood lazily all the long summer day in the cooling waters.

What brought about the change? A fire crept up the grass and destroyed it. The forest caught alight and was burned too. Then the farmer pastured sheep upon the bared hill in too great numbers. By them the new grasses were eaten up and trampled down, and the rich surface soil trodden loose. You can still see the paths by wich they were driven at sundown to the kraals below; they are marked by deep dongas that spread like a fan from the ruined homestead. For the thunderstorms came, and, where the

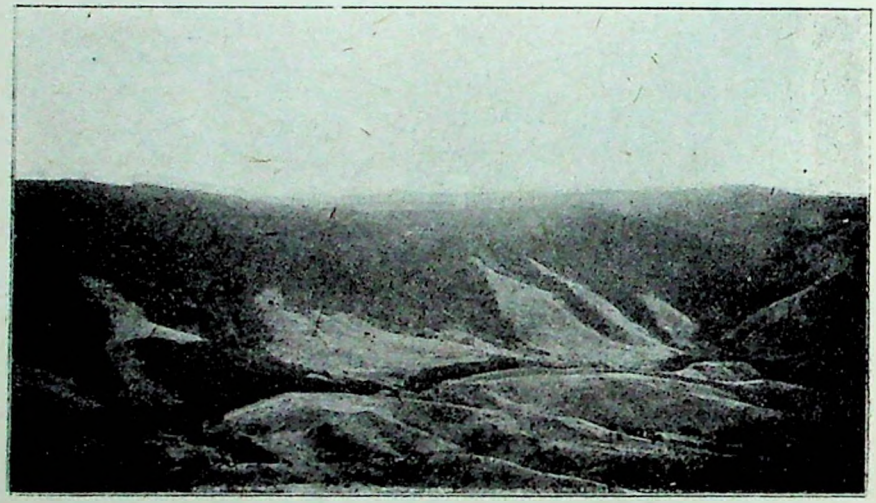


Photo I. B. Pole Evans.

Natural Forest on South Eastern Slopes of the Drakensberg.
(Department of Forestry's Plantations below.)

little hooves had worn away the grass, streams began to flow, eating out gaps that grew deeper and deeper in the hillside. Down these was washed the soil that had covered the top of the hill, leaving naked rocks exposed to view. The river, fed by these swiftly flowing streams, became a raging muddy torrent, and, tearing away the banks and bottom, became broader and deeper. So it has come to pass that to-day; in place of the beautiful green hillside, we have a dry wind-swept waste where the half-starved tortoise, sad-eyed, listlessly drags his weary body from one half-dead Karroo bush to another.

But now let us cross the river to the opposite side. This is still as the slopes we have left used to be. It is covered with rich vegetation which checks, and with little-trodden soil which drinks in, the rainfall. The ground is shaded with healthy plants, bushes and long grasses, and so remains damp. Willow trees are growing along the bank, and their roots have so matted the soil that the river has not been able to tear it away as on the side we have just left. Here, too, is a spring flowing freely, its water trickling down into the river bed.

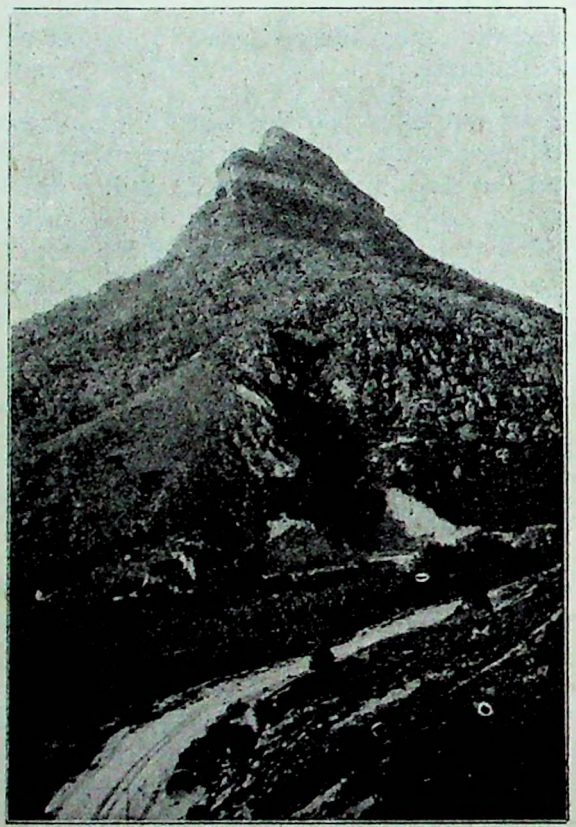
How is it that there is so great a difference between this side and the other side of the valley? Let us seek the answer in the forest.

The nearer we approach the cooler the air becomes. A light refreshing breeze is blowing towards us. We reach it and enter, to find, high above the soil, a thick roof of foliage through which the sun's rays do not strike directly. The air below this roof is cool and refreshing. Beneath the foot is a soft, thick carpet of leaves and branches.

Now we learned in our Geography lessons that THE SEA ROUND AN ISLAND KEEPS THE TEMPERATURE ABOVE THE LAND EVEN. Owing to water taking longer to become heated, and keeping its heat longer than the land, a sea breeze flows in from the sea each evening and out again each morn. The air over the sea is a never-failing store of temperate air, cooling the land in Summer and warming it in Winter.

WHEN A FOREST IS FAIRLY LARGE, IT ACTS IN VERY MUCH THE SAME WAY TOWARDS A TREELESS PLAIN CLOSE BY. If the plain be sun-smitten by day and the weather calm, the heated air above it ascends; while the cool air from the forest overflows its boundaries and spreads itself over the plain to take its place. When night comes, the air currents are reversed. The plain cools quickly until the air in the forest is warmer than the air outside. This happens because the cover checks the loss of heat. So the colder air moves away from the plain towards the forest, where it displaces the warmer forest air which in turn spreads over the plain. In these ways a forest regulates to some extent the daily temperature of a treeless plain beside it.

But look! a few falling drops tell us that it is raining. In the shelter of the trees we hardly detect this, for, above us, the multitude of leaves spread out their surfaces to catch the drops; the branchlets of the pines with their wiry leaves bunched together are like brushes dipped in water and hold more than their own weight of it. Thus they break the force of its fall and conduct it gently through the foliage and along the stems to the litter of branches and layer of leaf mould that cover the ground. These prevent a rapid run off and give the rain a much longer time to soak into the loose soil. The moisture slowly sinks downward,



Phot. I. B. Pole Evans.

Shrubs, Bushes and Silver Trees on Lion's Head.

following the roots and rootlets of the trees right down into the subsoil rock, to come up again as surface springs below the forest.

Slowly filled, the forest empties itself as slowly. THE SHELTER OF THE FOLIAGE KEEPS THE MOISTURE IN THE SOIL and months of drought pass before the dampness disappears. The FOREST MOUNTS GUARD over it. The river below, fed by the water from it, will run with even stream for many months, for the forest will but give it up again day by day in even flow, causing the river below to run regularly all the year round instead of, as now, off and on coming down and drying up, sometimes giving us plenty but leaving us most of the time to starvation and famine.

No torrents will flow down from this side in the way that the waters are running to waste from the naked hill opposite, scooping out the surface soil and joining to make a flood that on its headlong rush to the sea may cause great mischief.

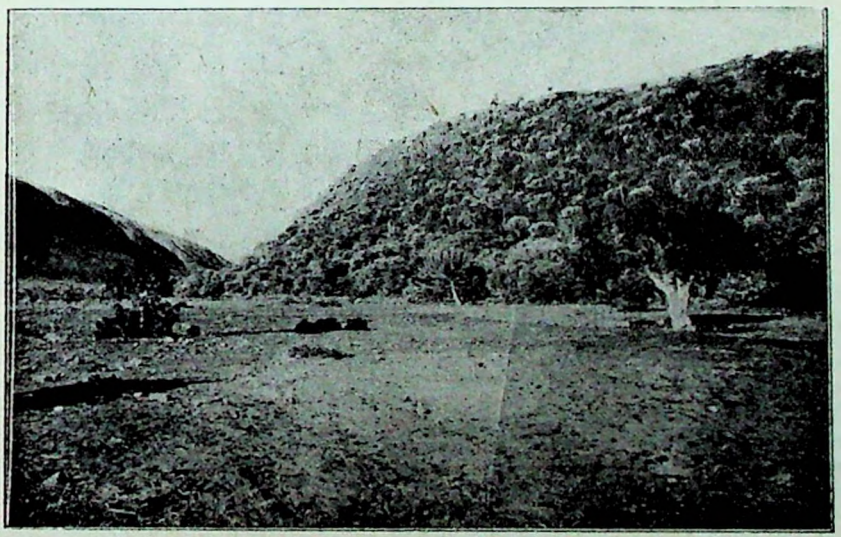


Photo I. B. Pole Evans.

BUSHVELD, Euphorbias.

It is true that grass and bushes have some power to check the rapid run-off from hill and mountain slopes, but they cannot do this as well as forests can. The small amount of water held by grass and bushes is soon carried away by wind and sun, against which there is no protection; but a forest-clad slope mounts guard in a way that grass and

bushes cannot. The FOREST COVER WILL STOP THE WATER RUNNING AWAY IN THE WET SEASON, AND WILL PRODUCE A BIG STREAM FLOWING FOR MONTHS OF THE DRY SEASON WHEN WATER IS MOST NEEDED; the waters which at present rush off to the ocean will then be kept in the country, and, after being used by man, will be taken back into the air and so added to the moisture brought yearly from the oceans by wind; a part of them will again come down as rain to be turned once more to the use of man.

Much of South Africa that is now waterless was once crossed by strong flowing rivers and dotted with lagoons. But, then, the veld was covered with growth which checked, and with soft untrodden soil which sucked up, the rainwater.

Photo J. B. Pole Evans.

BUSHVELD, TRANSVAAL. Natal Fig.

The ground was shaded with healthy plants, bushes and long grasses, and kept damp; the rain that fell was held back and sucked into the soil; springs which flowed all the year round, spreading reedy rivers, swamps, lagoons and vleis, were to be found here and there; the air was damp and there was something to draw down passing clouds and mists. It could rain more easily and more often, and it did.

