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Living Plant; the Root

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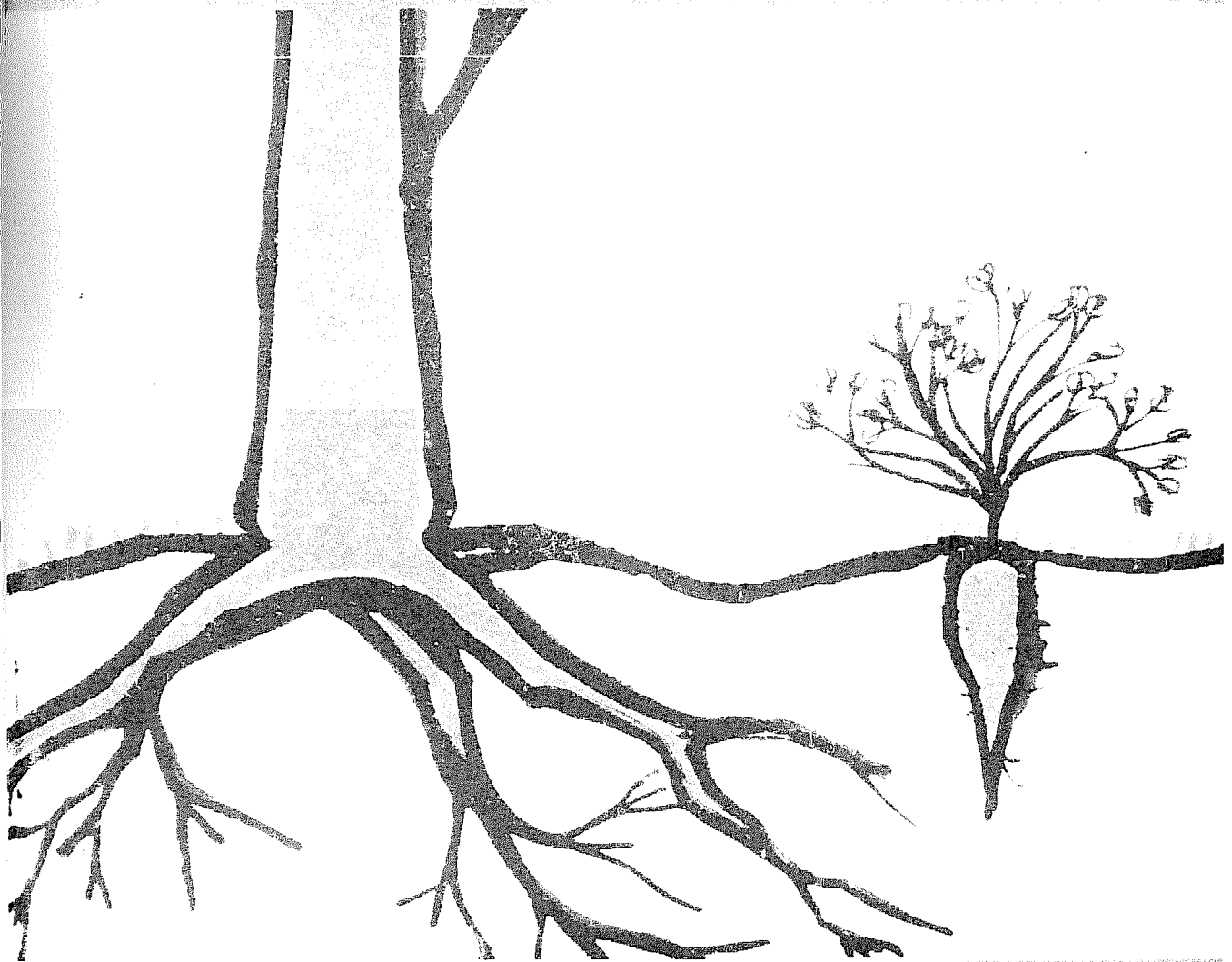
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the plant

the living plant
the root



BETTER FARMING SERIES

Twenty-six titles have been published in this series, designed as handbooks for a two-year intermediate level agricultural education and training course. They may be purchased as a set or as individual documents.

FIRST YEAR

1. The plant: the living plant; the root
2. The plant: the stem; the buds; the leaves
3. The plant: the flower
4. The soil: how the soil is made up
5. The soil: how to conserve the soil
6. The soil: how to improve the soil
7. Crop farming
8. Animal husbandry: feeding and care of animals
9. Animal husbandry: animal diseases; how animals reproduce

SECOND YEAR

10. The farm business survey
11. Cattle breeding
12. Sheep and goat breeding
13. Keeping chickens
14. Farming with animal power
15. Cereals
16. Roots and tubers
17. Groundnuts
18. Bananas
19. Market gardening
20. Upland rice
21. Wet paddy or swamp rice
22. Cocoa
23. Coffee
24. The oil palm
25. The rubber tree
26. The modern farm business

The plant

The living plant

The root

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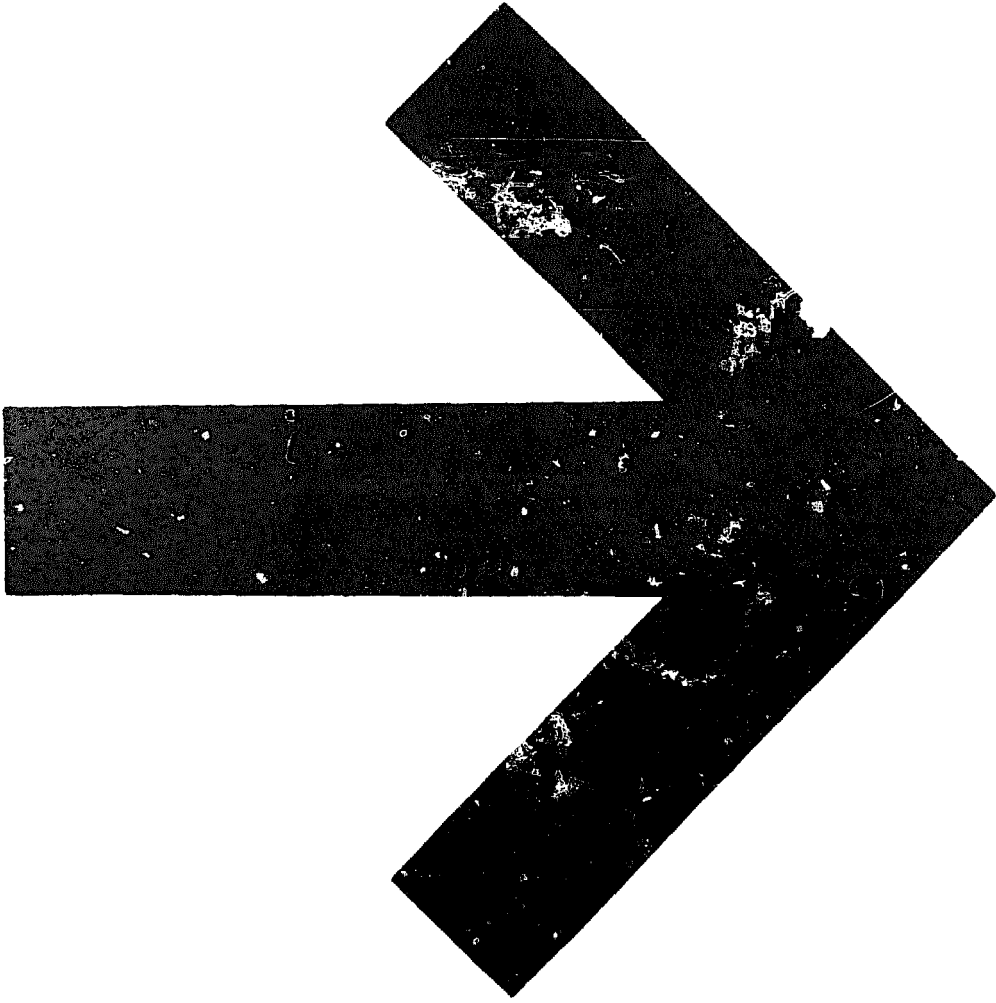
PREFACE

