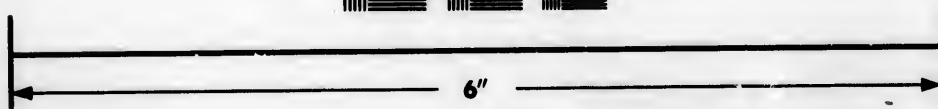
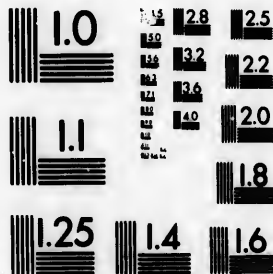


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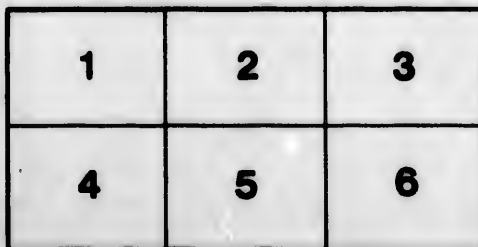
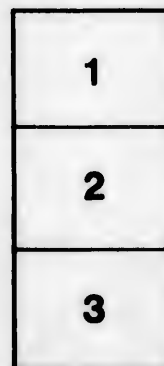
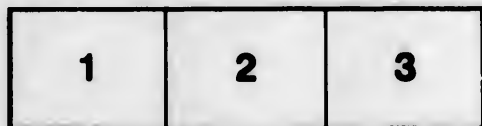
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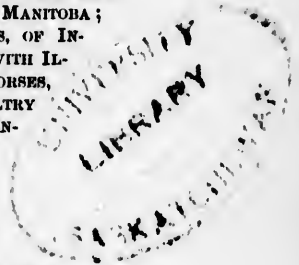
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AGRICULTURE

CONTAINING

A LIST OF CHEMICAL EXPERIMENTS; A SERIES OF EXPERIMENTS ON THE GROWTH OF SEEDS; A DESCRIPTION OF HOW PLANTS GROW; A SKETCH OF THE FORMATION OF THE PRAIRIE SOIL BY WATER AND ICE ACTION; AN ACCOUNT OF FARMING OPERATIONS AND OF CROPS ADAPTED TO MANITOBA; A DESCRIPTION OF DISEASES OF CROPS, OF INSECTS, AND OF BIRDS; AN ACCOUNT WITH ILLUSTRATIONS OF THE BREEDS OF HORSES, CATTLE, SHEEP, SWINE AND POULTRY ADAPTED TO MANITOBA; ADVANTAGES OF MIXED FARMING.



Authorized by the Advisory Board of Manitoba.

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PRAIRIE AGRICULTURE.

THE WORK OF THE FARMER.

Lord Bacon says in one of his most interesting essays, "God Almighty first planted a garden; and indeed it is the purest of human pleasures."

Man's first occupation in the Garden of Eden in which he was placed was to dress it and to keep it. We are never happier than when we are in close touch with nature, watching over the sprouting seeds, tending the opening flowers, cultivating the useful herbs and grains, and gathering from the fruitful soil what the Great Creator supplies as the reward of our industry. Some may look upon work in the garden or fields as drudgery, but to one of healthful body, sound mind, and good sense, it brings great satisfaction to sow and plant in spring-time, to receive from God Almighty's hand

"The warmth to swell the grain,
The breezes and the sunshine,
And soft refreshing rain."

What is more inspiring to the farmer than to walk

through his green fields in summer, to see every day adding to the growing grain, and to work amongst the sweet smelling hay cut down by his horses and mower, as it is raked together and cured and put in stacks for his herds in the coming winter! The sweet smell of the fresh cured hay and the cool breezes of the field come like the breath of Eden to the merchant or lawyer sitting in the stifling warehouse or hot close office of the city, as he remembers the farm where his childhood was spent.

And nothing can be more delightful than to watch the herds of cattle as they wander over the prairies and through the asters and sunflowers, or the July lilies and blue-bells, seeking the sweet grasses or the wild peas that grow in such abundance. The herd boy thinks the day long sometimes, but he is rewarded as he drives home the cattle in the evening, with swollen udders to give their rich returns in the milking time at sunset. Flocks of sheep and herds of horses now wander over the ranches and add interest to the plains as we view them in the summer time. Some will no doubt complain of the stinging mosquitoes, and the unruly cattle, and the hot midday sun, and of being weary in haying time, and of the hard work of pitching and stacking, and of misfortunes of the farm, but life everywhere has its troubles. Discouragements on the farm are not so bad as the dangers of the city, or the diseases and troubles from bad sewers and bad water, or the failures in business and the grinding toil which thousands in the cities endure.

There is no more joyous time to the farmer than the harvest. The golden grain, the rattling reaper,

the stooks of barley, wheat and oats, the gathering and stacking, the rivalry of the strong young men as to which can bring his load the soonest, which can make his stack the neatest, can do his work the quickest and best, besides the joy of harvest, the hurry of the threshing time, and the drawing of the grain to market—these are all scenes of autumn that make the farmer's life cheery and gladsome.

The farmer's aim then is to bring from the soil by work and care what may be useful to the world and of profit to himself. His crops are providing for the support of men. He is a food producer. He is feeding the hungry. How to do this to the best advantage; how to grow wheat and barley and oats of the best quality; how to raise cattle, sheep and swine and poultry of the best breeds; how to supply the world with what it needs, and how to do this in the cheapest and most comfortable way should be the study of the farmer.