About the year 1783 a Frenchman, Le Valliant, came to South Africa to collect birds. In his waggons he crossed the Zuurberg and little Fish River near the place where it joins the great Fish River, and pitched his camp there. Going out to shoot some game he walked along the banks of the river. He first tried to get a shot at a hippopotamus, but could not owing to the dense reed beds that flanked the side of the river which, he tells us, was a beautiful clear stream running level with its banks. Large pools and reaches stretched for miles up and down. He found hippopotami, crocodiles, flamingoes, cranes, storks, pelicans and wild fowl of varied kinds and many of them, and he tells us that the country was a beautiful one, covered with rich grasses and shrubs. Gordon Cumming, Burchell, Cornwallis, Harris, Anderson, and the older pioneer Boers tell us the same about the country further north, and say that it was difficult to see and shoot the smaller game for long grass.

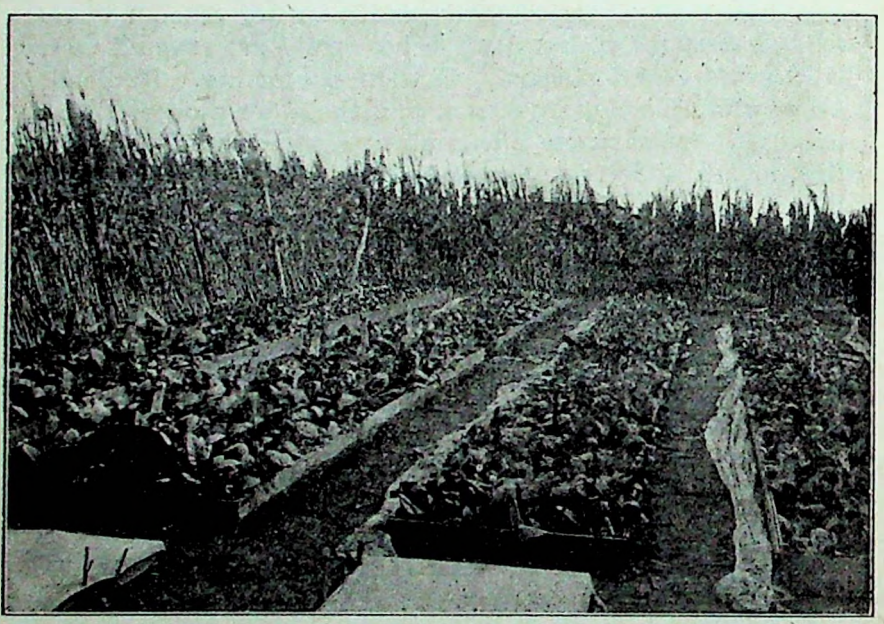
What a change has come over the country to-day! The beautiful clear reed-bound river has become a dry sandy sluit; where there were long deep pools are now level sand beds, and the grass-covered veld has become a dry wind-swept waste. Much the same has happened all over South Africa because trees and bushes were uncared for and because the veld was so overstocked with grazing animals that even the grasses were trodden out. Then came the loss of our richest and most fertile soil, which was washed out to sea, leaving behind the bare, hard, dead subsoil. The cream and fatness of much of South Africa is in the sea, and the sea never returns it.

By Forestry alone can we help nature to get back her former richness. TREES WILL CHECK AND KEEP THE WATER ON THE VELD. TREES WILL PUT A STOP TO THE TERRIBLE LOSS OF THE FLOWER OF OUR SOIL AND OF EVERYTHING WHICH SERVES TO FERTILIZE AND ENRICH IT. THE GROUND AND WATER ARE THE FLESH AND BLOOD OF THE EARTH. THE MORE THESE ARE LOST THE MORE WILL OUR EARTH BE LIKE A DRY AND DEAD SKELETON. (*)

(*) Write to the Librarian, Department of Agriculture, Pretoria, for Bulletin No. 4/1919, "Soil Erosion"

WINDBREAKS.

352. But trees store up the life giving rainwater in other ways than those already spoken about. The drawing away of moisture from sheets of water is not nearly so great when there are shelter-belts of trees. The waste of water from unsheltered ponds and streams in South Africa is well over 50 inches in a year, or over one million gallons per acre of surface. It has been found that when winds blow over a sheet of water at the rate of twenty-five miles per hour, the loss of water drawn off by evaporation will be six times



Tobacco seed bed showing Windbreak made of old mealie stalks.

as great as if the air above the water were calm. BY A SHELTER-BELT OF TREES, WE MAY PRODUCE A CALM OVER A DAM or even over a stream that is used for irrigation, and so lessen the amount of water drunk by the air.

Trees are the very best means by which serviceable wind-breaks can be made. When a strong air current strikes a solid block, such as a wall, it merely turns a somersault over it, and comes down again a short way beyond. But when it meets a belt of trees, part of the wind

drifts gently through the foliage, whereby its force is slowly checked, so that a gentle, almost unmoving air-cushion is floating some distance on the windward side of the belt, causing the wind coming on behind to be bent upwards and to pass over the trees. In the same manner the wind that filters through the foliage of the belt forms the same kind of air-cushion on its other side keeping the strong current above from coming down too quickly. A useful windbreak of this kind will shelter the land to a distance of five times its height on the side from which the wind blows, and to fifteen or twenty times its height on the other side.

A windbreak should be made of low bushy trees on the windward and of tall fast-growing trees on the leeward, so that the wind is naturally bent upward. Such a wind-screen will produce an almost perfect calm to a distance of about twelve feet for every foot in the height of the trees and will partly protect the land for a much greater distance.

353. SHELTER-BELTS OF TREES ALSO SERVE FOR THE PROTECTION OF FORAGE CROPS, OF ORCHARDS, AND OF STOCK. (*)

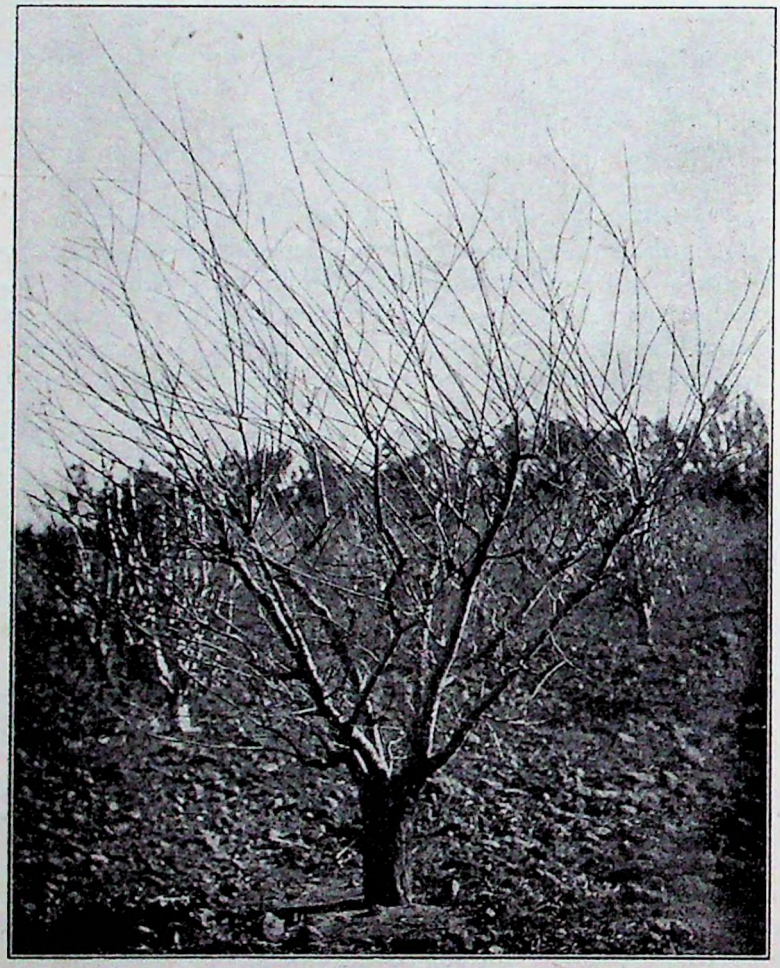
Unless protected by windbreaks, cultivated land in parts of South Africa may in a short time become drifting masses of sand, not only making the old part useless for further cultivation but killing all vegetation on neighbouring lands, the soil on which, after a time, also starts drifting until the evil can no longer be checked and the country becomes a sandy desert. In dry land cultivation, when the soil is sandy, there is danger that the wind may blow away the dry layer of earth which acts as a "mulch" to prevent waste of moisture. (†)

How often have not our Mealie crops to be resown two or three times on account of dry winds killing the tender young plants soon after they shoot up. Wind has the same harmful effect upon other forage crops. All this can be done away with by having windbreaks. In orchards they protect the blossoms from cold winds, store up the soil moisture, and protect the fruit against hot winds. They prevent wind-falls of fruit. All the difference between a paying orchard and a failure may depend on the windbreak.

(*) Write to the Department of Forestry, Pretoria, for Bulletin No. 1, 1918, "Shelter Belts for Orchards."

(†) See Sections 40-47.

Animals suffer through not being guarded from the dry hot winds of Summer or from the cold winds of Winter. IF STOCK BE GUARDED AGAINST COLD WINDS IT REQUIRES FAR LESS FOOD IN WINTER AND SPRING than if left unsheltered.



THE ORCHARD NEEDS A WINDBREAK.
Effect of strong wind on young growth.

For the shelter of stock a belt of trees along the outside boundary of the farm and along any public roads crossing the farm answers best, since in such a case one side is already fenced and only one other straight fence is required to give

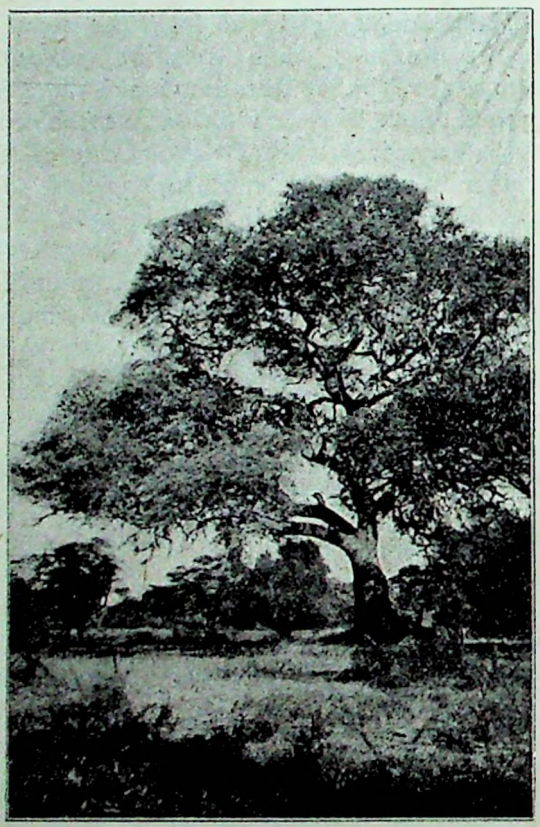
the trees protection while young. This double fence along the roadside and boundary lines serves a double purpose, for while shelter is provided, the stock are at the same time kept from contact with neighbours' or trek stock, and the risk of infectious disease is lessened.