This manual is a translation and adaptation of "La plante — la plante vit, la racine," published by the Agri-Service-Afrique of the Institut africain pour le développement économique et social (INADES), and forms part of a series of 26 booklets. Grateful acknowledgement is made to the publishers for making available this text; which it is hoped will find widespread use at the intermediate level of agricultural education and training in English-speaking countries.

The original texts were prepared for an African environment and this is naturally reflected in the English version. However, it is expected that many of the manuals of the series — a list of which will be found on the inside front cover — will also be of value for training in many other parts of the world. Adaptations can be made to the text where necessary owing to different climatic and ecological conditions.

Applications for permission to issue this manual in other languages are welcomed. Such applications should be addressed to: Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

The author of this English version is Mr. A.J. Henderson, former Chief of the FAO Editorial Branch.



OUTLINE OF COURSE

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PLAN OF WORK

FIRST WEEK

Read pages 4 to 13 on the living plant.

- Pay great attention as you read.
- Begin the experiments of making a plant germinate and lifting a plant.
- Look after what you have sown.
- Water them every morning.

SECOND WEEK

Read pages 14 to 19, on:

- How a root is made.
- How a rootlet is made.
- The inside of a root.

To help your memory
read pages 4 to 13 again.

Study the new lesson carefully.

Make sure you understand **what rootlets do** (see page 17).

This lesson is rather difficult,
but it is important.

THIRD WEEK

Read pages 20 to 26 on the **different kinds of roots**.

To help your memory
read pages 14 to 19 again.

Look at the drawings carefully
so that you understand the form of roots.

Study the page on sowing at the best density.

Look at how you sow in your plantation or field.

FOURTH WEEK

Read pages 27 and 28.

Read the whole booklet again quickly.

- Try to answer the question paper
without looking at the booklet.

Write your answers on a piece of paper.

Look in the booklet to see if your answers are right.

Then write your answers on the question paper,
without copying from the booklet.

INTRODUCTION

Why do we study the plant?

- You want a good crop of yams or cotton.

To get it you must learn
how yams or cotton grow.

If you look after the plants properly
you will get good crops.

- You want animals that are in good health and heavier.

To get them, you must give them
good grass and grains.

Then you will get fat oxen and goats.

- Too much nitrogen on groundnuts
does not help groundnuts to grow better.

Chloride on tobacco
prevents the leaves from burning.

Nitrogen on maize
will produce stronger plants with more grain.

So you must learn how to use fertilizers.

We must study plants and fertilizers.

THE LIVING PLANT

- Man is born, lives and dies.

The plant too is born, lives and dies.

- Man eats, feeds.

The plant too eats, feeds.

The plant gets its food in the soil,
through its roots.

- Man breathes.

**The plant breathes too,
through its roots.**

- Man reproduces himself, has children.

The plant too reproduces itself.

It has flowers.

It has fruits.

It has seeds.

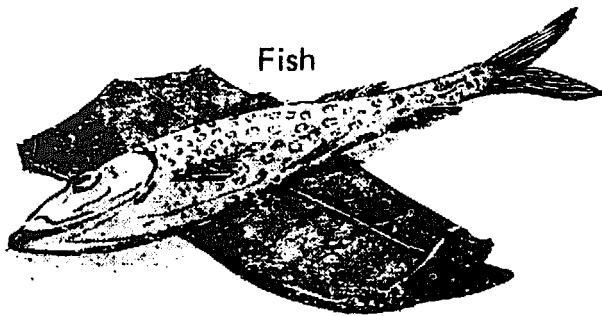
We must study how plants live.

Man is born

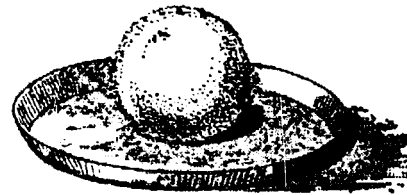


Man lives

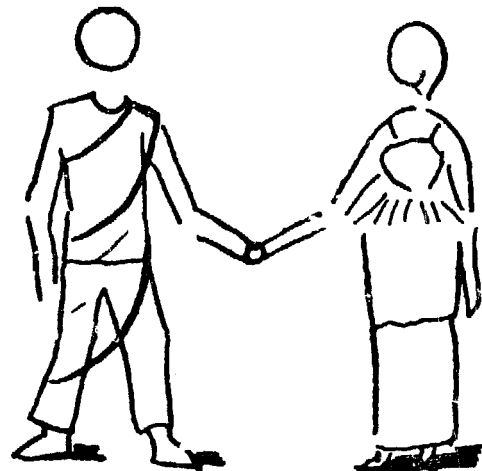
Man feeds



Ball of millet

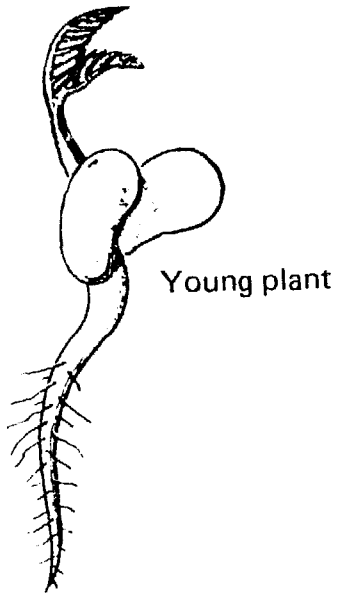


Man reproduces himself



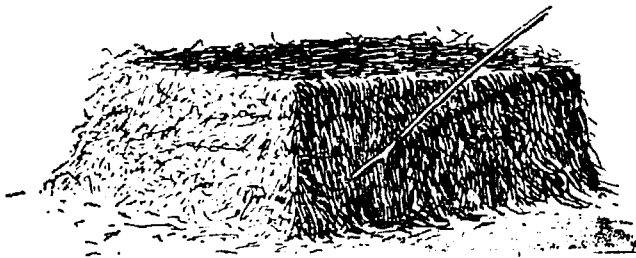
Man dies

**MAN AND PLANT ARE BORN
LIVE
AND DIE**



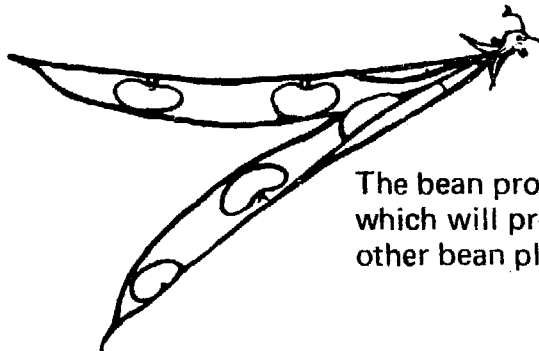
The plant is born

The plant lives



Manure put into the earth
feeds the plant.