In doing all this there is work, and plenty of it, for the farmer, for the farmer's sons, for the farmer's wife and daughters—but work is honorable.

The farmer, we have said, is a producer. He takes at first hand from the soil the good gifts which the Creator bestows. He is therefore the most independent of men. The merchant or trader is conveying the products from the producer to the consumer, and has not the independence or the satisfaction of the farmer. But yet, farmer and merchant and consumer are all necessary to each other. We all remember Æsop's old fable of the stomach and the members. "The members once said to the stomach: 'Shall we

always sustain you by our labor, whilst you enjoy the greatest ease? We will not do it.' When therefore they withheld food from the stomach, the body became weak, and, too late, the members repented of their envy." We may learn from this that all are needful to each other. What we need most of all is to see that honest labor is worthy. Whether it be done with hand or foot, with brain or muscle, with pen or spade, in the shop or office or field, it is all equally necessary. There is a dignity in labor. But if we are to select, we must say that the occupation of the farmer is the oldest, the most independent, the most useful, and the most conducive to comfort, contentment and good conduct of all the occupations in which men engage.



INTRODUCTORY CHEMICAL EXPERIMENTS.

[NOTE.—It is left to the teacher to introduce such further explanation of the chemical changes described as he may find profitable. The following jottings are for the teacher. A box containing all the chemicals and apparatus necessary for these experiments will be placed by the Department of Education in every public school in Manitoba.]

AIR—

1. To Illustrate the Existence of Air. Take glass funnel. Wrap the neck with wet rag. Place in bottle tightly. Water cannot be poured down the funnel.
2. To Illustrate the Existence of Air. Take syringe. Put nozzle in water. Will draw up water when piston is drawn out. Why?
3. To Illustrate the Existence of Air. In syringe tube, piston driving down air will expel water. Why?
4. To Burn Oxygen out of Air. Take deep plate. Fill half full of water. On it float capsule or flat cork with pea of phosphorus (describe phosphorus). Set fire to phosphorus. Cover quickly with tumbler. Water rises in tumbler. Why? In the tumbler nitrogen is left. Prove it with a lighted match.
5. To Examine the Phosphoric Acid formed. In tumbler in "4" there was a "miniature snow storm." After a time the white substance is taken up by the water. Try water now with blue litmus paper. This turns red, showing an acid. The acid is Phosphoric Acid. United with lime it is largely found in

our bones. It also occurs in grains of wheat.

6. How to get Oxygen.

Heat chlorate of potash with manganese dioxide in glass retort or test tube placed upon tripod. Put retort nozzle in plate of water. Invert test tube full of water over nozzle, under water. A gas will rise in tube and drive out water. Why? This is oxygen. Collect three test tubes full and keep them covered.

7. How to know Oxygen.

(a) In first tube put splinter with spark burning. It bursts into flame. Why?

(b) In second tube put bit of charcoal with spark. What happens?

(c) On capsule put pea of phosphorus. Set fire to it. From third tube pour oxygen on flame. What is the effect?

Air is made up of four-fifths Nitrogen and one-fifth Oxygen.

WATER—(Found in air as vapor).

8. To Remove Oxygen from Water.

On plate with hot water put pea of sodium metal (describe sodium). Sodium unites with oxygen of water; sets free hydrogen. Hydrogen unites with oxygen of air and takes fire. What color is seen?

Water is made up of Hydrogen and Oxygen.

9. Forms of Water.

Ice is the solid state of water. Put piece of ice in large test tube. Put thermometer in tube alongside ice. (Have a lesson on thermometer.) Note the reading and mark it down. Melt the ice over

lamp. Read thermometer when the ice is nearly all melted; note reading. Heat the water till it boils. Mark down the reading of thermometer. Steam is given off. Thus water vapor; water, the liquid; and ice are different states of one substance.

10. Dissolving in Water.

Take porcelain dish. Fill half full of water. In this put chlorate of potash or common salt. Boil. Salt disappears. Where has it gone? Evaporate by continued boiling. Note the salt on the bottom of the dish. What is it?

11. Well or River Water May Have Many Impurities.

(a) If water is muddy, take funnel; put in it a paper filter; run water through it into bottle; it will be purer.

(b) Fill test tube half full of water. In it put half a pea of silver nitrate. If milkiness appears there is salt in the water.

(c) Take two test tubes. In one put water containing a few drops of dish water; in other pure water. Add a little dissolved permanganate of potash, very dilute, to each. The violet color is unchanged in pure water; in filthy water the color gradually fades away.

(d) Water with bad smell may be made better by passing through charcoal filter.

12. How to Get Pure Water.

Water may be got nearly pure by distilling. Boil water in a tea kettle. Over spout put mouth of a demijohn or

large bottle. Steam is caught in bottle and liquifies. This water is nearly pure. To cool steam put bottle in a basin, having around bottle, pieces of ice.

13. CARBON DI-
OXIDE.
(3 volumes found
in 10,000 of air.)

(a) We breathe carbon dioxide from the lungs through a glass tube into lime water. Milkiness is seen.

(b) Again, prove this by filling a bottle with water and inverting in the water of the full plate. Then take glass tube and breathe through it under mouth of bottle, displacing the water in the bottle. Invert and cover bottle. It contains carbon dioxide. A match cannot burn in it. Lime water poured in will be turned milky on being shaken.

(c) When bottles of preserves "work," and in making yeast, carbon dioxide is given off. This is caused by very minute vegetable germs acting on the sugar of the mixture. Alcohol is formed and carbon dioxide is given off. This is called "fermentation."