In addition to these uses trees make the country look pretty and relieve the sameness of bare veld and uninterrupted hill and dale; they mark the course of rivers and boundary fences, and usually give the farm the beauty and comfort which are wanting when trees are absent. Unlike the usual farm crops, timber does not make the soil poorer, but leaves it in a much better condition than before. The soil of a forest is always improving from the day of its birth, were it for thousands of years. In Europe, where the need is not so great as in South Africa, it is held that one-fifth of every farm should be covered by shelter woods. Very few places are so bleak that some trees cannot be grown, while lands unfit for other farming may be made use of in this way. Stony ground, if the stones are such as to allow roots to creep in between them, is no drawback, but rather good for the growth of trees.

354. Other countries understand the great importance of tree-planting. France has been spending millions and giving employment to thousands in the work of reafforestation to lessen the terrible floods and the wholesale ruin of the land. In America, where vast forests were disappearing by leaps and bounds, millions upon millions of acres have been added to her national parks, until she has now close on two hundred million acres in the West alone, marked out for tree-planting. Indeed, the whole world is being roused to fight this great evil. We in South Africa should wake up to this danger and gradually afforest a large part of our kopjes, mountains and other slopes, blocking up the sluits and dongas, beginning at their heads, and planting them and the banks of spruits with trees or other vegetation; planting some sort of vegetation on all bare ground such as old roads; building catchwater dams wherever possible, and planting windbreaks all over the level country. If we do this we shall prevent the terrible loss of the flower of our soil.

TREE-PLANTING.

355. Tree-planting is not only necessary for the prosperity of South Africa, but will be of great profit to the farmer, who can afford to wait for the return of his money. This country imports most of her wood—a necessity of life; the time is not far distant when every civilized country will want all the wood it can produce; and, since foreign supplies are becoming used up, wood is fast rising in value, the market price advancing by leaps and bounds in the ten years before the war. As a result of the war there is a serious timber famine throughout the world, with which we in South Africa must deal by planting as many trees as possible.



LEADWOOD TREE.

Plants can usually be bought more cheaply and of better quality than they can be raised, but if preferred they may be grown from seed, which (except in the case of wattles and pines) should not, if possible, be more than a year old. (*)

(*) Write to the Department of Forestry, Pretoria, for Bulletin No. 1, "Propagation of Trees from Seed."

356. The time for growing varies with the variety and the district. The soil should be finely sifted and mixed with a very little sifted old stable manure, the proportion being about one part of manure to six parts of fresh garden soil. This mixture should then be put in paraffin tins, cut in half lengthways, or boxes in the bottom of which holes have been cut for carrying off the water, and in which a layer of gravel or sticks has been placed.

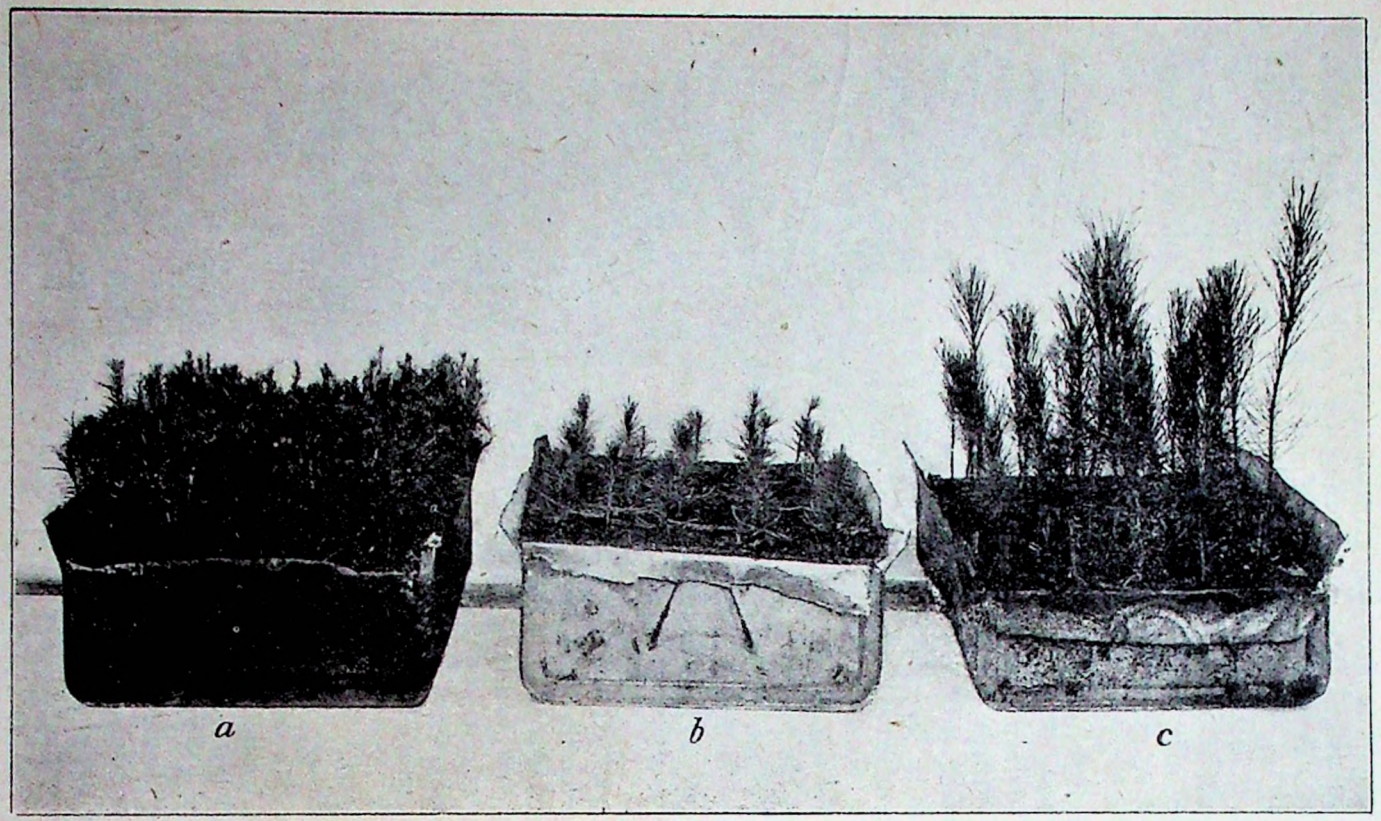
357. The seed is then evenly sown broadcast on top of the soil and lightly pressed down with a piece of board, and covered to a depth of about twice its thickness with fine clean sand. The seed tins must be watered every evening with a fine rose, so as not to disturb the seed, and must be covered with some kind of shade to keep the soil just moist and to prevent caking. This can be done with reeds or long grass. Great care must be taken never to let the seed tins become dry. They must always be kept damp, but never wet.

When the seed begins to sprout, the shade can be raised above the tins and gradually taken away from day to day as the seedlings become stronger. In about two weeks after sprouting all the shade can be removed.

358. The length of time before sprouting takes place varies with different seeds. Some, such as gums and pines, take from three to six weeks. Others take longer and sprout very irregularly. The seed of pencil cedar, for instance, may take more than a year to sprout. Hard-coated seeds, such as those of the wattles, must be soaked in hot water for twenty-four to thirty-six hours before sowing.

359. When the small seedlings are strong and are beginning to throw out side-rootlets (which will be when they are about two to three inches high), it is time to "prick them out."

Fresh soil with manure is again prepared in tins as for sowing. The soil may, however, with advantage be somewhat heavier, but not so heavy as to "cake." The seedlings are transplanted in these tins, putting twenty-five seedlings in a tin in even rows. This should be done in shade and during dull cloudy weather.



RAISING OF TREES FROM SEED.

(*a*) Pines in the seedling stage. (*b*) Pines newly "pricked out" or transplanted. (*c*) Pines ready for planting out in the field.

The seedlings should be carefully taken from the seed-trays so as to knock their side roots about as little as possible, but no harm will be done if the main root be shortened a little in order to guard against the danger of the seedlings being planted out with the main root doubled up. When this happens the transplant nearly always dies. Great care must be taken to see that the main root is planted straight and not crumpled up, that the side roots should not be crushed, and that it be firmly planted at the same depth as it stood in the seed tins. The soil should be pressed against its roots, for if an air space is left around the roots the young plant quickly dies.

360. After transplanting, the young trees must be well watered and kept in shade till growth starts again, when they must get gradually used to the full heat of the sun. Thereafter, till the trees are ready to be planted out on the veld, they will only need watering and weeding. The tins should be looked over every fortnight or three weeks, and if the roots are found to have grown through, they must be scraped off.

YOUNG TREE PLANTATION.

361. When about six to twelve inches in height they may be transplanted out into plantations. This should be done during and after heavy rains. Each young tree should be carefully cut out of the tray with a gardener's trowel, so that as much earth as possible sticks to the roots. Before removing the tree from the tray a hole should be made with a trowel in the veld to receive it, and it should be planted so as to stand about one to two inches deeper than it originally stood in the tin. Unless planting is being done

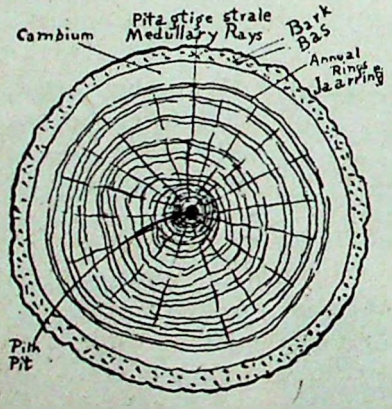
in the rain, the young tree will need to be watered to settle the earth about its roots.

362. In most cases it is best to plant trees closer than they are meant to remain till they reach full size, and by so doing to make sure of timber free of knots and having straight growth. Trees planted closely shoot up tall and straight to reach the sunlight and have no room to stretch their arms, but they must be early and often thinned.