The plant feeds



The plant reproduces itself

The bean produces seeds
which will produce
other bean plants.

The plant dies

**MAN AND PLANT ARE BORN
LIVE
AND DIE**

WE MAKE TWO EXPERIMENTS

We are going to see how a plant is born,
that is, **make it germinate.**

A seed germinates
when the stem and the root come out.

Then we shall lift a plant.

Like this we shall understand better
the course on the plant.

We shall make these **two experiments**
at the same time.

This will enable us:

to see better,

to observe better,

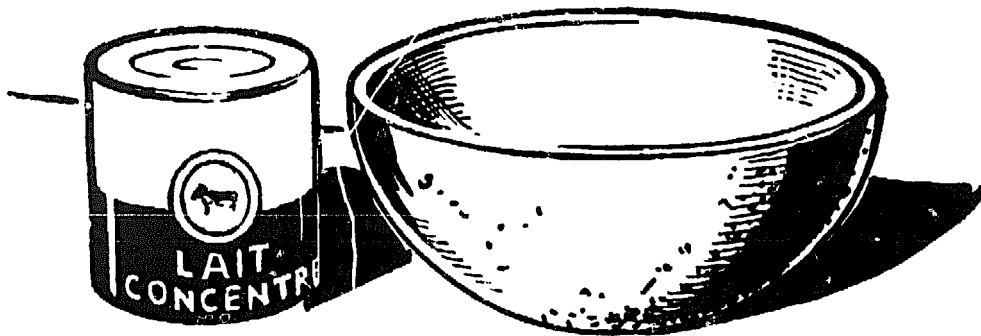
to understand better

how a plant grows
and how a root is made.

First experiment

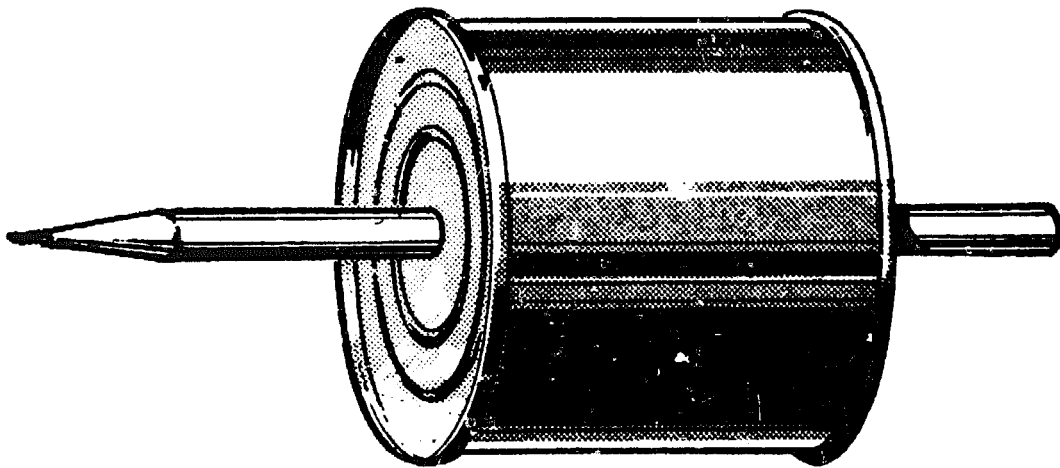
MAKING A PLANT GERMINATE

1. Take some containers which are no longer wanted, for instance, stone jars, empty cans, cracked gourds or gourds with holes in them.

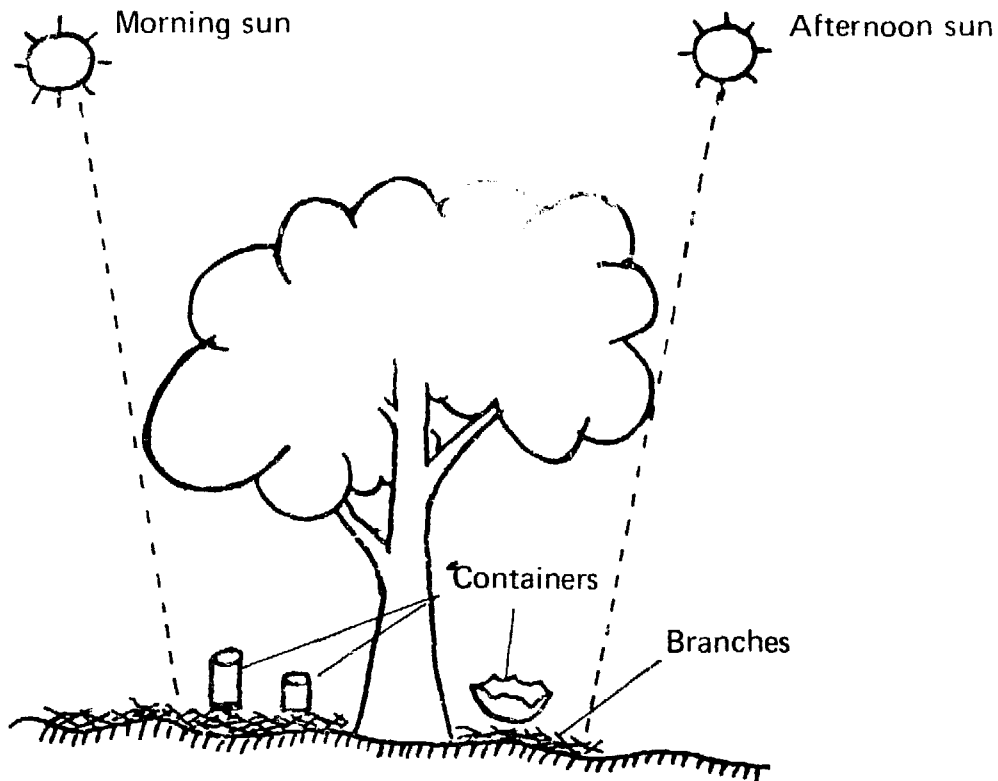


- Make a hole in the bottom of each container.

Make it big enough for a pencil to go through.



- Fill the containers with sand.
You will easily find some.
Do not press the sand down.
Leave some space above the sand.
This space should be
about equal to a finger's thickness.
- Put your containers under a tree
so that they are not in the sun.
Put them on big palm fronds or on branches
so that they do not touch the ground.