(d) Bottles of pop or ginger ale give off carbon dioxide when opened. This is because carbon dioxide has been forced into them to cause effervescence.

(e) When charcoal, which is chiefly pure carbon, is burned, it is by its taking oxygen from the air that carbon dioxide is formed.

Wood and coal are largely made up of carbon; which in other shapes is found as black lead and diamond.

14. Plant Life and Carbon Dioxide

Take two bottles containing carbon dioxide, obtained as in 13 (b). In one leave for two days growing over water a plant. Keep the other closed. Examine, and it will be found that while the second is unchanged and puts out a burning match, the first has had carbon dioxide consumed, and the air with oxygen in it will allow a match to burn.

ALKALIES—(15 to 20).

15. AMMONIA.
—(There is a trace of ammonia in the air.)

Take a bottle of ammonia. It has a pungent smell. It will turn red litmus paper blue. If mouths of bottles of ammonia and hydrochloric acid be placed together dense fumes form. Why?

16. POTASSIUM
—(The compounds of this metal are found extensively in plants and in the soil.)

Take a pea of metallic potassium (describe potassium). Throw on the plate of water. Why does it burn? Is the color of the flame violet or red? Test the water of the plate with red litmus paper. The burning of potassium on the water produces caustic potash. When this unites with nitric acid it forms nitre or common saltpetre.

17. Leaching and Soap-Making.

Take wood ashes. Put in funnel fitted with filter paper. Run water through into bottle. Test lye thus got with red litmus p. per. Evaporate lye in porcelain dish. Deposit is chiefly potassium carbonate, usually called potash. With another portion of lye in porcelain dish boil a small piece of fat pork. Soft soap is formed. By throwing in salt it becomes hard on boiling.

18. What is Nitri-
fication ?

- Plants need nitrogen. In the humus, which is the name given to the partially decayed matter of soil, there is nitrogen, but the plant cannot extract it. By the agency of minute vegetable organisms named Bacteria, the oxygen of air unites with the nitrogen of the humus and with the ammonia of manure, and forms nitrates of the potash, of soda, and of lime present, and these, being easily dissolved, are taken up from the soil by the plant.

By this process also saltpetre is made on the large scale.

19. SODIUM.—
(The compounds of
this metal are found
largely in sea plants
and in sea water.)

We have met with this substance in experiment 8, where caustic soda was formed in the water. Take a small piece of caustic soda from bottle and dissolve in dilute hydrochloric acid. Evaporate, and common salt remains. Throw common salt on lamp flame and notice the yellow color. Soda carbonate, employed in baking, and borax, used in welding iron, are both compounds of sodium.

20. LIME.—
(Found in the earth
in great quantities
in limestone, mar-
ble, gypsum. Oc-
curs largely in the
soil.)

Take piece of newly burnt lime. Pour water upon it. Heat is produced. The lime is slaked. Lime is made from limestone in kilns by driving off carbon dioxide by heat. Place piece of lime on charcoal. Blow lamp flame upon it with blow pipe and notice the great brilliancy. (Have lesson on the blow-pipe and its uses.)

Lime water is made by putting some slaked lime into a bottle with water, and then shaking it violently. Let it settle, and pour off the clear lime water. When lime water stands open to the air a crust forms on it. What is this?

21. PLASTER OF PARIS and BLEACHING POWDER (Chloride of Lime.)

Place a piece of gypsum (lime sulphate) from bottle upon the stove. Water oozes from it. When water is dried up plaster of Paris remains. Take a piece of selenite from bottle. Though in layers it is the same substance. Make the same experiment with it.

Bleaching powder is another compound of lime. Place a small quantity in a porcelain dish. Pour hydrochloric acid on it. Heat gently. A dangerous gas, chlorine, is given off. It must not be breathed. Dissolve bleaching powder in a test tube of water. Add a few drops to a solution of sulphate of Indigo. It will be bleached.

22. SULPHUR and SULPHUR DIOXIDE.

Burn sulphur in a porcelain dish. Notice and describe what you see. The blue flame is sulphur dioxide. The sulphur takes the oxygen from the air. The gas formed will bleach straw. This gas will disinfect rooms where disease has been. Hold a cork in molten sulphur until crust forms. Break two holes in crust; when cool observe the crystals with magnifying glass. From burning sulphur by an intricate process sulphuric acid (oil of vitriol) is formed.

23. SULPHURETTED HYDROGEN.

1 > Mix paraffin wax with sulphur in porcelain dish. Heat gently. What do you detect? This disagreeable gas
 2 (is given off at Banff hot springs. It
 3 > gives the evil smell of rotten eggs and rotting cabbage. It is Sulphuretted
 (Hydrogen.

24. CLAY.—
 (A Compound of the metal Aluminium. Examine and describe it.

Dissolve a little clay in water. Pass through filter. Is all clay removed? Clay is made into pottery, porcelain-ware, and bricks, by burning. Clay mixed with limestone is called marl. Alum is got by leaching clays which contain potash.

25. SAND.—
 (Is broken fragments of quartz, or flint, also known as Silica. Found in sandstone.)

Examine with a magnifying glass. What do you see? Take a ripe stalk of wheat, or a common horsetail which grows on sand banks, and by soaking it in strong acid, or by carefully burning the stalk, the silica remains as a perfect cast. Sand is largely used in building and glass-making, and is the substance of many gems.