TIMBER.

363. If a tree-trunk be cut across, the wood will be seen to be formed of many layers or rings called annual rings because each represents a year's growth.

As age advances the inner layers become harder and are known as *heartwood;* the outer or softer ones are *sapwood.* ONLY HEARTWOOD SHOULD BE USED WHEN THE WORK IS MEANT TO LAST.



CROSS SECTION OF TREE.

The thin bands which extend as rays to the centre and serve to bring sap and moisture to the inside of the tree are called *medullary* rays. These are more marked in some kinds of trees, for instance in the oak, than in others, and wood for ornamental work and for good furniture is usually chosen on account of such markings.

364. The value of timber depends chiefly upon its strength, the length of time it will continue sound and fit for use, and the care and time which have been taken to season it.

365. Trees should not, as a general rule, be felled until they have reached maturity, that is, are fully ripe. If felled earlier, the wood is not so lasting, nor does it season so well. The best season for felling is usually thought to be winter, when trees contain little moisture.

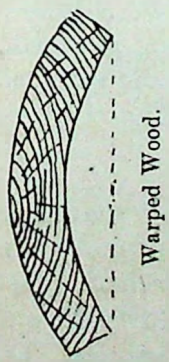
366. GREEN TIMBER IS NEVER USED. It is no use covering wood with paint until it be thoroughly dried or SEASONED. After sawing it should be stacked in such a way that neither rain nor sun can harm it. Logs or planks are best stacked in a dry airy shed so that air can pass between them. Unless they be stacked flat and true they may twist, warp or split.

367. If timber be not well seasoned it is more likely to be attacked by DRY ROT. The cure for this disease is thorough airing. A great deal of air should be allowed to pass under floors, through roofs, and around pieces of furniture.

368. Timber is sold in the following sizes:

	Breadth.	*Thickness.*
Planks	from 11 inches.	$1\frac{1}{2}$—$4\frac{1}{2}$ inches.
Deals	9 inches.	Not more than 4 inches, usually 3.
Battens	not more than 7 inches.	From $\frac{1}{2}$ to $2\frac{1}{2}$ inches.
Boards	6 inches. or more.	Up to but not including $1\frac{1}{2}$ inches.

SOME USEFUL TREES.



369. OAK.—The common European Oak was brought into this country a few centuries ago and splendid ones are to be seen in the Cape Province, especially in the Cape Peninsula. The properties of oak timber are well known. It is largely used for building where the work must be strong and lasting, also for furniture, in the making of barrels, and in other trades.

370. PINE.—These trees grow in the cooler parts of the Northern Hemisphere. There are many sorts of Pines growing in this country, the most common being the Cluster Pine (*P. pinaster*) and the Insignis Pine (*P. insignis*). Both these do very well in the South-Western coastal districts of

Cluster and Aleppo Pine growing in an exposed place. (24 years old.)

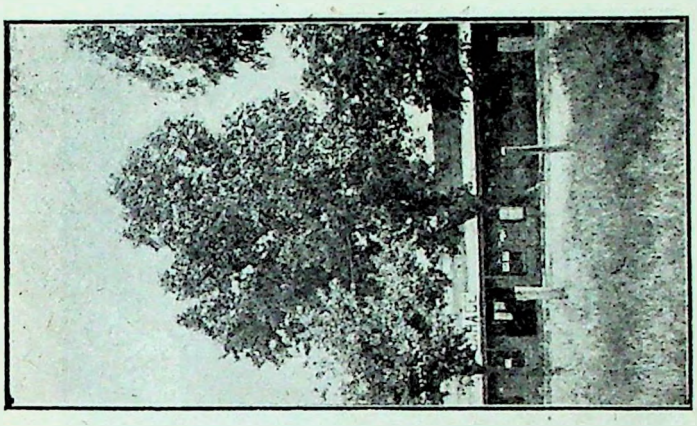
the Cape. Imported deals largely belong to this class of timber. The South African wood, properly grown, can hold its own. The wood of Insignis Pine is a light deal good for match-boarding, shelving, joinery, box and packing-case manufacture, and for many other things for which timber brought in from other countries is now used. Cluster Pine has a heavier and denser timber useful for building construction and (when soaked in a liquid called *creosote* to preserve it from decay) for railway sleepers, and of late it has been used on the Rand Mines as a prop.

374. Poplar.—This tree, too, comes from the Northern Hemisphere; it is a useful light timber for building purposes, and as a match-factory wood it has no equal in South Africa. It is grown almost everywhere throughout the Union where there is enough moisture.

372. Bluegum.—Under this name most of the large number of Gums (*Eucalypts*) growing in the country are known. These came to South Africa from Australia. Bluegum (*Euc. globulus*) itself is perhaps the most widely grown. It should not be planted in very cold or dry localities. Of all the Eucalypts it yields the greatest bulk of timber per acre per year. It produces a useful wood, but has less strength and lasting qualities than the ironbarks and many other kinds of Eucalypts. It is much used as a mine prop.

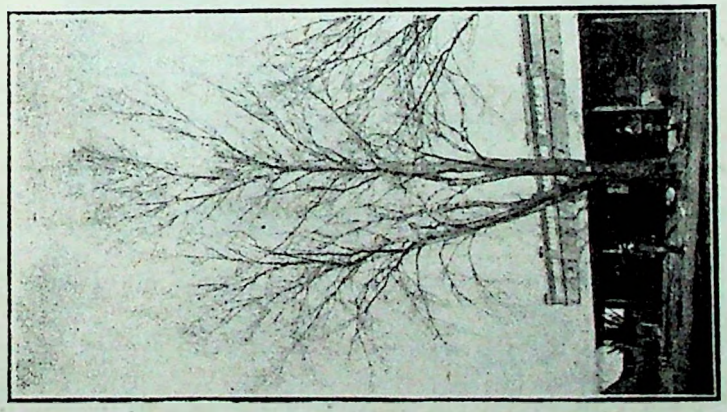
373. BLACK WATTLE (*Acacia decurrens*).

An Australian tree, the wood of which is useful for pit props and fuel, and the bark of which contains TANNIN, the substance by means of which leather is tanned. (*) It will



A POPLAR TREE.
(*Populus sendtinc.*)

grow on any well-drained loam where there is plenty of moisture. Many districts of the Transvaal and of the Cape



The same Poplar Tree without foliage.

Province are well suited to it but it grows best in the " mist belt " of Natal. The young trees cannot stand severe frost nor very great heat.

(*) See Industries Bulletin No. 15, "South African Tanning and Dyeing Materials." Division of Mines and Industries, Pretoria.

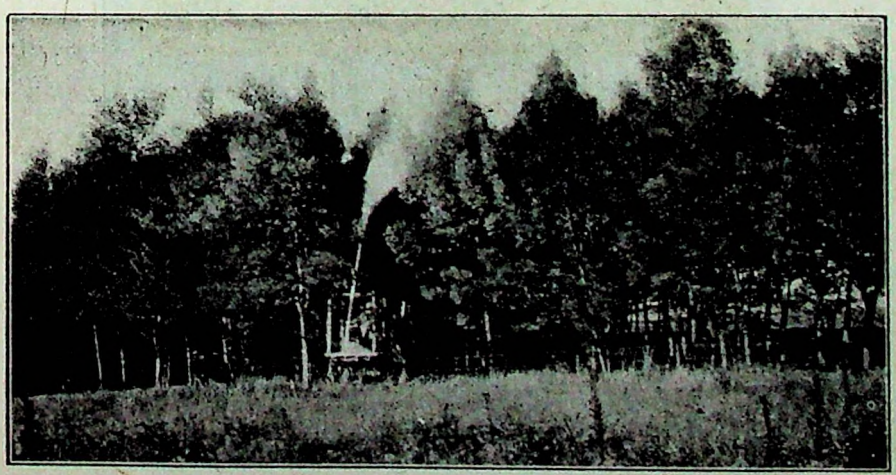
The seeds, before sowing, are softened by being placed in boiling water and let stand for 24 to 36 hours. When the bark is ripe enough, at about the end of seven years, the twigs and small branches are first cut away and the trunk is stripped. It is 'ringed' about seven feet from the ground and

BLUEGUMS (*Eucalyptus diversicolor*).
24 years old.

the bark below the ring is pulled in strips downward towards the root so as to get as much from the upper portion of the roots as possible, for the bark at this place contains most tannin. The tree is then felled and the rest of the bark taken off. The bark, spread or hung out in the sun, but with the inner bark protected from the light, takes from a week to a fortnight to dry.

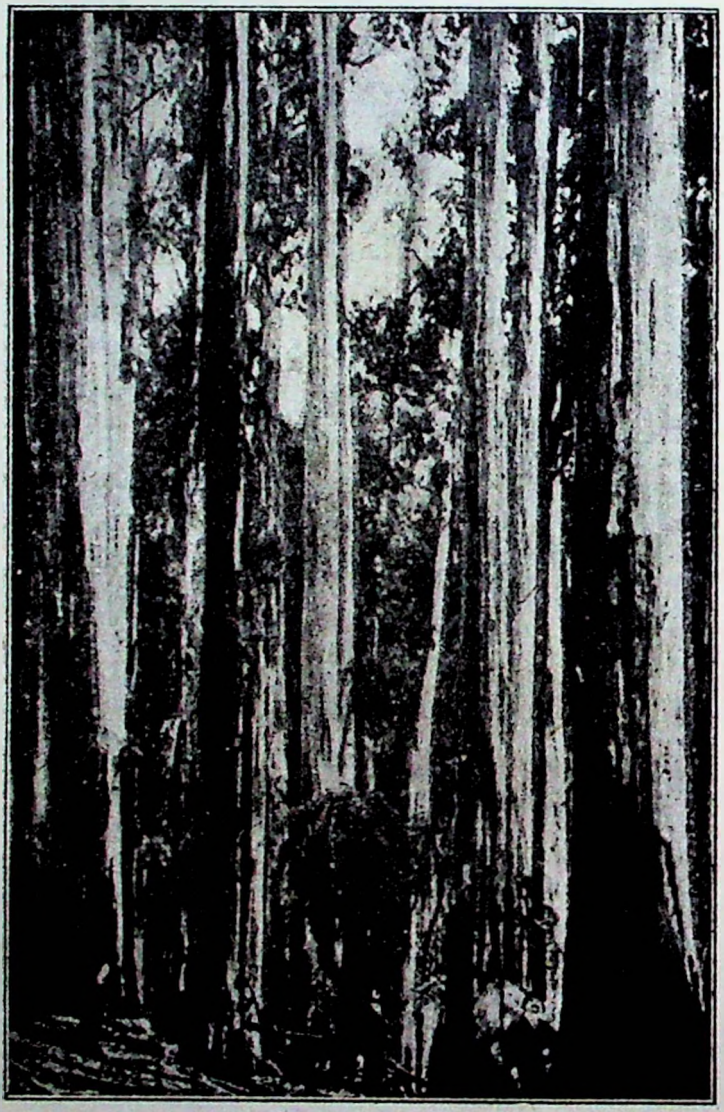
A PEST OF THE WATTLE TREE.