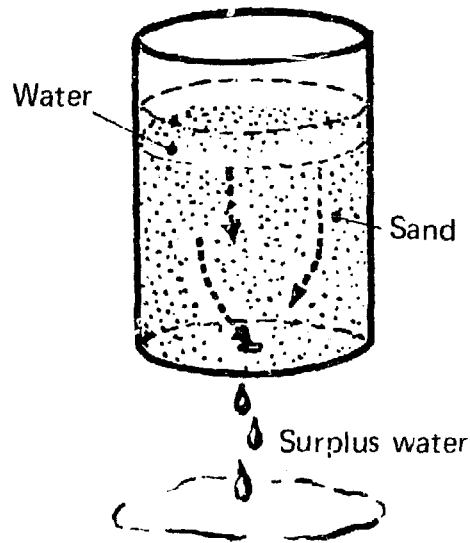


- Get some water.
Pour water into your containers.
It should flow over the edge.

- The water will pass into the sand and will make it damp.
The surplus water will flow out through the hole in the bottom.

The containers are separated from the ground by the palm fronds or the branches.

The water can easily flow away.



- The surplus water does not flow out quickly. It stays on the surface of the sand. That is because the sand you have taken is too fine. You must begin again. Otherwise the seeds may not grow.
- Look out for young goats and pigs. They may knock over the containers. Put up a screen to protect your seeds.

2. Leave your containers of damp sand for a whole night.

The next day take four or five seeds of maize, millet, cowpeas or beans.

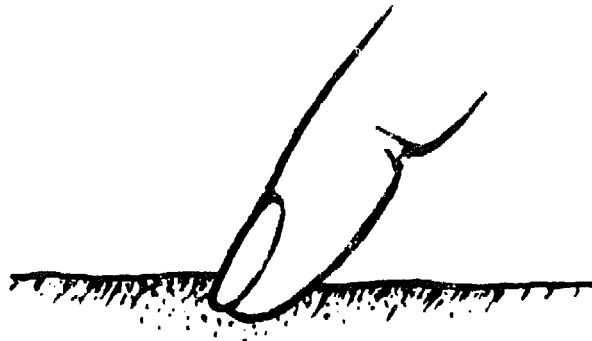
Sow one seed in the middle of each container.

D

3. The way to sow.

Push your finger very gently into the sand as shown in the sketch below.

Pushing the finger into the soil •



- When you have put the seed in the hollow made in this way, cover the seed with a very little sand.

- After sowing, water lightly.

If the water uncovers the seed, add some sand.

Water every morning before the sun is really hot.

- Two or three days later, the root will grow, and five or six days afterwards the seedling will come above the soil.

The seed has **germinated**.

The stem and root come out.

Second experiment

LIFTING A PLANT OF MAIZE OR MILLET

One part of the plant is below ground – **the root**.
Take care not to damage the roots
in lifting them out of the ground.

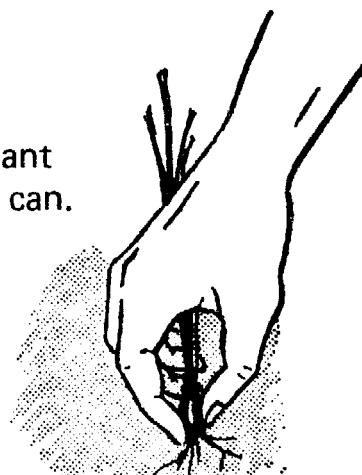
How to get the roots out of the ground

- You must **pour a lot of water round the plant**.
Take a gourd full of water.
Pour the water all round the plant.
Wait until the soil is very damp.
If your finger will not go easily into the soil,
pour on still more water.
It is very important for the soil to be very wet,
otherwise you will break the roots
in lifting them out.
If the plant does not come out of the ground easily,
pour on still more water.

- When you lift, take hold of the plant
as near to the ground as you can.

- The part you are holding
is called the **stem**.

The part that
comes out of the ground
is the **root**.



Right way to hold
the seedling for
transplanting

THE ROOT

How is a root made?

- We lifted a plant.

Let us take a look at it.

- What do we see?

- A green part,
in the air
– the stem.

- A grey part,
in the soil
– the roots.

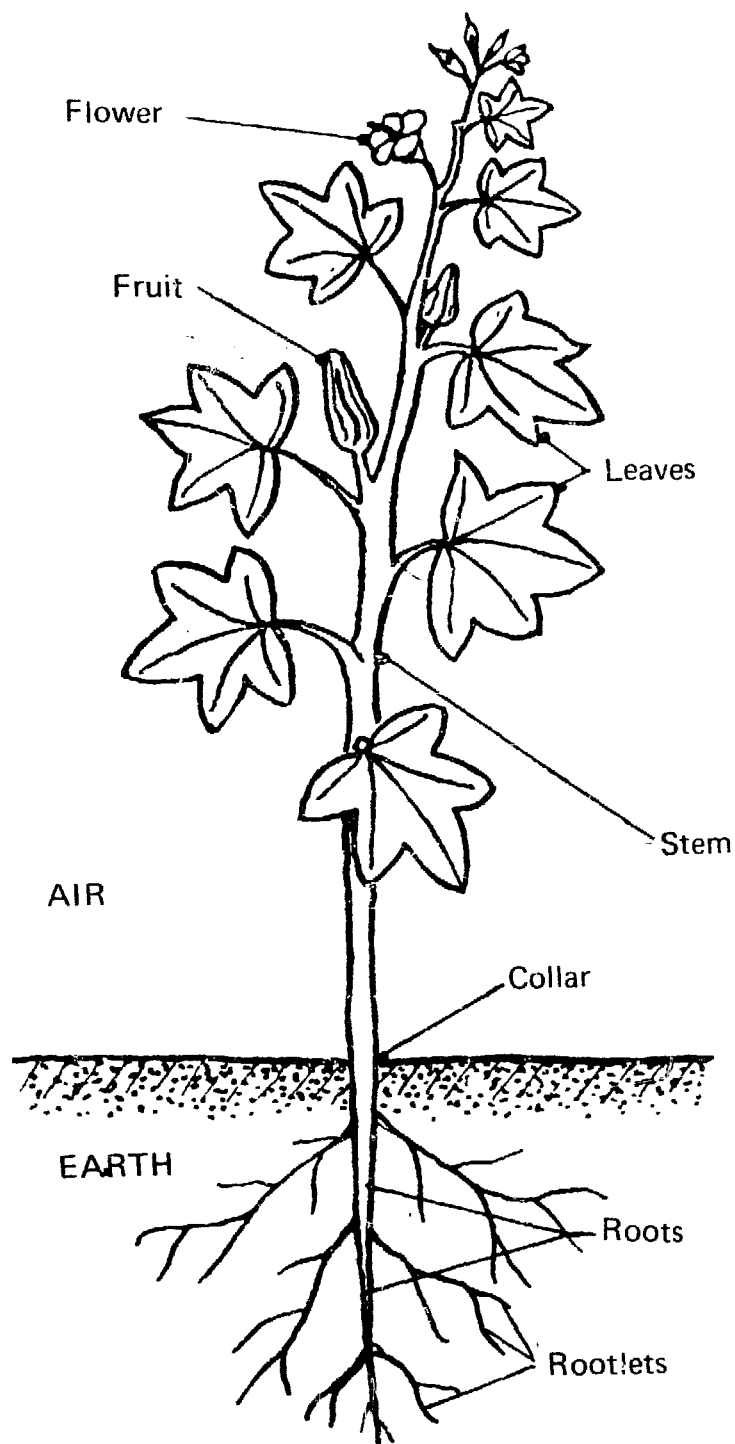
- Between the stem and the roots
– the collar, or crown.

