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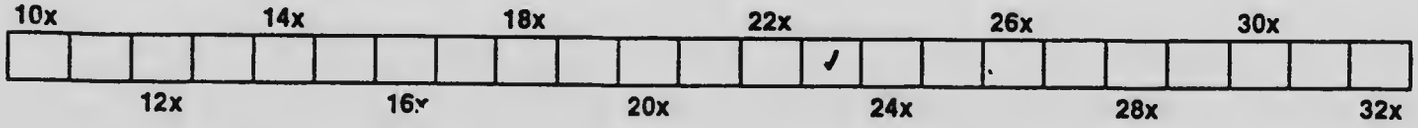

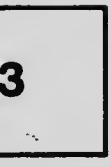

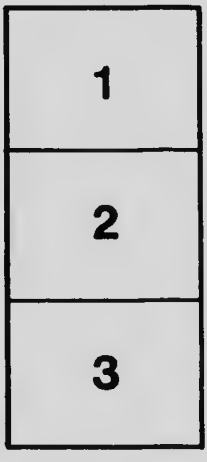

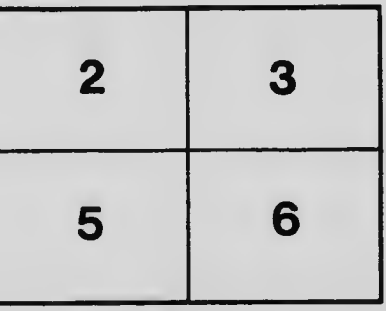

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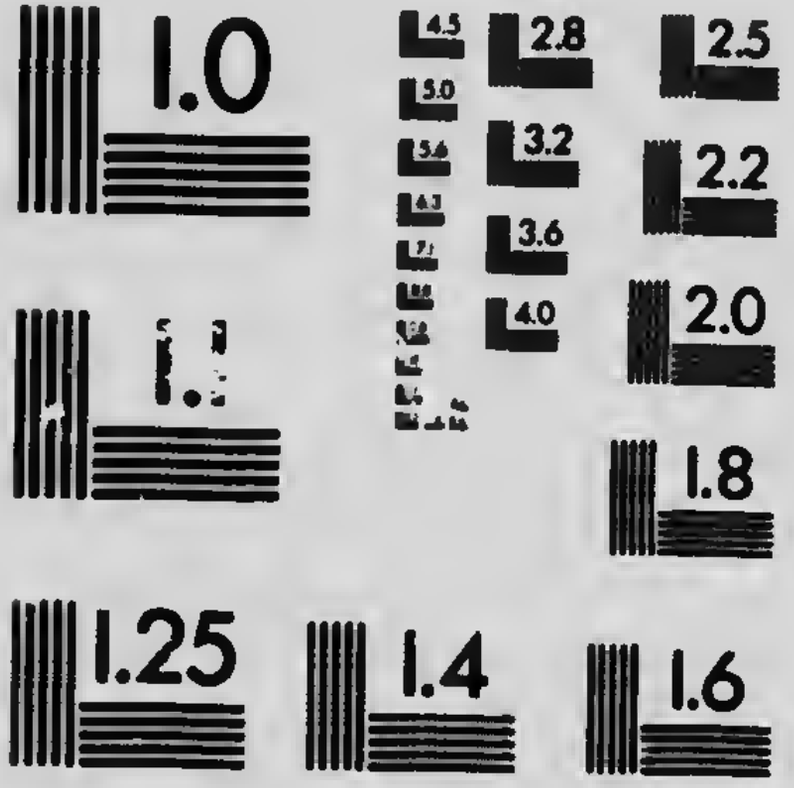

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DOMINION OF CANADA.

DEPARTMENT OF AGRICULTURE.

EXPERIMENTAL FARMS.

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DIVISION OF CHEMISTRY.

THE FARMER AS A MANUFACTURER.

BY

A. T. STUART, B.A., Assistant Chemist.

Part I.—The world's sole manufacturer of Protein, Fats, Carbohydrates and Cloth Fibres.

THE REAL NATURE OF THE INDUSTRY.

The raw materials at the hands of the farmer and the proportions of each used are, roughly speaking, air, 20 pounds; water, 75 pounds; and soil 5 pounds. From these elements of nature he manufactures 100 pounds of products—Protein, Fats, Carbohydrates and Fibres. *It is important* that every farmer should be well acquainted with the nature of these products, for his whole life's work is involved in their manufacture. He will then find greater interest in every operation and will be better able to conduct his work that it may yield maximum profits.

The *ultimate object of farming is to prepare substances which will yield these products in maximum quantities and of the best quality.* Nature can be encouraged to add to these substances attractive colours, lours and flavours. Food materials can be produced in digestible forms, clothing materials (fibres) of good texture, oils of good quality for paints, lubricants, etc.; barley can be grown specially valuable for brewing and malting; corn for starch industries; sugar-cane and beets for sugar, wheat to yield flours for special purposes, etc., etc., etc.

In foods we always find one or more of the constituents, Protein, Fat and Carbohydrates. This is true of everything we eat, whether it be fish, oysters, meat, potatoes, apples, ice cream, celery or candy, and even beer. The chief differences in foods lie in the amounts of water and protein they possess—strawberries may contain 96 per cent water and flour only 8 per cent; cheese may contain 3 per cent protein; apples less than 1 per cent. Nature does things up in neat packages of fibres and by introducing colours, odours and flavours we get apparently an endless variety. Illustrations of this are everywhere abundant, as witness the orange, apple, bananas, etc.