Wattle Bagworm clustering on stem and in forks of branches of a Wattle Tree.



Dusting Wattle Trees with poison to kill Bagworm.

A plantation need not be sown a second time. The branches of the felled tree are burnt in lines, and this causes the seeds lying in the soil in these narrow strips to sprout.



Jarrah Trees, a species of Gum, growing in Australia.

INDIGENOUS TREES.

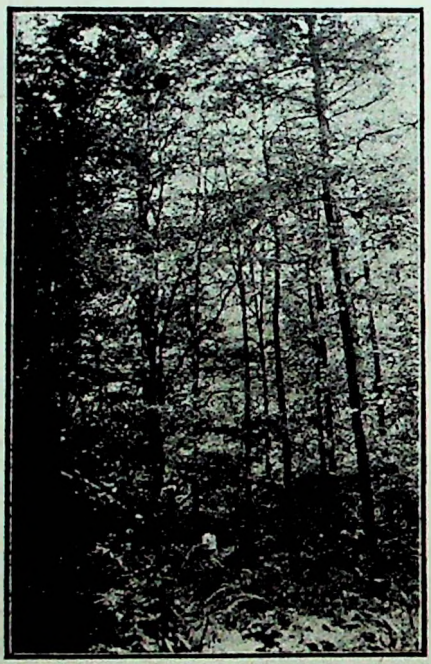
The following useful trees are native to South Africa:

374. Yellowwood (*Podocarpus sp.*).—Yellowwood grows in the belt of natural forest running along the coast from the Cape to Natal. This timber can be put to many uses. It is a light wood and is rather better than foreign pinewood or deal for the purposes to which these are generally put. It is slightly harder and heavier than pine,

YELLOWWOOD TREE.

but is much stronger, looks much finer, and is almost free from the heavy knots found in most imported wood. It requires, however, great care in seasoning. It is excellent for beams, rafters, flooring and ceiling boards, doors, butter boxes, etc., and also for railway sleepers when soaked in creosote to preserve it from decay.

375. Stinkwood (*Ocotea bullata*).—This is considered to be one of the most valuable of South African native woods. It occurs in the Cape Peninsula and at Knysna and in the Transkeian, Natal and Transvaal forests, but seems most vigorous at Knysna. Stinkwood is well known throughout the country as a furniture wood and it is also useful for wagon building.



YELLOWWOOD TREES.

376. Assegai (*Curtisia faginea*).—This grows almost everywhere throughout the belt of forest along the coast. It is much sought after by wheelwrights for spokes.

Vegetables.*

401. To get good crops of vegetables three things at least are needful, viz., a SUITABLE SOIL, GOOD SEED and CLEAN CULTIVATION.

402. Generally there is too little time spent on getting the land into good condition, so that the crop is a poor one.

Gardening Tools.

Vegetable soils should be rich and loose, a sandy loam being perhaps the best. (†) If the soil be stiff, or shallow and resting on gravelly subsoil, it should be brought by degrees to the best condition by heavy dressings of stable

* See Department of Agriculture's Bulletins No. 18, 1916, "Composition and Value of Some of our Common Vegetables," and No. 14, 1916, "Vegetable Growing under Karroo Conditions."

† See Section 11.

manure(*) and by ploughing at different seasons to various depths. Where too much water remains on the soil, especially where winter rains are looked for, the land should be drained.(†) A dark-coloured soil—one with plenty of decayed matter—will give the earliest crops; a sandy soil may be made better by adding vegetable matter in the form of green crops which are ploughed under just as the blossoms appear.(‡)

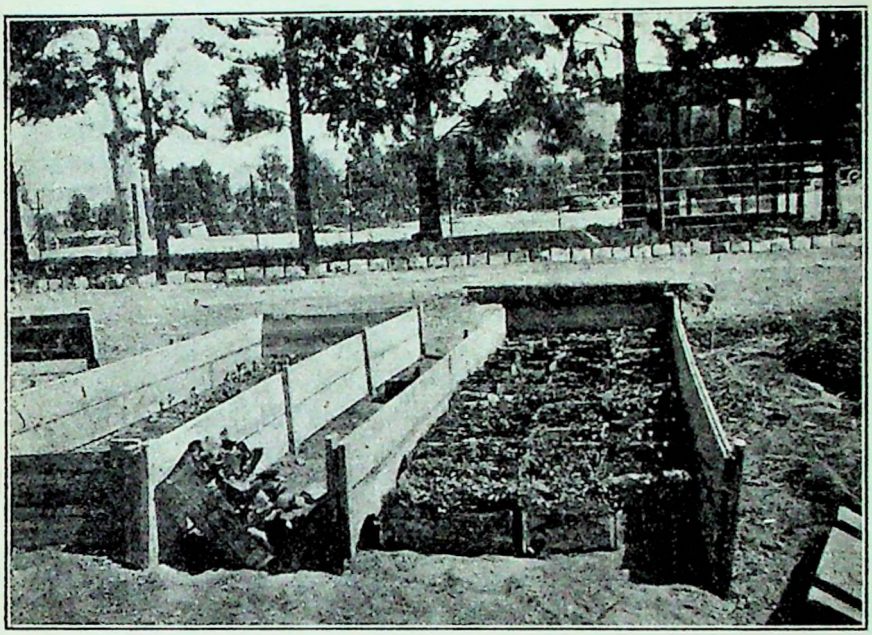
403. DEPTH is an important point. Do not try to grow vegetables unless the soil has been ploughed, dug, or broken up in some way to a depth of eighteen inches or two feet: the deeper the working has been, the looser the surface will be and the more moisture will be kept in the soil for the seeds and roots. Plenty of manure, as has been said before, should always be put into the soil, and, as far as possible, throughout the full depth of the upper layer of soil. It should be laid on and well worked into the soil as long as possible before any crop is planted, so that it can thoroughly decay and enrich the soil before the roots touch it.(§)

SOWING SEED.

404. When sowing tender plants such as Tomato, Early Cucumber, Vegetable Marrow, Herbs, and many others, it is best to sow the seed in shallow boxes or tins under a canvas or glass frame. An ordinary paraffin tin cut lengthwise with a few holes punched in the bottom to let the water drain off, makes a very good seed pan. These pans, tins or shallow boxes are more easily managed when watering; insect pests are more easily kept in check by spraying and keeping apart; the trouble of weeding large beds containing a few seedlings is done away with, and waste of seed is prevented. When sowing seed in the open ground,—this is done when frosts are no longer feared—it must be remembered that THE SEED BED CANNOT BE TOO FINELY WORKED.(‖) Before any seeds are sown in the beds,—which should be arranged in width to make weeding and watering easy—the soil should be thoroughly watered, allowed to stand for a day or two according to weather

(*) See Sections 100-194.
(†) See Sections 51-61.
(‡) See Section 111.
(§) See Sections 100-104
(‖) See Section 25.

conditions, and then raked over to break up the crust. After this is done sow the seeds.



Seed Tins.

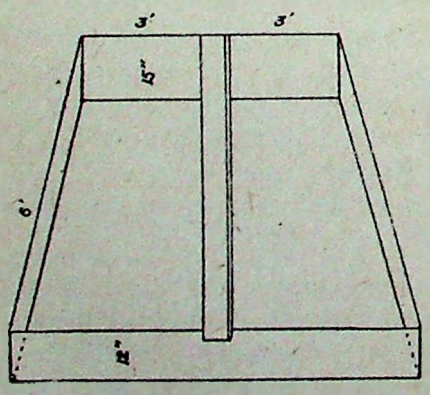
405. You ought to know the way in which many seeds push through the soil.(*) Those of such vegetables as the bean, onion and pumpkin all come through the soil with bent stems. If the soil be watered after sowing, a crust is formed; the stems cannot push through this and break, so that the seedlings are killed. Always sow the seeds in drills or rows, as this makes it easy for the grower to weed and cultivate without spoiling the plants. GOOD VEGETABLES DEPEND ON GOOD SEED; cheap seed is worthless, and it is a waste of time to thoroughly prepare seed beds and then sow seeds which will not sprout, or will produce weak plants only.

406. When tender sorts of vegetables are raised under canvas or glass frames, the hardening off of their seedlings will need some care and judgment. The simplest and safest method of hardening off is little by little to let the seedlings

(*) See Sections 212-216.

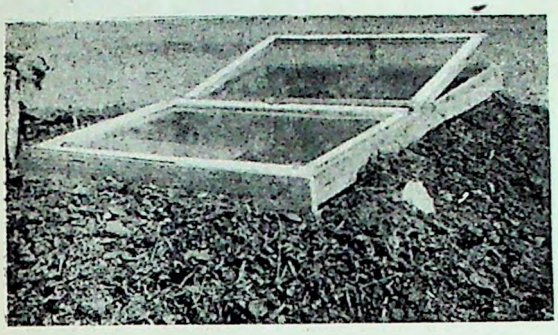
feel the full sunshine. This can be done, without the plants feeling any check, by lifting off the canvas or glass during the early morning—putting it back again to shade during the heat of midday—taking it off again during the afternoon and covering again at night to guard against frost. Very soon the seedlings will be strong enough to transplant from the seed tins or boxes; this must be done to prevent them from being "drawn" or weakened by growing too closely together. If possible choose a dull day for this work and, having prepared either a bed in a cold frame or a number of shallow tins, the young plants are set out, or as gardeners say "transplanted" about two inches apart. To do this transplanting well a few common mistakes must be guarded against: never place the seedlings in an open place where the wind will tear them and break the leaves, nor in the full glare of the sun where the leaves and stems will be baked. About two weeks after transplanting the seedlings will be so hardened as to be able to stand being planted out in the open, if there be no frost. When transplanting Cabbage, Cauliflower or Onion seedlings from seed beds in the open ground, it is a good plan to pick off a few of the leaves so that the plant shall not give off too much moisture and then dry up, and it is also well to shorten the tap roots so as to encourage a new and strong root system; to establish them in their new quarters the plants must be watered immediately after planting.