Let us look at the roots.

They are divided
into smaller roots
and rootlets.

- The smallest roots are called rootlets.

The rootlets come at the end of the roots.



How is a rootlet made?

- There are parts of the rootlet which perhaps you cannot see, because they are too small or because they have remained in the ground.
- To see them better, make another seed germinate. Put a bean seed in the earth. After three days lift it carefully. The root should be about as long as a match. To see better you need a lens. Perhaps your teacher can lend you one.

What do you see?

- At the tip of the rootlet there is **the root-cap**.

The root-cap is small and hard.

Its purpose is to enable the rootlet to penetrate the soil.

- On the rootlet there are **absorptive hairs**.
- Above the absorptive hairs there is a dark, hard part.

This is the oldest part of the root.

It does not take in food.

It does not absorb food.

The absorptive hairs of the rootlet

- There are very many of these hairs, but they are very thin, very short and very fragile.

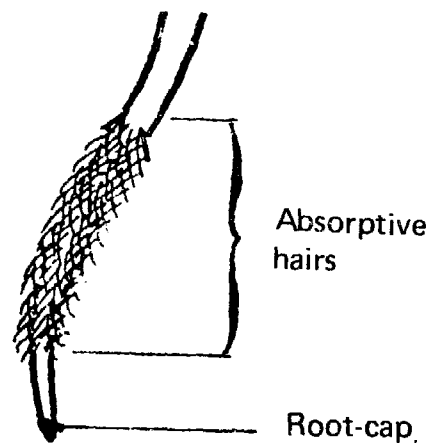
You may not be able to see them.

These hairs are like those on your head, but they are very short, and thin, and there are very many of them.

These hairs are called **absorptive hairs** because they take from the soil the food which the plant needs in order to live and grow.

They are like little mouths which take in food for the plant.

The hairs absorb food.



A rootlet

A plant feeds only through the absorptive hairs on its rootlets.

How is the inside of a root made?

Let us cut a root with a knife.

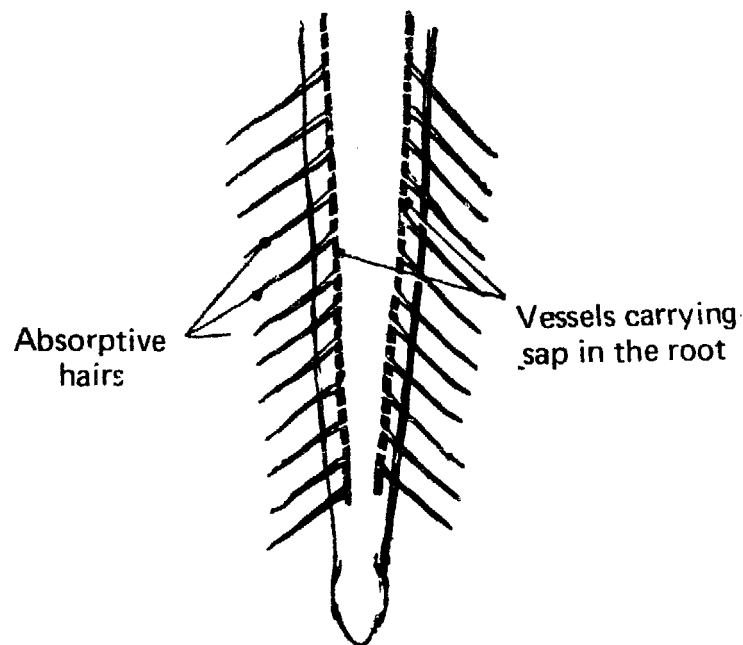
What do we see?

- On the outside is **the skin**.
- Under the skin is a hard, moist part, where the **sap** flows in little tubes called **vessels** that make up **the vascular system**.

Through this system the sap flows.

In man blood flows through veins and other vessels.

In the plant **sap flows through the vessels.**



What are the foods which the plant takes from the soil?

They are **mineral salts**.

- In the soil,
mixed with it,
are mineral salts.

These mineral salts are the plant's food.

The mineral salts and the water are absorbed by the root hairs.

They become **sap** in the plant.

When there are plenty of mineral salts in the soil, the soil is rich. The plant grows well.

- When there are not many mineral salts in the soil, the soil is poor. The plant grows badly.

The soil can be given mineral salts in the form of fertilizers and manure.

DIFFERENT KINDS OF ROOTS

- The roots of a maize plant,
a millet plant
and a rice plant
are alike.

- The roots of a mango tree,
an orange tree
and a lemon tree
are alike.

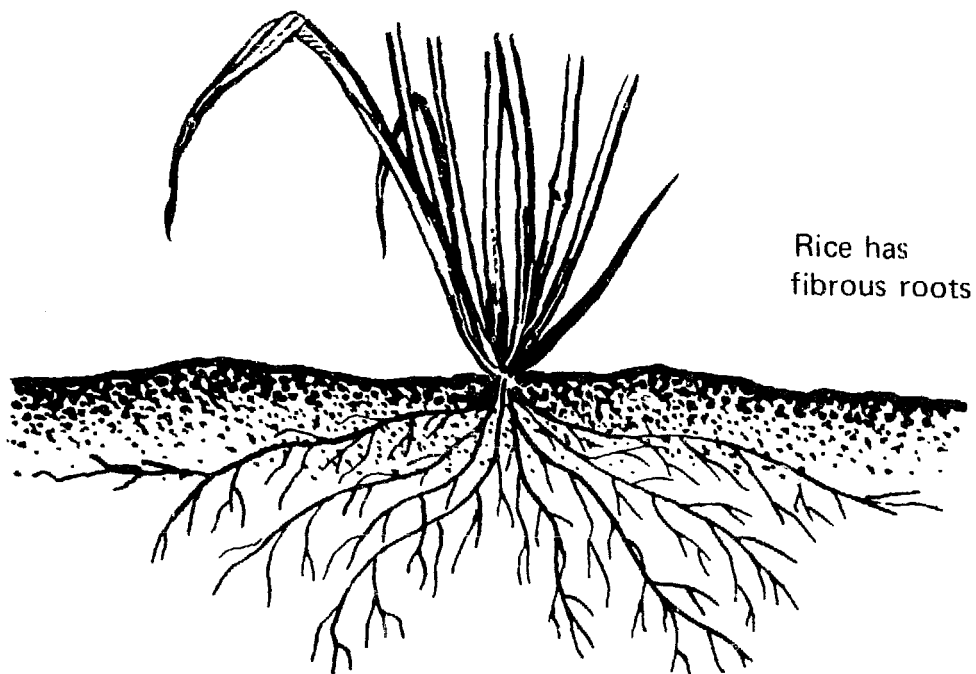
- The roots of maize, millet and rice
are not like
those of the mango tree, the orange tree
and the lemon tree.