26. MAGNESIUM AND ITS COMPOUNDS.

Burn a piece of magnesium wire in lamp flame. It burns brilliantly. Magnesia is formed. Dissolve this white ash in sulphuric acid. Evaporate in watch glass. Crystals of Epsom salts are formed. Examine with magnifying glass. This salt is found largely in alkaline water in Manitoba and the North-West Territories. Magnesium carbonate is used in medicine.

27. IRON AND GREEN VITRIOL.

Take iron filings from bottle. These are attracted by magnet. (Have lesson on the magnet.) Dissolve iron filings in sulphuric acid in porcelain dish. Evaporate. Green vitriol (copperas) is formed. Heat a crystal of green vitriol in porcelain dish till it becomes powder. Note color. Test iron salt dissolved in test tube by a drop of potassium Ferrocyanide. What color is produced?

28. COPPER AND BLUE VITRIOL.

Dissolve pieces of copper clippings in dilute acid. Describe what you see. Beware of fumes. Dissolve a piece of copper sulphate in water. Dip knife blade in this. What happens? Explain. Dissolve copper clippings in vinegar, verdigris is produced. What is it?

29. Organic Substances Produced in Plants and Animals.

NON-NITROGENOUS.

(a) (Made up of carbon, hydrogen and oxygen.) Examine carefully the starch, sugar, gum, fat, oil, and describe each substance. Note what use they serve in everyday life.

NITROGENOUS.

(b) (Made up of carbon, hydrogen, oxygen, nitrogen and a little sulphur.) Albumen:—Got by drying white of egg on glass. Albuminoids, also called Proteids, or flesh formers, are closely related to albumen. They are Gluten, Legumin, Fibrin, and Casein. Glutin:—Knead wheat flour in muslin bag; wash out starch with water; white sticky substance left is gluten. Legumin:—Got in same way from pea flour. Fibrin:—Stir blood of ox or pig with bunch of twigs; greyish white stringy

substance on twigs is fibrin. Casein :—Add a few drops of hydrochloric acid to milk ; curd formed contains casein and butter fat. Gelatin : Got by boiling tendons, skin, etc., of ox or pig ; is closely related to Albuminoids.

30. Acids found combined with bases in plants.

Examine with magnifying glass specimen taken from the bottle labelled potassium tartrate. Taste it.

What gives the acid taste in *Oxalis* and other like plants ?

List of articles to be provided in box for foregoing chemical experiments :—

GLASS—Funnel, 2 bottles, syringe, alcohol lamp, nest of test tubes (5), 3 pieces of flat glass, thermometer, 3 pieces glass tube, watch glass, small magnifying glass.

EARTHEN—Small capsule, 2 porcelain dishes.

METAL—Tripod, tin bottle, magnet, blowpipe, small file.

WOOD AND PAPER—Corks, piece of charcoal, wooden test tube holder, package filter papers, books of red and blue litmus.

SUPPLIES :—1. Bottle of Potassium chlorate ; do. slaked lime ; methylated spirit.

2. Bottles of ammonia, hydrochloric acid, sulphuric acid.

3. Bottles of phosphorus, manganese dioxide, sodium, potassium, caustic potash, caustic soda, chloride of lime, sulphur, paraffin wax.

4. Bottles of silver nitrate, potassium permanganate, saltpetre, common salt, borax, pieces of marble, gypsum, selenite, indigo, green vitriol, blue vitriol, potassium ferrocyanide, alum, gum, fat, oil, potassium tartrate.

5. Metallic specimens :—Aluminium, magnesium wire, iron filings, copper clippings.

Obtained at Home :—Deep plate, tumbler, tea kettle, demijohn or large bottle, clay, sand, starch, sugar.

EXPERIMENTS ON PLANT GROWTH.

Another series of experiments useful in preparing us for the study of agriculture relates to the growth of plants. Each scholar is expected to plant seeds, watch them sprout, describe their changes, and write out clearly all that is seen. We shall see how this may be done. (We are largely indebted to Newell's, "From Seed to Leaf.")

1. What Seeds to use.

We may at first select a number of special seeds which have been found useful. Obtain a few seeds of Morning Glory, Sunflower or Squash, Pea, Bean and Indian Corn, and some grains of Wheat and Oats. A number of Maple seeds and Acorns may also be used. Before the seeds are planted they should be soaked in water for a day or two.

2. Plants in the School Room.

The seeds selected are planted in boxes filled with clean sand or mould. The boxes may be covered with panes of glass till the seedlings are well started, and should be under a temperature of 60° or 70°. The boxes are covered while the seeds are sprouting. The plants do not need light, but must be kept warm. If the planting is done in winter, it will not do to leave the plants in the school house over night where the fire goes down. If common heat is used the months of September in the autumn or of May and June in spring and summer are best. During the

winter months the growing can only be done at home, and somewhat near the fire. After starting seeds, as soon as they sprout and come above the ground, it is well to plant another set of the same kind of seeds, so that when we come to study any plant it may be had in the different stages of growth. It will take two or three weeks to have one set of the seeds sprout and appear above the earth.

3. How to Study the Plants.

Each pupil of the class is expected to have his or her own plant, and to keep in a note book the changes seen in growth from day to day. On the day of the lesson each scholar will, on coming to school in the morning, draw in the note book a figure of the plant being studied, compare it with the plant of the previous lesson, write the name of the several parts upon it, and note anything of importance. In order to help the pupil to begin the study, we may state a few of the questions to be asked about each plant.

Morning Glory

Sunflower.

Bean.

Pea.