PREPARATION OF THE HOT BED OR FRAME.



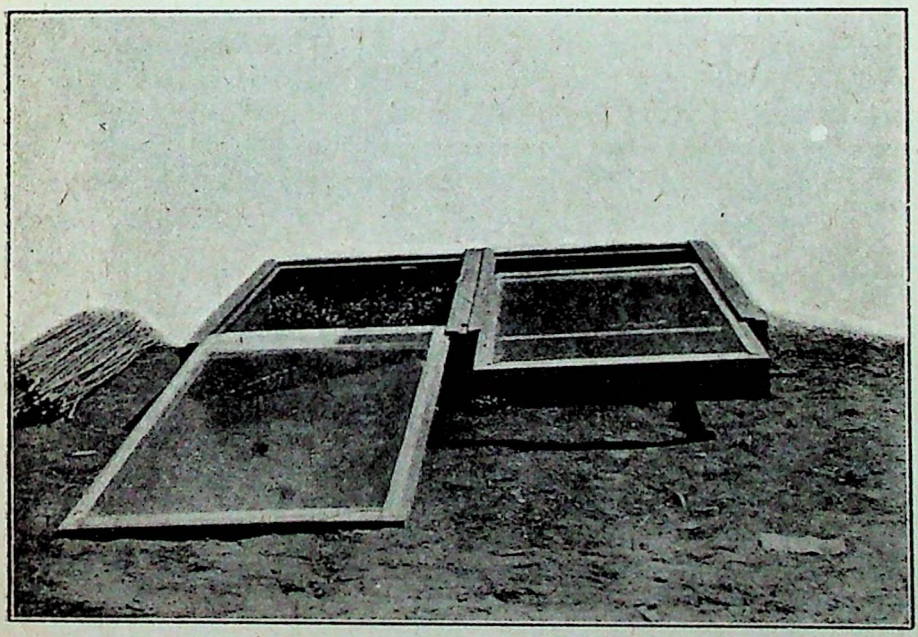
Type of frame for making a Hot Bed.

407. In order to have a number of plants to set out early after frosts have passed, they must be raised on a hot bed. This can be made as follows:—Find a sheltered corner with plenty of sunshine, dig a pit one foot longer and one foot wider than is really wanted to take the frame, then fill up this pit with fresh stable



Hot Bed made by using an old window placed in a frame on manure.

manure; have plenty of it, tramp it town tight and allow the manure to heat up until after, a few days, steam is noticed coming out.(*) Then turn it over thoroughly with a fork and form it into a pile again till steam escapes a second time, which should happen in about two days. It should now be ready to spread into the wished for shape. Tramp it down firmly and evenly.



Cold Frames.

The bed should be two feet or two feet six inches deep and seven feet long; and it must be wide enough to hold the frame.

(*) See Section 103

408. Make a frame out of packing-case wood or flooring boards 6 feet long and 3 feet wide for each sash used—the accompanying diagram will show how to make it. This is placed on the hot bed of manure and more manure is banked around the sides. A thermometer is placed in the manure after spreading, and when it registers between 85 and 90 degrees Fahr., soil can be spread evenly over the manure to a depth of six inches; three days after seed may be sown in the soil. If seed be sown in tins, pans or boxes, place them on top of the manure. The sashes should be whitewashed or covered with canvas or reeds during the daytime, and with something thicker during the night. When the seedlings begin to come up, give them air by lifting the sash each morning and closing again at night.

COLD FRAMES.

409. These do not have any manure to keep them warm. They can be made any length and any width, though 4 feet wide will be found the best size. Ceiling boards or other handy material can be used for the sides; the covering is usually made of reeds or canvas or anything that will prevent the sun and wind from hurting the seedlings after they have left the hot bed.

ROTATION OF CROPS.

410. Read again Sections 115, 116, 119-127.

By this we mean the GROWING OF A SUCCESSION OF CROPS UPON THE SAME SOIL, so that the plant food in the soil is drawn upon to the greatest extent. This is a very important matter where quantities of vegetables are grown, because it is possible to use different layers of the soil by planting deep and shallow rooting crops one after the other, and because different vegetables require different plant food to grow the very best kinds; doing this we do not need so much manure. ROTATION GREATLY HELPS IN GETTING RID OF INSECT PESTS, DISEASES AND WEEDS, for, with changing crops and continual cultivation, these enemies of crops do not get a chance to spread. To get the most out of the soil, the grower needs to keep A DIARY OF SEEDS SOWN, when they were transplanted and the date of harvesting, so that he may know what ground he has that can be used for future crops.

411. Asparagus, Rhubarb, Artichoke and Seakale, which are planted in the same soil for several years, are always well covered with decayed stable manure during the Autumn to keep the crowns from getting hurt and at the same time to enrich the soil. When these roots are taken out they should be followed by quickly ripening crops such as Radish, Lettuce or Beans. Peas or Beans should follow Potatoes, Carrots, Parsnips or Turnips; Beans can follow Early Cabbage or Cauliflower. Root crops such as Carrot and Parsnip follow Lettuce, Radish and Spinach. Tomato

Potato Tuber with Common Scab. (*)
Causes scab spots or pits on surface.
Can be prevented by rotation of crops.

follows Onion, Peas, or late Cabbage. Onions can be grown on the same soil for a few seasons, but there is always a danger of Mildew or Rust hurting the plants. The climate and the place will decide for each grower just what crops it is possible to grow and at which season the seed can be sown. Generally, there is very little growth on the High and Middle Veld or in the Karoo during the Winter months, that is from May to August. In the Karoo very little growth takes place later than April. In the Low Veld, along the Coast Belt and in the South-Western Province, however, owing to the absence of frost, it is possible to grow some, if not all, of the tender vegetables throughout the whole year.

(*) See Department of Agriculture's Bulletin, L.S. 28.

The following vegetables are those most often grown, and a few general directions are given to help to grow them successfully.

BEANS, DWARF FRENCH.

413. Most people know the Canadian Wonder bean; it is sown in drills two feet apart and the seed is dropped six to nine inches apart in the drills. This vegetable delights in rich free soil, and can be picked eight weeks after sowing. The plants are tender to frost; they can generally be sown from August to February. The beans should be gathered as soon as they are fit to pick, as the plant's life is much shortened if the beans are allowed to ripen. There are many kinds of dwarf beans; some are called Wax Pods or Butter Beans on account of their golden colour; all are delicious when young.

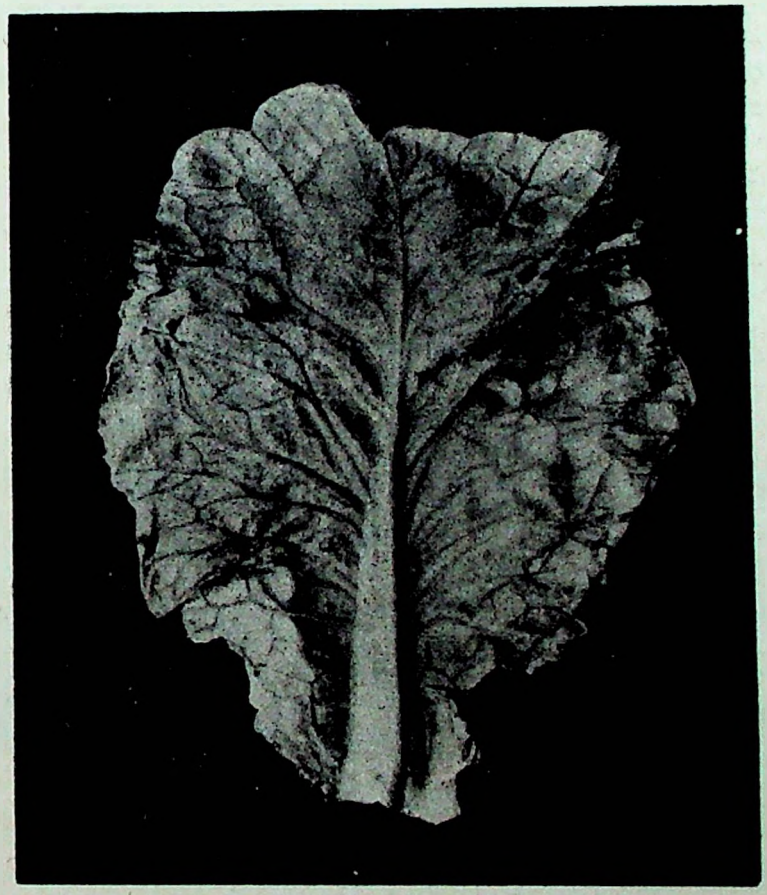
BEETROOT.

416. This is perhaps one of the best known of our salads. Sowings can be made every eight weeks for some months except during the depth of Winter. Soil that has been heavily manured for a previous shallow-rooted crop suits it best, as soil that has just been manured causes the roots to grow into odd shapes. Seed should be sown in drills eighteen inches apart. When the seedlings are strong and well grown they must be thinned out to allow plants to stand six inches apart. When gathering, the root should be washed but not cut, otherwise the colour boils out when cooked.

CABBAGE.

418. This can be grown all the year round, if the grower sows the right sorts at different seasons, cultivates thoroughly, and has either a good rainfall or a good supply of water for irrigation purposes. Inland, Cabbage is really an Autumn, Winter and Spring crop—in the Summer months there are too many insect enemies. During April or May sow the seeds in open beds; cover them to a depth of ½ an inch, give a good watering and then cover the soil lightly with long straw manure. The seeds sprout in

about five to seven days; in six weeks from sowing, the plants will be large enough to take from the seed bed to the ground prepared for them. Early sorts are set out in rows two feet six inches apart and each plant two feet apart in



Black Rot of Cabbage.
Discoloration of veins and gradual dropping of leaves.
Seed disinfection with Corrosive Sublimate (K). Practise crop rotation.
Watch seed beds and destroy diseased seedlings.

the row; they should be ready to gather in about 112 days from sowing. Main crop varieties sown during November, December and January are set out in rows three feet by two feet six inches; these ripen more slowly and are gathered in about 130 or more days after sowing.