- Different plants have different roots.

FIBROUS ROOTS

Some plants have small, thin roots,
all of the same length.

- These roots form a tuft,
as for instance the roots of onion,
rice,
millet,
maize.



- A plant that has many small roots
of the same length,
the same thickness,
the same shape,
has **fibrous roots**.

CREEPING ROOTS

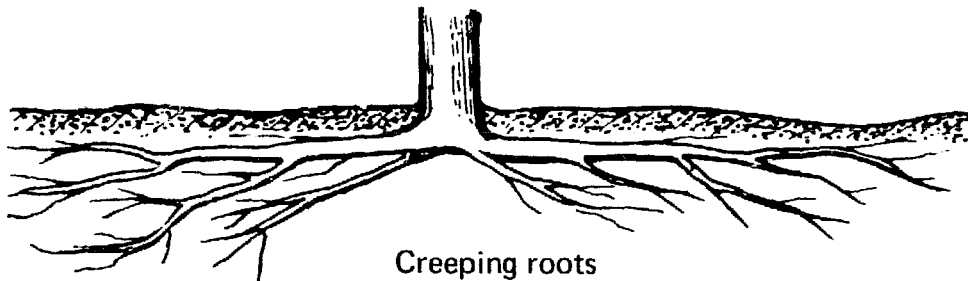
Some plants have roots
that are shallow and long.

- Creeping roots do not go deep into the soil.
- These roots go a long way from the base of the plant.

They cover a large area.

They have to find in a small depth of earth
the food necessary for the life of the plant.

Many trees have creeping roots.



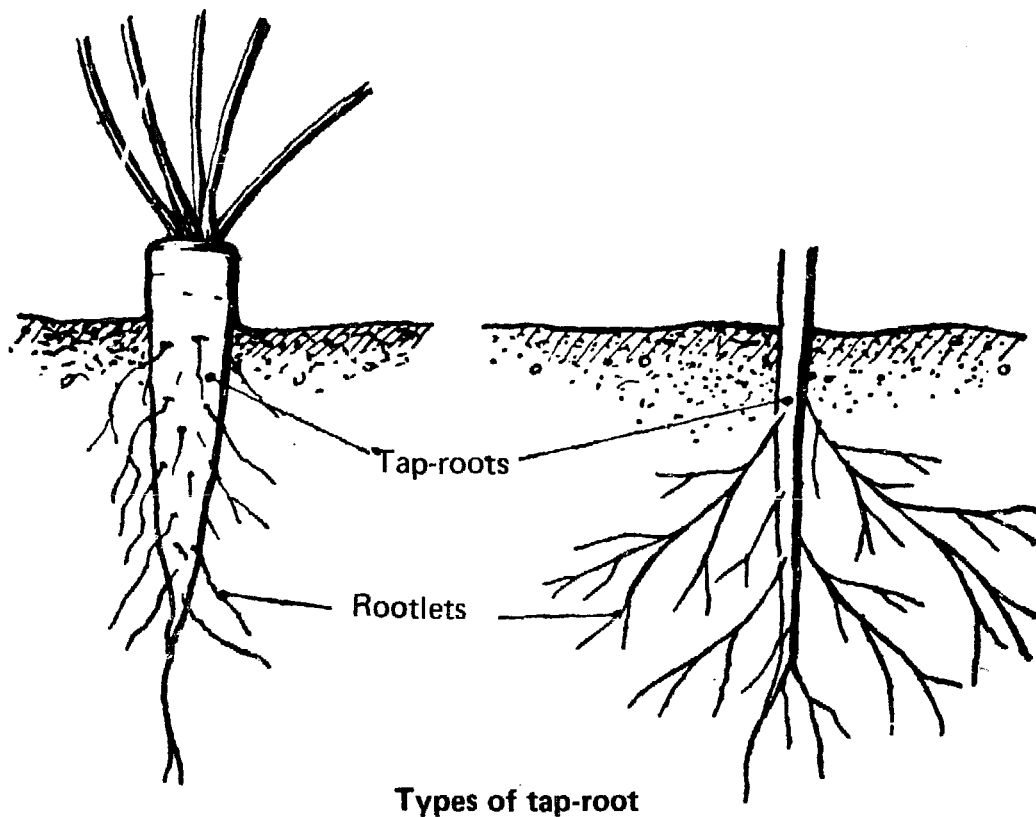
Creeping roots

- A plant that has shallow, very long roots
has **creeping roots**.

TAP-ROOTS

Some plants have only one root,
very thick,
deep,
straight,
called a **tap-root**.

- Smaller roots grow on this thick root;
they are called **rootlets**.
- Tap-roots go deep into the soil.
They cannot penetrate soil that is too hard.



- Cotton, coffee, cocoa, okra, carrots, papayas
all have a root that goes deep into the soil,
is very thick and straight.

They have a **tap-root**.

TUBEROUS ROOTS

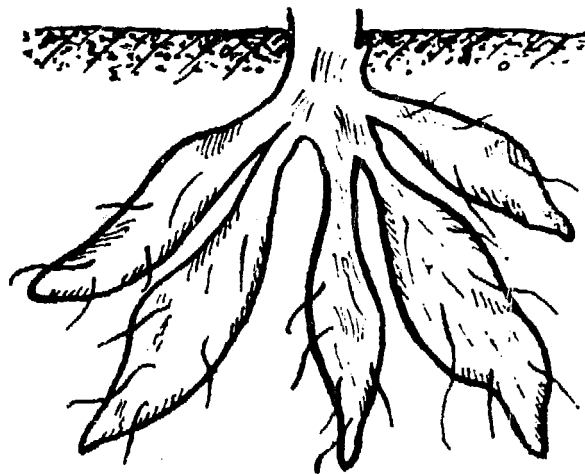
Some plants have very thick roots.

- These roots store up food.
- These roots are thick because they have taken up a lot of food from the soil.

The food is stored up
in order to feed the whole plant.

The plant is said to have **built up reserves**.

For example, cassava.