1. What are the parts of the seed in each?
2. How do the seeds differ?
3. How do the first leaves change as the seedling grows?
4. What have these seeds in common?
5. How many leaves are on the joint of the stem in each plant?
6. From what part do the roots grow?

4. Parts of the Seed.

On comparing the four selected seeds, we see many differences in their modes of sprouting and growth. It must be remembered that the whole growing plantlet in the seed is the embryo or germ; hence, the sprouting of seeds is called germination.

(a) *Outer seed covering.*

In looking at these four seeds that of the Sunflower is seen to have an outer covering, which none of the others have.

(b) *Seed covering proper.*

All of these four seeds have a real seed covering. Take a sharp penknife and prove this.

(c) *Albumen.*

The albumen is the whitish part of the seed which, when it is crushed and ground fine, we call flour. At the stage when the seed is sprouting the albumen softens and becomes a white, jelly-like substance. In the Morning Glory the albumen surrounds the seed leaves of the embryo, but in the other three, the first leaves are thickened by the albumen which is on the inside of them. Because we do not see the albumen, which in the case of these three is contained within the leaves, we say they are ex-albuminous, or without albumen. But whether inside or outside the first leaves, this albumen is the first food of the plant.

(d) *Cotyledons.*

This name is given to the seed leaves. In each

of the four plants chosen they are two in number. In the Morning Glory the cotyledons are seen to be leaves in the seed; in the Sunflower the thick, clumsy-looking leaves turn into ordinary green leaves with veins; in the Bean the thick leaves seem likely to turn into real leaves but do not; in the Pea they never appear to attempt it. The plumule springs out between the two cotyledons, and may be considered the beginning of the stem of the plant.

TABLE.

Albuminous	} Morning Glory	without plumule	{ Morning Glory (Flax, Maple) Sunflower
Ex- Albuminous			

(e) *Caulicle.*

This is the small organ which grows out from the seed, but it is only from the tip of the caulicle that the root grows. The remainder of the caulicle is of the nature of stem. The plumule is found in the seed of the bean and pea because they have so much food that they are able to support both caulicle from which the root springs, and plumule from which the stem grows. In Morning Glory and Sunflower, where the food is less, no plumule is found till after the caulicle grows.

(f) *Growth of root and stem.*

The root grows from the tip, the stem through its whole length. The difference in the mode of growth of the root and stem may be shown by dipping a needle in ink and piercing spots at equal distances on a young root, say of Indian corn or bean. The marks on the older parts of the root do not change their relative distance, the mark on the tip will be carried on, showing the point of growth. By the same plan of piercing spots, say an inch apart on the stem, the stem will be seen to grow regularly through its whole length.

(g) *Dicotyledons and Monocotyledons.*

The four seeds chosen above were all dicotyledonous. Let us take a grain of Indian corn, which is different. Stripping off the seed cover, we see the greater part of the seed to be albumen. Very close to one side of this albumen is the single cotyledon. This completely surrounds the plumule and gives it food from the albumen. There is a line running down the middle of the cotyledon, and it may be split along this line, showing the plumule and caulicle within. The difference between those plants having two cotyledons (Dicotyledons), and those having only one (Monocotyledons), has now been explained; but in determining plants, it will be remembered, we found the Dicoty-

ledons generally to have net-veined leaves, and the Monocotyledons straight-veined leaves.

(h) *Food of seedlings.*

We have seen that the white substance called albumen, sometimes outside the embryo and sometimes within the seed-leaves, is the food of the infant plant. On this it thrives and gains strength. At a later stage, as we shall see, it is dependent on the air and the soil for its food. How wonderful is the revival of life in the sprouting seed!

THE SEED SONG.

Little brown seed, O little brown brother,
 Are you awake in the dark?
 Here we live cozily, close to each other,
 Hark to the song of the lark!
 "Waken!" the lark says. "Waken and dress you,
 Put on your green coats, and gay
 Blue sky will smile on you, sunshine caress you,
 Waken, 'tis morning, 'tis May!"

Little brown seed, O little brown brother,
 What kind of flower will you be?
 I'll be a poppy, all white like my mother,
 Do be a poppy like me!
 What? You're a sunflower. How I shall miss you
 When you're grown golden and high,
 But I shall send all the bees up to kiss you!
 Little brown brother, good bye!

HOW PLANTS GROW.

We have seen in our experiments how the seed first imbibes moisture through its coats, swells a little, and as it feels the warmth the embryo gradually wakes from its long and deep sleep, and, as it were, stretches itself. It has now only to grow and produce more of what it already has. How this is done we shall learn from the description, somewhat modified, of a brilliant British writer.

1. How Plants Eat.

First of all, then, we will inquire how plants eat. And in this inquiry we neglect, for the most part, the very early and simple plants and deal chiefly with those more advanced and complicated types, the flowering plants, with which everybody is familiar.

PLANTS EAT WITH THEIR LEAVES. The leaves are, in fact, their mouths and stomachs.

Now, what is a leaf? It is usually a rather thin, flat body, often with two parts, a stalk and a blade, as in the oak or the poplar, though sometimes the stalk is suppressed, as in grass. Almost always, however, the leaf is green; it is broad and flat, with a large expanded surface, and this surface is spread out horizontally, so as to catch as much as possible of the sunlight that falls upon it. Its business is to swallow carbon dioxide from the air, and digest and assimilate it under the influence of the sunlight. And, as different situations require different treatment, various

plants have leaves of very different shapes, each adapted to the habits and manners of the particular kind that produces them.