(K) See Appendix, Fungicides K.

CAULIFLOWER.

419. This requires much the same treatment as cabbage, the seed of early and late sorts being sown at the same time. The soil must be well manured, deep, and have a plentiful supply of water, as SUCCESS DEPENDS UPON THE RAPID GROWTH. When the flower appears in the centre of a plant, it is best to give it shade to preserve its whiteness; this is done by bending over two or three of the inner leaves.

A Field of Winter Cabbages (Savoy).

CARROTS.

421. These may be grown all the year round; a good supply of roots can be obtained to carry through the Winter by sowing during January or February. The SOIL MUST BE DEEP to enable the roots to get down; it must also be rich and loose. NEWLY MANURED SOIL IS NOT SUITABLE FOR CARROTS because it causes the roots to become forked and badly shaped. Sow the seed in rows 12 inches to 15 inches apart; do not sow too thickly, and when the seedlings are large enough to handle they should be thinned out to allow those which remain to develop. The earlier sorts are Dutch Horn

and Oxheart; both are stump rooted varieties. Half-long sorts are best for main crop sowings; when ready for market the roots are pulled, washed and tied in bundles of three.

LETTUCE.

424. This is our chief salad vegetable and can be grown all the year round. During Spring and Summer, seeds of the cabbage sorts should be sown, and for Winter use the tall Cos sorts are sown, as these stand the cold much better. To obtain good, quick, tender crops the soil must be very rich and plenty of water must be given to the plants; on poor, dry soil the leaves become small, bitter and unpleasant to the taste, and the plants run to seed. All kinds of Lettuce seed is sown thinly in drills eighteen inches apart, the plants being thinned out at an early stage to twelve inches. Lettuce does not generally transplant with any measure of success as this checks the growth. During cold weather the leaves of the Cos varieties are sometimes tied together at the top; this renders the hearts more tender and juicy.

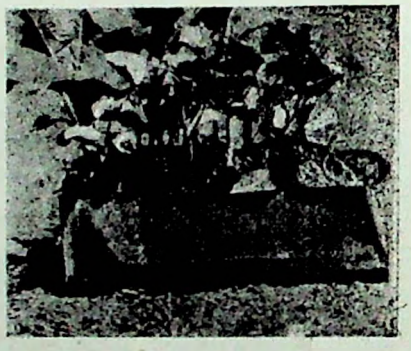
MELONS.

425. Here we have two distinct desert fruits classed as vegetables, though really they are berries! Everybody knows the "Spanspek," or Sweet Melon, with its beautiful golden, juicy sweet-smelling flesh, as well as the delightful cool, crisp-fleshed Water Melon. Both are very tender to frost and should not be sown in the open until all danger is past. In places where there is no frost, seed is sown about July in holes or plots that have been well manured, though many growers say that the soil should be new. For Sweet Melons the holes are usually made six feet apart, whilst eight feet is close enough for Water Melons; four to six seeds are sown in each hole, pressed into the soil about one inch deep and well watered. When the plants have grown somewhat, the strongest three are retained, the others thrown away. To grow Melons, much water is needed during dry weather, and constant cultivation to keep the soil loose and free of weeds. When the runners have set a number of fruits their growth is sometimes helped by

pinching out the growing points. Several sowings may be made from August to December in the warmer districts, but sowings made later than November are not usually of much use, as the cooler weather during Autumn keeps them from growing quickly.

MARROWS.

426. These can be got in many forms. Sometimes they are called Squashes on account of their shape. The best known Vegetable Marrows are the pretty round fluted Custard Squash, the Long White and Long Green Bush Marrow. All are tender to frost and cannot be sown in the open ground until all danger of frost is over. A few early plants can be raised in tins; as a matter of fact the Chinese gardeners make a point of doing this, and then planting them out in order to get early Marrows on the markets before large supplies from general sowings bring down the prices. Bush varieties are the best because they take up less room than the runner sorts, and they bear more fruit. For planting out or sowing seed of the Bush type, beds need to be well manured and deeply dug four feet apart each way. The plants require frequent watering during dry weather. Vegetable Marrows or Squashes should be cut whilst still young and tender, not only because they are then more tasty for the table, but because if they are allowed to grow big the plant stops bearing new Marrows. When the skin is too hard to be marked by pressing with the finger nail the flesh is too old for cooking.



Raising early Marrows.

ONIONS.

427. These can be grown successfully throughout the Union. The usual method of getting plants for setting out is to sow seed in small beds, and when the seedlings are large enough, about six to eight weeks after sowing, to transplant

them into rows eighteen inches apart and nine inches in the rows. Early crops are got by sowing early sorts during February, March and April; these grow through the Winter and ripen in the Spring. Main crops are sown from August to October to mature in the Autumn, and are used dry during Winter. The best soil for Onions is one that has already been well manured for a previous crop, as they develop better in a firm land than in a loose one. A common mistake is planting the seedlings too deep; where this is done the Onions are not large and their market value is much less than those sown at the right depth. After the plants have made some growth and the roots are beginning to swell, it is a good idea to scrape away a little soil from the rows; when the leaves begin to turn yellow at the end of the growing season they are usually trodden down flat to make them grow more quickly, and they are gradually given less water. The crop is pulled during dry weather, the tops being left on. If the sun be not too hot to scorch the bulbs they are laid on the land for a day to dry; after this they are carried to a shed; where the tops are taken off, if required for immediate bagging, or where they are tied together in ropes and hung up to keep. Owing to the mildness of our Winter it is found very difficult to keep Onions from sprouting when stored in large quantities. Weeds are the chief trouble in Onion growing; they must be constantly checked by frequent surface cultivations, as deep cultivation would loosen the soil and injure the roots.

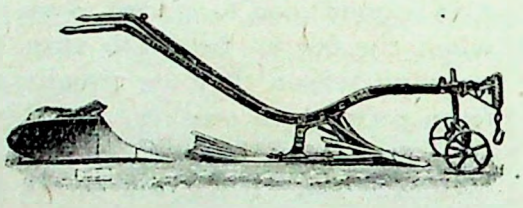
PEAS.

429. These are not a success everywhere; they thrive best during the Spring and Autumn when the weather is generally cool. In the warmer districts sowings are made from April to June to obtain early Spring crops, which yield good prices. General sowings are made during July and August. The best soil is a fairly rich one containing a little lime; this element should be well worked in with cultivators; the Peas are then sown in rows two feet apart, being dropped every three inches. The dwarf sorts are more easily managed than the pole varieties, and come into bearing earlier. Pole or tall Peas require three feet between the rows and six inches in the rows; sticks about three feet

six inches long should be placed in the soil along the rows as soon as the seedlings appear above the soil; the young plants, having some support to fasten on to, grow rapidly, especially when well cultivated and watered.

POTATO.

430. This plant, which comes from America, provides one of the chief foods of man. The best soil for its cultivation is a deep, fairly rich loam which can be easily worked and is not likely to crack. Any soil that is poor in lime should be given a dressing before anything else is done to it. About two weeks later plenty of well-rotted kraal or stable manure should be spread on the land and then ploughed or dug in. The ploughing or digging should be at least one foot deep so that the soil may hold enough moisture for the roots to draw upon. The first plantings may be made during July or August so that when the plants come above the soil they are not likely to meet with frosty weather. For a first crop the variety "Early Rosé" is the quickest to ripen, but it does not give heavy crops.



(Messrs. Ransomes, Sims & Jefferies, Ltd.)

A PLOUGH FOR "RIDGING" AND FOR "RAISING" POTATOES.

(The "raising" prongs may be taken off and the "ridging" body, as shown on left, attached instead.)

Potatoes in large quantities for marketing are grown either under irrigation or on 'dry land.'

WHEN GROWN UNDER IRRIGATION plantings may be made any time from July to February, following "Early Rose" with "Factor," "Flourball," "Five-Towers" and "Up-to-Date." When planting the seed potatoes, furrows are made 30 inches apart, and about 5 inches deep; the potatoes are planted by hand and placed from 12 to 15 inches apart in the furrows. A few days after the seed has been planted the land should be harrowed to level and smooth it; this also checks an early crop of weeds and stores up soil moisture. When the plants have grown about six inches above the soil, they are 'earthed up' or 'ridged,' to provide

drainage and keep insects from doing harm to the stems and roots. If planted closely there is not enough soil between the rows to allow of a good 'ridge' being made along each row; the 'ridge' must be wide enough to keep the potatoes from the light, which turns the skin green and makes the potatoes unfit for food.

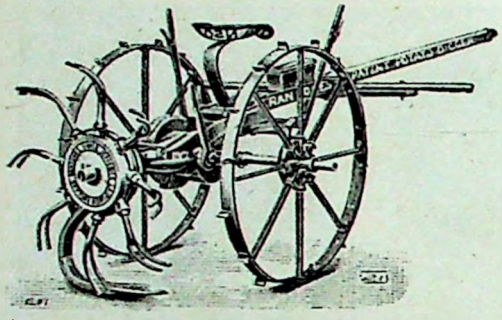
Rhizoctonia, a Disease of Potatoes. (*)
Tiny black bodies on surface of potato, often mistaken for soil particles sticking to it.
Seed treatment with Corrosive Sublimate (K). Practise crop rotation. (†)

GROWN ON 'DRY LAND,' the main crop is set out in the same way as when grown under irrigation; planting is done during November and December. Because of the light rainfall and the fact that droughts are likely to occur, the storing up of water in the soil is a very important matter. A great deal of cultivation, too, is needed, so on these soils flat cultivation is carried on. The space between the rows of potatoes is kept well worked and loose so that the soil may remain damp.