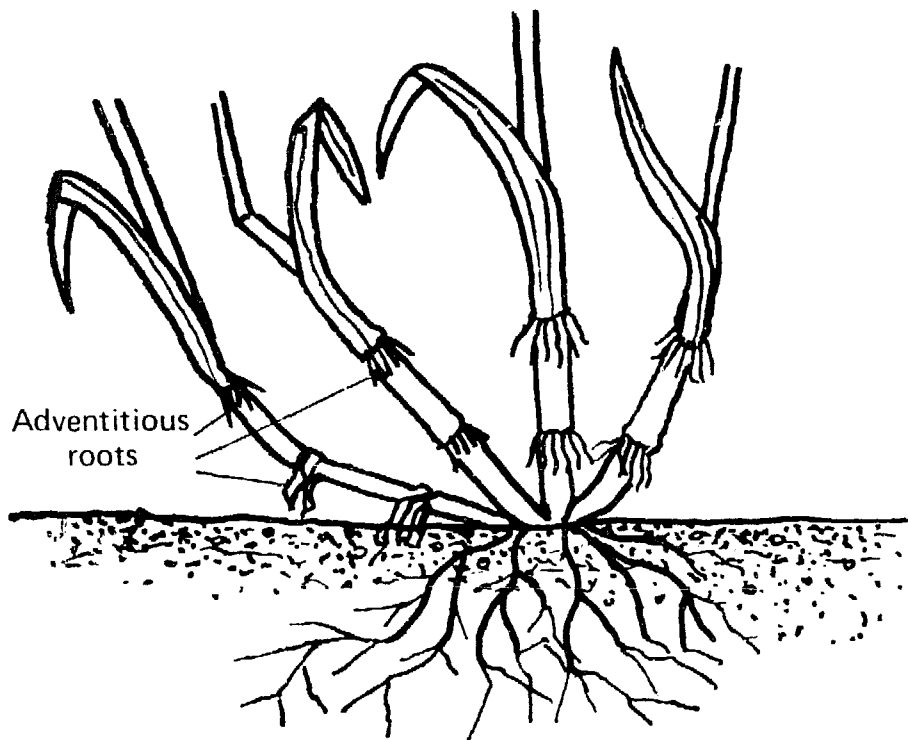
Cassava roots

- A plant that stores up reserves in thick roots has **tuberous roots**.

ADVENTITIOUS ROOTS

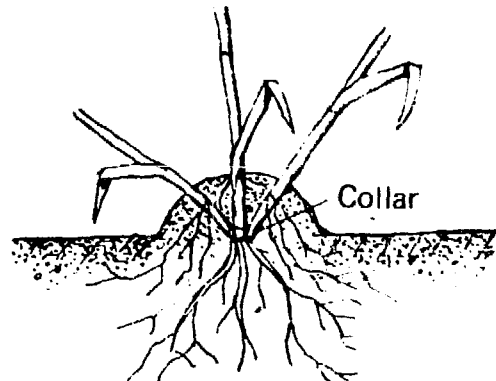
In some plants
roots start from the stem above the soil,
that is, above the collar,
and afterwards go down into the earth.

- **Adventitious roots** grow above the collar.
For example, mangrove, bamboo, maize and rice
all have adventitious roots.



A rice plant

- Soil put around the collar
helps adventitious roots
to grow; the plant is
earthed up.

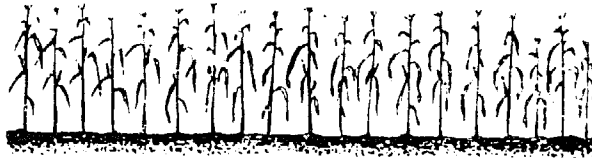


Earthing up encourages
adventitious roots to develop

- A plant with roots
on the stems has
adventitious roots.

SOWING AT THE BEST DENSITY

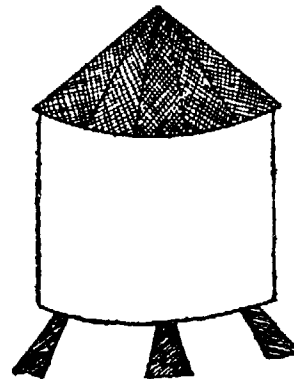
- When seeds of maize or millet are sown too close together, each plant has not enough earth to make good roots, and to get good stems and ears of grain. The harvest will be poor.



- When seeds of maize or millet are sown too far apart, you harvest fine ears of grain, but there are not many of them.



- Seeds must be sown so as to get the largest possible number of strong plants on the smallest area.



- You must find out how many seeds can be sown in a field; you must sow at the best density.

SUMMARY OF COURSE

What are roots for?

1. Roots hold the plant to the soil.

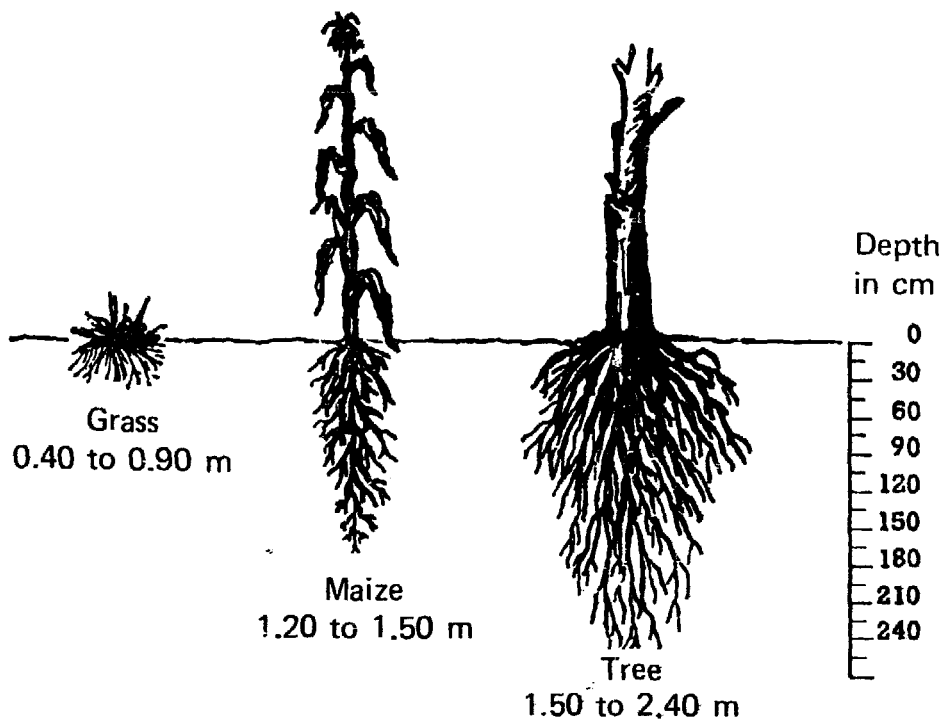
- The rain, a stream or the sea sometimes pulls out roots.

Then the plant or the tree falls and dies.

To live,
the plant must remain held to the soil by its roots.