What does the leaf eat? Carbon dioxide. There is a small quantity of this gas always floating about dispersed in the air, and plants fight with one another to get as much as possible of it. Most people imagine that plants grow out of the soil. This is quite a mistake. The portion of its solid material which a plant gets out of the soil (though absolutely necessary to it) is hardly worth taking into consideration, numerically speaking; by far the larger part of its substance comes directly out of the air as carbon, or out of the water as hydrogen and oxygen. You can easily see that this is so if you dry a small bush thoroughly, leaves and all, and then burn it. What becomes of it in such circumstances? You will find that the greater part of it disappears, or goes off into the atmosphere; the carbon, uniting with oxygen, goes off in the form of carbon dioxide, while the hydrogen, uniting with oxygen, goes off in the form of steam or vapor of water. What is there left? A very small quantity of solid matter, which we know as ash. Well, that ash, which returns to the soil in the solid condition, is practically almost the only part the plant got from the soil; the rest returns as gas and vapor to the air and water from which the plant took them. You must never forget this most important fact, that *plants grow mainly from air and water*, and hardly at all from the soil beneath them. Unless you keep it firmly in your mind you will not understand a great deal that follows.

Why, then, do gardeners and farmers think so much about the soil and so little about the air, which is the chief source of all living material? We shall answer the question in the next section, when we come to consider What Plants Drink, and what food they take up dissolved in their water.

Carbon dioxide, though itself a gas, is the chief source of the solid material of plants. How do plants eat it? By means of the green leaves, which suck in floating particles the gaseous food. Their eating is thus more like breathing than ours—nevertheless, it is true feeding; it is their way of taking in fresh material for building up their bodies. If you examine a thin slice from a leaf under the microscope, you will find that its upper surface consists of a layer of cells with transparent walls, and no coloring matter. These cells are full of water; they form a sort of water cushion on the top of the leaf, which drinks in carbon dioxide from the air about. Immediately below the cushion of water-cells you come again upon a firm layer of closely-packed green cells, filled with living green stuff, which takes the carbon dioxide in turn from the water-cells and manufactures it forthwith into sugars, starches, and other materials of living bodies. The lowest spongy part evaporates unnecessary water, and so helps to keep up circulation.

The plant has often many hundred leaves, that is to say, many hundred mouths and stomachs. Why do plants need so many when we have but one? Because they cannot move, and because their food is a gas, diffused in minute quantities through all the

atmosphere. They have to suck it wherever they can find it. And what do they do with the carbon dioxide when once they have got it? Well, to answer that question, we must tell you a little more about what the ordinary green leaf is made of, and especially about the green stuff in its central cells. Now, what is this green stuff? It is the true life material of the plant, the origin of all the living matter in nature. Animals, as well as the plants themselves, are entirely built up of living jelly, which this green stuff has manufactured under the influence of sunlight. And the material that does this is such an important thing in the history of life that we venture to trouble you with the scientific name, CHLOROPHYLL. When sunlight falls upon the Chlorophyll it at once proceeds to set free the oxygen (which it turns loose upon the air again), and to build up the carbon and hydrogen (with a little oxygen) into a material called starch. This starch, as you know, possesses energy—that is to say, latent light and dormant heat and movement, because we can eat it and burn it within our bodies. Other materials, hydro-carbons and carbon-hydrates, as they are called, are made in the same way. The main use of leaves, then, is to eat carbon and drink water, and under the influence of sunlight, to take in energy and build them up into living material.

The starch and sugar and other things thus made are afterwards dissolved in the sap, and used by the plants to manufacture new cells and leaves, or to combine with other important materials.

2. How Plants Drink.

We have now learnt that plants really eat for the most part with their leaves. They grow, on the whole, out of the air, not, as most people seem to fancy, out of the soil. Yet, you must have noticed that farmers and gardeners think a great deal about the ground in which they plant things, and very little, apparently, about the air around them. What is the reason of this curious neglect of the real food of plants, and this curious importance attached to the mould or soil they root in?

That is the question we will have to consider in the present chapter, and we shall answer it in part at once by saying beforehand that, though plants do grow for the most part out of the carbon dioxide supplied by the air to the leaves, they also require certain things from the soil, less important in bulk, but extremely necessary for their growth and development. What they eat through their leaves is far the greatest in amount; but what they drink through their roots is nevertheless indispensable for the production of that living green stuff, chlorophyll, which, as we saw, is the original manufacturer and prime maker of all the material of life, either vegetable or animal.

Plants have roots. These roots perform for them two or three separate functions. They fix the plant firmly in the soil; they suck up the water which circulates in the sap; and they also gather in solution certain other materials which are necessary parts of the plant's living matter.

The first and most obvious function of the root is

to fix the plant firmly in the soil it grows in. Very early floating plants, of course, have no roots at all; they take in water and the dissolved materials it contains, with every part of their surface equally, just as they take carbon dioxide with every part of their surface equally. They are all root, all leaf, all flower, all fruit. But higher plants tend to produce different organs, which have become specially adapted by natural selection for special purposes. If you sow a pea or bean you will find at once that the young seedling begins from the very first to distinguish carefully between two main parts of its body. In one direction it pushes downward, forming a tiny root, which insinuates itself with care among the stones and soil; in the other direction, it pushes upward, forming a baby stem, which gradually clothes itself with leaves and flowers.