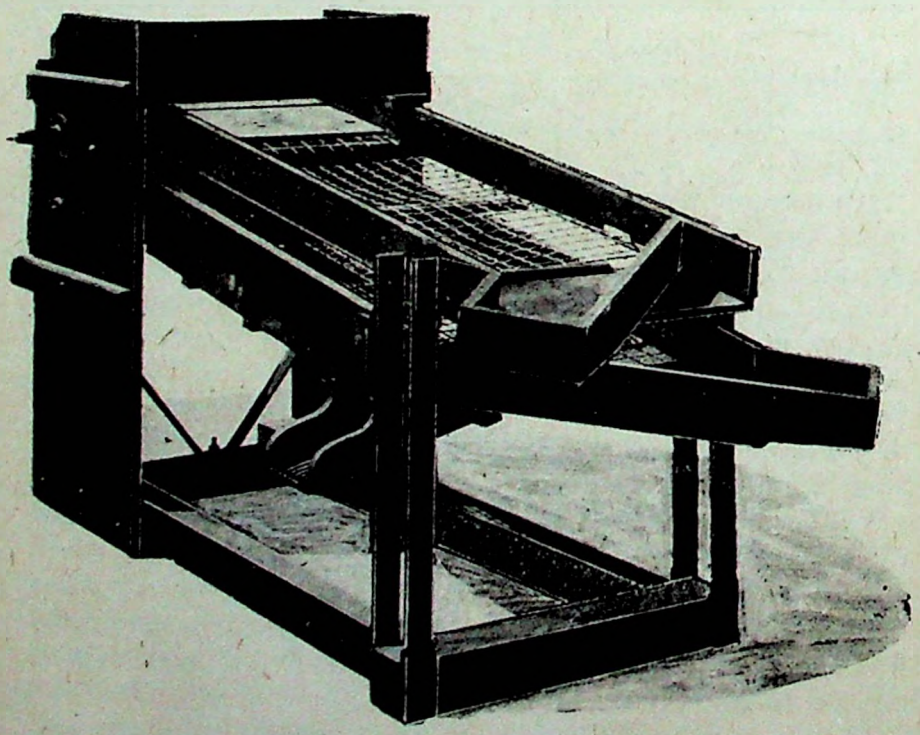
The best types of seed for planting are potatoes about the size of a hen's egg. If large potatoes be used, they should be cut into quarters; each piece should have at least two or three 'eyes,' a good amount of flesh, and should weigh about three ounces. About 2,000 lbs. of seed will be needed to plant a morgen of land.

(*) See Department of Agriculture's Bulletin, L.S. 49.
(K) See Appendix, FUNGICIDES K.
(†) See Section 410.

Early sorts of potatoes are dug out for marketing when about the size of an egg, and are washed and sold in bags weighing 153 lbs. each. Main crop sorts are not harvested until the tops of the plants have died down; they are then ploughed or dug out during dry weather, for if gathered during wet weather both bags and potatoes would be covered with soil and the potatoes would not store well; they should not be left out under a scorching sun, nor be allowed to lie out uncovered during frosty weather if it should be required to store them for even a few weeks. To keep potatoes for any length of

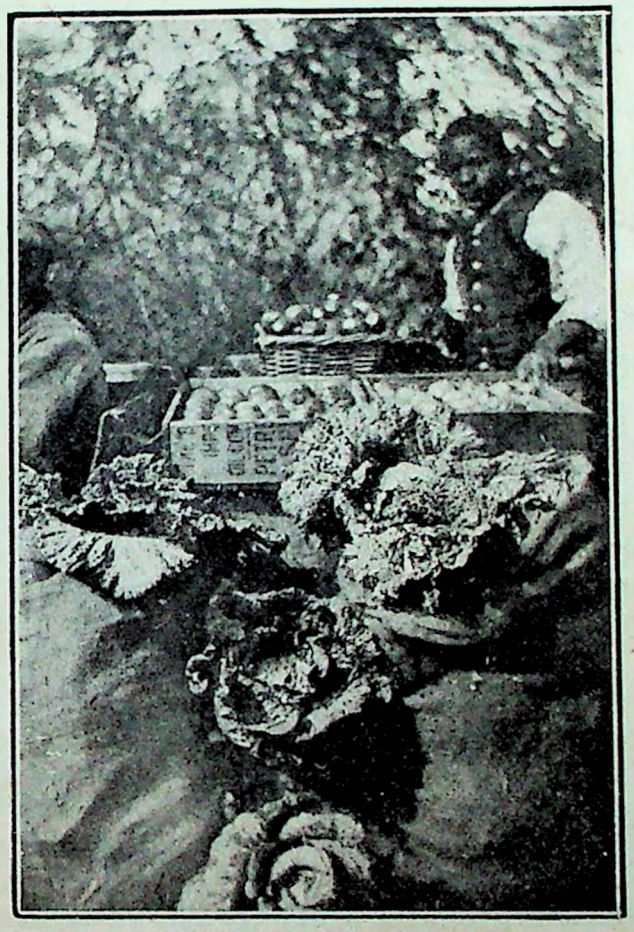


(Messrs. Ransomes, Sims & Jefferies, Ltd.)
A POTATO DIGGER.



(Messrs. G. North & Son.) A POTATO SORTER,
The potatoes are sorted into three grades—large, medium and small.

time it is not necessary to take them out of the ground, as they will keep perfectly fresh in the soil during the dry season, and can be dug or ploughed out from time to time as required.



Packing Tomatoes and Winter Cabbages.

Leaving them out in the air over any length of time during the dry season causes potatoes to shrivel, and they are spoiled also by the grubs of the Tuber Moth, which render them unfit for food.(*)

(*) Write to the Librarian, Department of Agriculture, Pretoria, for Bulletins: "The Potato Tuber Moth," No. U.R. 4/1917; "Potato Diseases," Nos. L.S. 26 and 28, U.R. 55, 60, 61 and 62.

PUMPKINS.

431. These are really a farm crop, as the plants when growing in good rich soil cover wide spaces. The seeds are sown in well-manured beds about nine feet apart each way, in the same manner as described for Melons and Marrows. The plants being tender to frost, sowings are not made until the danger is over, usually about September or October. All of the varieties are picked when the vines have been blackened by frost; some sorts have very thin skins and should be stored where frost cannot reach them to cause decay; others are known as Ironbarks, and are often placed on roofs for safety until wanted; the frosts appear to have no effect upon them.

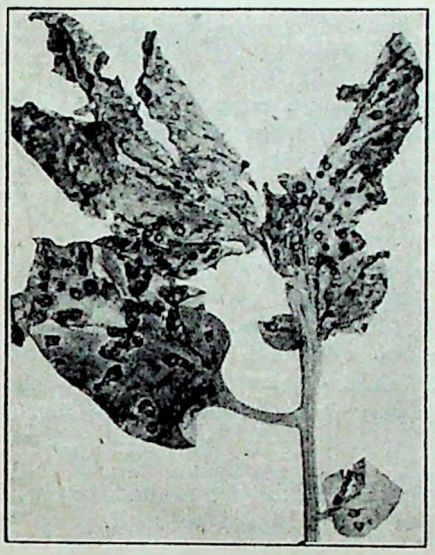
RADISHES.

433. These are easily grown all the year round in any ordinary garden soil. During the Summer months when growth is rapid the Turnip-rooted sorts are ready for use in one month; after that time they become coarse, hollow and hot. During the cooler months, from March to July, it is best to grow the long-rooted sorts; these grow slower, root deeper and do not run to waste so rapidly. Seed should be sown in drills nine inches apart; no thinning is required.

TOMATO.

435. This is not a vegetable even though it can be grown as such. In places where there is no frost it may be grown all the year round. Generally seed is sown in flat tins or boxes under frames from July to September, as the plants are tender to frost. In about two or three weeks the seeds sprout, and when the seedlings are a few inches high and have grown their true leaves, they are "pricked off" into tins containing twenty-five each. Here under shade they become strong and hardy, to await the time when the danger of frosts is over, and they can be planted out in the open. In districts of the North and North-Eastern Transvaal, where there is no hard frost during the Winter, seed is sown during March to produce plants which fruit throughout the winter months; it is at this time that Tomatoes packed in small boxes holding six, eight or ten pounds realise high prices. The soil where the plants are to grow

needs to be deep and enriched by digging or ploughing in large quantities of well-decayed stable manure; a further dressing of Superphosphate well worked into the soil after the plants are growing is also recommended.(*) If this be done there will be very little trouble caused by flowers dropping. When planting out, set the plants in rows four feet apart each way, and where possible provide stakes or a trellis of several wires to tie the plants to as they grow. Planted in this way there is less danger of disease, the crops are large and cultivation can be carried on. The plants will grow about five feet high when trained, and soft material should be used for tying, as the stems are easily broken and increase in size rapidly. During the season many blind side growths appear; these should be pinched out often so as to get the greatest amount of nourishment and light for the fruits. Many people overfeed their Tomato plants, and this results in long jointed plants which become weak; in such cases stop watering for a time. Tomatoes should be sent to market in flat boxes; the present way of packing is not a good one. An ordinary paraffin case cut into two or three sections lengthwise makes a very useful box for sending away by road or rail. When frosts put an end to the growth of the vines any fruits which may be on the plants can be picked and ripened on shelves in a warm room.



TOMATO LEAF SPOT.
Pale spots with darker borders on leaves, which curl up and at last dry and fall.
Spray with Bordeaux Mixture (A). First application when plants are coming into flower.

(*) See Section 108.
(A) See Appendix, Fungicides A.

APPENDIX

FUNGICIDES* (FUNGUS-KILLERS).

A.—BORDEAUX MIXTURE.

Copper sulphate	4 lb.
Quicklime	4 lb.
Water	50 gallons.

Prepare stock solution by dissolving 25 lb. copper sulphate in 25 gallons of water and carefully slaking 25 lb. of quicklime with 25 gallons of water. These solutions are of definite strength 1 lb. to 1 gallon, and will keep for some time; the mixture should be made only when needed.

To make 50 gallons of the mixture dilute 4 gallons of the stock solution of copper sulphate with 21 gallons of water; thoroughly stir the stock solution of milk of lime and place 4 gallons in another vessel containing 21 gallons of water. The two solutions thus diluted should slowly be poured together into a 50-gallon barrel, or, if more convenient, the copper sulphate can be slowly poured into the lime water, but not the reverse process.

The spray will adhere much better if the mixture is made up with water in which a prickly pear leaf has been allowed to soak.

Test the mixture before using: (1) insert the blade of a penknife into the mixture; if the polished surface assumes the colour of copper-plate the mixture is unsafe, and more lime water must be added. If the colour of the blade remains unchanged the mixture may be safely used. (2) Pour some of the mixture into an old plate or saucer and breathe on the surface; if the mixture is properly made a thin pellicle, looking like oil on the water will begin to form on the surface of the liquid.

K.—CORROSIVE SUBLIMATE.

For Seed Disinfection and for Dipping Seed Potatoes:—

Corrosive sublimate (A DEADLY POISON) ...	1 part.
Water	1,000 parts.

(*) From Agricultural Department's Bulletin L.S. 78, "Common Fungous and Bacterial Diseases of Plants."