REQUIREMENTS OF MAN.

All the necessities of life are included under the three headings of Food, Clothing and Shelter and of these the farmer must supply the first and second. All materials of clothing (wool, cotton, leather, silk, linen, etc.,) are made up of either animal or vegetable fibres. To understand the nature of foods we must first ascertain the requirements of the animal, including man.

The body of a man weighing 148 pounds, is made up as follows::

Water	90 lbs.
Protein	26.6 "
Fats	23. "
Carbohydrates	trace
Mineral	8 3 "
	148 0 "

The food requirements of man, as well as of animals, are—

Water to dissolve and convey the material.

Protein (containing 16 per cent Nitrogen)—for flesh and blood production, to heat the body and produce energy.

Fats (or oils)—for generation of vital heat and energy and store of fat.

Carbohydrates (starches and sugars)—for heat, energy and store of fat.

Mineral matter (seen in plant ashes)—to produce bone.

These foods must be in digestible forms in order that they may be absorbed and utilized by the body. In the potato, 92 per cent of the starch is digestible, but only 72 per cent of the protein. Thus all foods vary in value in the amounts and proportions of their nutrients as well as in their digestibility.

HOW THE PRODUCTS ARE MADE.

In nature the farmer has only air, water and soil to start on. First he produces all the varied plants (crops), some of which are used directly as food, while the cheaper ones and their by-products are converted into animals and their products. As a result he produces directly vegetable protein, vegetable fats and vegetable carbohydrates and indirectly animal protein and animal fat.

The composition of the chief constituents of food are:

	Protein. Per cent.	Fats. Per cent.	Carbohydrates. (sugar and starch) Per cent.
Carbon	53	76.5	44.
Hydrogen	7	12.5	6.
Oxygen	24	11.5	50.
Nitrogen	16	none	none
	100	100	100

We thus see that these foods are composed of four different things gathered from air, water and soil. The mineral part of the plant is very small and is seen as ashes when the plant is burned. All the rest comes directly or indirectly from air and rain.

THE WORK OF PLANTS.

The plant gathers its supply as here described:

Carbon or charcoal—from air, in which exists a *gas* (carbon dioxide). This gas is always formed and sent into the air when plants decay, coal or wood burned, by

respiration from lungs, etc. In the air over each acre of land in the world are eight tons of this gas—the supply therefore is inexhaustible. *Leaves* of plants inhale it directly from the air and under the influence of sun-light build it up into starch, sugar, etc.

Hydrogen and Oxygen from *rain.* These *gases* constitute water which is only supplied by rain or melted snow. Water is absorbed by *roots* of plants.

Nitrogen from *air* first, later from the soil. This gas comprises ⅘ of the air and over each acre of the world's surface there are 35,000 tons of this gas. Certain soil bacteria, inhabiting the roots of clover, alfalfa, peas, etc., obtain it from the air and in this way nitrogen becomes fixed in the soil. In this form it is taken up by *roots* of plants.

Mineral matter (ash of plants) from soil.

To sum up—

	Source.	Nature.	Taken in by.	Required for.
Carbon..	air	solid	leaves	Protein, Fat. & Carbohydrates.
Hydrogen..	water	gas	roots	" " "
Oxygen..	"	"	"	" " "
Nitrogen.. .. .. ..air first, then soil		"	"	Protein.

THE IMPORTANCE OF NITROGEN.

We see from the above that *nitrogen* is absolutely necessary for the formation of protein; one of the principal parts of food. No plant can fully develop without nitrogen. It exists in the air as a *gas,* but before being absorbed by plants it *must* be fixed in the soil. No plant can breathe it in through the leaves as it does carbon dioxide. However, the legumes (clover, alfalfa, etc.,) seem to offer breeding places on their roots for special bacteria which able to take the nitrogen from the air and supply it to the roots of their host. By the decay of the roots the soil is enriched in nitrogen. The logic may thus be set forth.

A man's body contains 26 pounds of protein, and a man must eat protein.
Protein exists in plants and animals: Animals eat plants.
Therefore, a plant must make protein.
But every 100 pounds of protein contain 16 pounds of nitrogen.
Therefore a plant must eat nitrogen.
But all plants take in nitrogen through the roots only.
Therefore, nitrogen must be fixed in the soil.
But nitrogen is a gas in the air and no plants can take it from the air directly.
But certain soil bacteria absorb this gas into their bodies and the roots of legumes offer places for them to live.

THEREFORE:—

GROW LEGUMES to take the nitrogen from the air
to enrich the soil.
to feed other crops
to make vegetable protein
to sell as food for man
OR to feed the animals
to make animal protein
to sell as food for man.

The Israelites could not make bricks without straw;
The farmer cannot make protein without nitrogen.

RESUMÉ.

Thus we see that all human food originates in air and rain, except five odd pounds in every 100 pounds of food which comes from the soil. The supplies of air and usually rain are unlimited—only that of the soil may fail. Without any one ingredient, no matter if all else be present in abundance, no plant can mature.

The soil may be regarded as the table at which the plants feed, though in addition to the food there provided they also eat a very small bit of the table. Man must prepare the table properly and carefully attend to the guests—his crops—and see that each gets enough to eat and drink and not too much nor too little. Further, he must look after their health and keep them clean and free from pests and parasites and weeds—the uninvited guests.

Published by direction of Hon. MARTIN BURRELL, Minister of Agriculture, Ottawa, Ont.