The tip of the root is the part of the plant which exercises the greatest discrimination and ingenuity, so much so that Darwin likened it to the brain of animals. For it goes feeling its way underground, touching here, recoiling there, insinuating little fingers among the pebbles and crannies, and trying its best by endless offshoots to fix the plant with perfect security. Large trees, in particular, need very firm roots to moor them in their places, and withstand the force of the winds to which they are often subjected. After every storm, as we know, big oaks and pines may be seen uprooted by the power of this invisible but very dangerous enemy.

The root, however, does not serve merely to anchor the plant to one spot, and secure it a place in which

to grow and feed ; it also *drinks water*. The hairs and tips of the roots absorb moisture from the soil ; and this water circulates freely as sap through the entire plant, dissolving and carrying with it the starches and other materials which each part requires for its growth and nourishment. Without water, as we all know, plants will wither and die ; and the roots push downward and outward in every direction in search of this necessary of life for the leaves and flowers.

In addition to these two functions of fixing the plant and drinking water, however, roots perform a third, and almost more important one, in *absorbing the other needful materials of plant life from the soil about them*. They drink not water alone, but other things dissolved in it.

What are these other things? Well, the answer to that question will fairly round off our first rough idea of the raw materials that life is made up from. We saw already that plants eat carbon and hydrogen from the air and water. Out of these they manufacture a large number of compounds, such as starches, oils, sugars, and so forth, all of which contain a little oxygen, but far less than the amount contained in the carbon dioxide and water from which they are manufactured. These useful materials, however, though possessing energy—that is to say, the power of producing light and heat and motion—are not exactly live stuffs. In order to make out of them the living green matter of leaves, chlorophyll, or the living cell-stuff of all bodies, animal or vegetable, protoplasm, we must have a *fourth element, nitrogen* ; and that element is supplied by the substances in solution.

So now you see the full importance of the roots. They add to the oils and starches manufactured in the leaves that mysterious body, nitrogen, which is necessary in order to turn these things into protoplasm and chlorophyll.

A few other things besides nitrogen are also needed by the plant from the soil. The most important of these are sulphur and phosphorus. The plant, however, does not take in these substances in their free or simple form, as nitrogen, sulphur and phosphorus, but in composition as soluble nitrates, sulphates and phosphates.

Now we are not going to trouble you with a long chemical account of how the plant combines these various materials—a thing about which chemists and botanists themselves know as yet very little. It will be enough to say here that the plant builds them up at last into an extremely complex body, called *protoplasm*; and this protoplasm is the ultimate living matter, the “physical basis of life,” the thing without which there could be no plants or animals possible.

What is protoplasm—this mysterious stuff which builds up the bodies of plants and animals? It is a curious transparent jelly-like substance, full of tiny microscopic grains, and composed of carbon, hydrogen, oxygen, nitrogen and sulphur. Sometimes it is almost watery, sometimes half-horny; but, as a rule, it is waxy or soft in texture. It is very plastic. Its peculiar characteristic is that it is restlessly alive, so to speak. Seen under a microscope, it moves about uneasily, with a strange streaming motion, as if in search of something it wanted. It is in point of fact

the building-material of life ; and out of it the living parts of every creature that lives, whether animal or vegetable, are framed and compounded.

But it is plants alone that know how to make protoplasm. Animals can only take it ready-made from plants, and burn it up again by reunion with oxygen in their bodies. The plant manufactures it. The animal destroys it. Chlorophyll, or the active green-stuff of leaves is a special modification or variety of protoplasm ; and chlorophyll alone possesses the power to manufacture new energy-yielding and living material, under the influence of sunlight, from the dead and inert bodies around it. The materials which it thus produces are afterwards worked up by the plant, together with nitrogen, sulphur and phosphorus supplied to the roots, into fresh protoplasm and fresh chlorophyll. These the animal may afterwards eat, either in the form of leaves, like grass, or in the form of seeds or fruits, like corn, rice or berries.

The tiniest primitive one-celled plant contains protoplasm and chlorophyll (though a few degenerate plants, like fungi, have none of the living green-stuff, and can make no new material for themselves, but depend, like animals, upon the industry of others). Every living cell of every plant contains protoplasm ; a cell without any is dead and lifeless. Protoplasm, in short, is *the only living material we know*, and its life constitutes the larger life of the wholes compounded of it.

Well, now you are in a position to see why the farmer and the gardener attach so much importance to the soil and so little apparently to the air and

sunlight. The reason is that the air is everywhere ; you get it for nothing ; but the soil costs money, and when cultivated it requires to be supplied from time to time with fresh stores of the particular materials which the plants take from it.

In farms and gardens, the farmer takes care that every plant shall have plenty of room and space ; in other words, free access to sunlight and carbon dioxide. He "gives the plants air," as he says, not knowing that he is really supplying them with their aerial food-stuff. He does this by keeping down weeds, by plowing, by digging, by hoeing, by tilling. Indeed, what do we really mean by cultivation ? Nothing more than destroying the native vegetation of a place in order to make room for other plants which we desire to multiply. We plow out the grasses and herbs that occupy the soil ; we sow or plant thinly seeds or cuttings of corn or vines or potatoes that we desire to propagate. We give these new plants plenty of space and air—in other words, free access to sunlight and carbon dioxide. And that is the fundamental basis of cultivation—to keep down certain natural plants of the place, in order to give free room to others.

But as the crop-plants require to root themselves, the farmer naturally thinks the most of the soil they root in—which he has to buy or rent—while the carbon dioxide comes freely to him unperceived with the breath of heaven. Where water is scarce, as in irrigated desert lands, the farmer recognizes quite equally the importance of water. But he never recognizes the true importance of carbon dioxide.