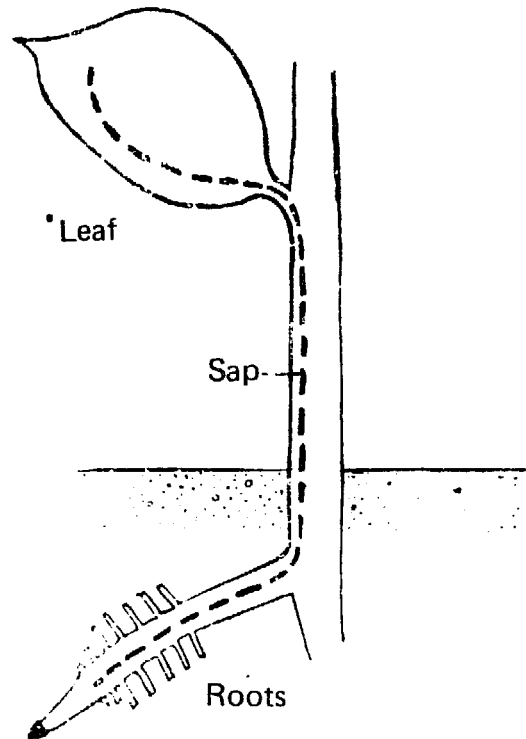
- The plant will be a fine one if its roots are strong.

To become vigorous,
a plant must be able to spread its roots.



Roots go to different depths.

2. Roots feed the plant.



Roots take the plant's food from the soil

- If the plant has well developed roots, it will be well fed and the harvest will be better.
- If the plant can get more foods from the soil, the plant will be well fed and the harvest will be better.

A plant is finer,
gives a better harvest
and produces more

- if its roots are better developed,
- if the soil is richer.

SUGGESTED QUESTION PAPER

FILL IN THE MISSING WORDS

The plant lives like all living things, the plant,
reproduces itself and

The part of the plant that lives in the soil is called the

The root serves to the plant to the soil,
and to the plant.

The plant feeds through the of the rootlets.

All roots are not
..... roots stay on the surface of the soil.
..... roots go down deep into the soil.
..... roots store up food.

ANSWER THE FOLLOWING QUESTIONS

Give some examples of tap-roots.

What are creeping roots like?

Why must the base of plants be earthed up?

What is a rootlet?

Where does sap come from?

What are roots for?

Explain to a friend why you must pay attention to the sowing density.

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Israel	Emanuel Brown, P.O. Box 4101, 35 Allenby Road and Nachlat Benyamin Street, Tel Aviv; 9 Shlomzion Hamalka Street, Jerusalem.
Italie	Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome; Libreria Scientifica Dott. L. De Biasio "Aeiou", Via Meravigli 16, 20123 Milan; Libreria Commissionaria Sansoni "Licosa", Via Lamarmora 45, C.P. 552, 50121 Florence.
Jamaica	Teachers Book Centre Ltd., 96 Church Street, Kingston.
Japan	Maruzen Company Ltd., P.O. Box 5050, Tokyo Central 100-31.
Kenya	The E.S.A. Bookshop, P.O. Box 30167, Nairobi.

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Korea, Rep. of	The Eul-Yoo Publishing Co. Ltd., 5 2-Ka, Chong-ro, Seoul.
Liban	Dar Al-Maaref Liban S.A.L., place Riad El-Solh, B.P. 2320, Beyrouth.
Luxembourg	Service des publications de la FAO, M. J. De Lannoy, rue du Trône 112, 1050 Bruxelles (Belgique)
Malaysia	MPH Distributors Sdn. Bhd., 71/77 Stamford Road, Singapore 5, Singapore.
Maroc	Librairie "Aux Belles Images", 281 avenue Mohammed V, Rabat.
Mauritius	Naïanda Company Limited, 30 Bourbon Street, Port-Louis.
México	Dilitsa, Calle 22 D, Apartado 24-448, México 7, D.F.
Netherlands	N.V. Mink, Lange Voorhout 9, The Hague.
New Zealand	Government Printing Office: Government Bookshops at Rutland Street, P.O. Box 5344, Auckland; Cambridge Street, Private Bag, Wellington; 130 Oxford Terrace, P.O. Box 17, Dunedin; Princes Street, P.O. Box 1104, Dunedin; Alma Street, P.O. Box 1104, Dunedin.
Nicaragua	Cultura, Apartado de Oriente, Apartado 4741, Managua.
Nigeria	Univer Bookshop Nigeria Ltd., University of Ibadan.
Norway	Johan Grundt Tanum Bokhandel, Karl Johansgt. GT 41-43, Oslo 1.
Pakistan	Mirza Book Agency, 65 The Mall, Lahore 3.
Panama	Distribuidora Lewis S.A., Edificio Dorasol, Calle 25 y Avenida Balboa, Apartado 1634, Panamá 1.
Peru	Libreria Juan Mejia Baca, Azangaro 722, Lima.
Philippines	The Modern Book Company, 928 Rizal Avenue, Manila.
Poland	Ars Polona-Ruch, Krakowskie Przedmiescie 7, Warsaw.
Portugal	Livraria Bertrand, S.A.R.L., Apartado 37, Amadora; Livraria Portugal, Dias y Andrade Ltda., Apartado 2681, Rua do Carmo 70-74, Lisbon - 2.
Rep. Dominicana	Fundación Dominicana de Desarrollo, Casa de las Gárgolas, Mercedes 4, Santo Domingo.
Roumanie	Ilexim, Calea Grivitei No. 64-66, P.O. Box 2001, Bucharest.
Saud: Arabia	Khazindar Establishment, King Faysal Street, Riyadh.
Singapore	MPH Distributors Sdn. Bhd., 71/77 Stamford Road, Singapore 6.
Somalia	"Samater's", P.O. Box 936, Mogadishu.
Sri Lanka	M.D. Gunasena and Co. Ltd., 217 Norris Road, Colombo 11.
Suisse	Librairie Payot S.A., Lausanne et Genève; Hans Raunhardt, Kirchgasse 17, Zurich 1.
Sweden	C.E. Fritzes Kungl. Hovbokhandel, Fredsgatan 2, 103 27 Stockholm 16.
Tanzania	Dar es Salaam Bookshop, P.O. Box 9030, Dar es Salaam.
Thailand	Suksapan Panit, Mansion 9, Rajadamnern Avenue, Bangkok.
Togo	Librairie du Bon Pasteur, B.P. 1164, Lomé.
Turkey	Güven Kitabevi Müdafaa Cad., Güven Building 12/5, Ankara.
United Kingdom	Her Majesty's Stationery Office, 49 High Holborn, London, W.C.1; P.O. Box 569, London, S.E.1 (trade and London area mail orders); 13a Castle Street, Edinburgh EH2 3AR; 109 St. Mary Street, Cardiff CF1 1JW; 7 Linenhall Street, Belfast BT2 8AY; Brazennose Street, Manchester M60 8AS; 258 Broad Street, Birmingham 1; Southey House, Wine Street, Bristol BS1 2BQ.
United States of America	UNIPUB, 650 First Avenue, P.O. Box 433, Murray Hill Station, New York, N.Y. 10016.
Uruguay	Juan Angel Peri, Alzaibar 1328, Casilla de Correos 1755, Montevideo.
Venezuela	Blume Distribuidora S.A., Calle 3, N° 508, Quinta Palmera Sola, Campo Alegre, Chacao, Caracas.
Yugoslavia	Jugoslovenska Knjiga, Terazije 27/11, Belgrade; Cankarjeva Založba, P.O. Box 201-IV, Ljubljana.
Other countries	Requests from countries where sales agents have not yet been appointed may be sent to: Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.
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