That is why most people wrongly imagine that plants grow out of the soil, not out of the air. Still, when we burn them the truth becomes clear. The portion of the plants derived from air and water goes off again into the air in the act of burning, so too does the nitrogen—the remaining portion, derived direct from the soil, is only the insignificant residue returned to the soil as ash when we burn the plant up.

3. How Plants Digest.

In the stem of the plant a wonderful process is continually being carried on. This is nothing less than the constant manufacture of new cells, new tissues, and a vast quantity of new wood. Let us examine the three functions of the stem. The first is to raise the foliage, with the flowers and fruit as well, visibly above the surface of the ground on which they grow, so that the leaves may gain the freest possible access to rays of sunlight and to carbon dioxide while the flowers are visited by insects and birds or other fertilising agents. The second is, to conduct from the root to the foliage and other growing parts what is commonly called the raw sap—that is to say, the body of water absorbed by the rootlets, together with the nitrogenous matter and food salts dissolved in it, all of which are needed for the ultimate manufacture of protoplasm and chlorophyll. The third is, to carry away and distribute the various matured products of plant life, such as starches, sugars, oils, and protoplasm from the places in which they are produced (such as the leaves) to the places where they are needed for building up the various parts of

the compound organism (such as the flowers and fruit or the growing shoots), as well as to the places where such materials are to be stored up for safety or for future use (as, for example, the tubers and bulbs, and other dormant organs). Each of these essential functions we must now proceed to consider separately.

In order to raise the leaves and branches visibly above the ground into the air above it, the stem is made much stronger and stouter than the ordinary leaf-tissue. If the plant does not rise very high above the ground—indeed, as in the case of small herbs, and especially of annuals—its stem need not be very hard or stiff, and is often, in point of fact, quite green and succulent. But in proportion as plants grow tall and spreading, carrying masses of foliage, and are exposed to heavy winds, do they need to form a stout and woody stem, which shall support the constant weight of the leaves, or even bear up under the load of snow which may cover the boughs in winter weather.

Every stem is thus a piece of ingenious engineering architecture, adapted on the average to the exact weight it will have to bear, and the exact strains of wind and weather which on the average it may count on being exposed to in the course of its life-history. We see the result of occasional failure of adaptation in this respect after every great storm, when the grain in the fields is beaten down by hail, or the trees in the forest are snapped off short like straw by the force of the tempest. But the survivors in the long run are those who have succeeded best in resisting even such unusual stresses; and it is they that

become the parents of after generations, which of course inherit their powers of resistance.

Most stems, at least of perennial plants, and all those of bushes, shrubs and forest trees, are strengthened for the purpose of resisting such strains by means of a material which we call *wood*. And what is wood? Well, it is an extremely hard and close-grained tissue, manufactured by the plant out of its ordinary cells by a deposit on their walls of thickening matter. This process of thickening goes on in each cell until the hollow of the centre is almost entirely filled up by the thickening material, leaving only a small vacant space in the very middle. The thickening matter, which consists for the most part of carbon and hydrogen, is built up there by the protoplasm of the cell itself; but as soon as the process is quite complete, the protoplasm emigrates from the cell entirely, and goes to some other place where it is more urgently needed. Thus wood is made up of *dead cells*, whose walls are immensely thickened, but whose living contents have migrated elsewhere.

In large perennial stems, like those of oaks and elms, a fresh ring of wood is added each year outside the ring of the last growing season. This new ring of wood is interposed between the bark and the older wood of the core or heart, which was similarly laid down when the tree was younger. In this way the number of rings, one inside another, enables us roughly to estimate the age of a tree when we cut it down; though strictly speaking we can only tell how many times growth in its trunk was renewed or retarded. Still, as a fair general test, the number of

rings in a trunk gives us an approximate idea of the age of the individual tree that produced it.

This principle is only true, however, of the great group of *dicotyledonous* trees, such as poplars or ashes, as well as of the pines and other conifers. In monocotyledonous trees, like the palms and the bamboos of the tropics, the stem does not increase in quite the same way from within outward, and there are therefore no rings of annual growth to judge by. Palms rise from the ground as big, or nearly as big, at the beginning as they will ever be in the end; and though each year they rise higher and higher into the air, and produce a fresh bunch of leaves at their summit, they seldom branch, and never produce large buttressed stems like the oak or the chestnut.

The second main function of the stem is to convey the raw sap absorbed by the roots to the leaves and branches, and especially to the growing points. This is such a very important element in plant life that we must now consider it in some little detail.

If you look for a moment at a great spreading oak tree, with its top rising forty or fifty feet above the level of the ground, and its roots spreading as far and as deep beneath the earth, you will see how serious and difficult a mechanical problem it is for the plant to raise up water from so great a depth to so great a height without the aid of pump or siphon. For the plant cannot work miracles. Yet every leaf must be constantly supplied with water—that prime necessary of life—or it will wither and die; and every growing part must obtain it in abundance, in order to give that plasticity and freedom which are

needful for the earlier constructive processes. Protoplasm itself can effect nothing without the assistance of water as a solvent for all the materials it employs in its operations.

How does the plant get over these difficulties? Well, the stem is well provided with a whole system of upward distributing vessels in which water may be conveyed to the various parts, just as it is conveyed in towns through the pipes and taps wherever it is needed. But what is the motive power for this mechanical work? How does the plant raise so much liquid from such a considerable height, without the intervention of any visible and tangible machinery?

Two main agents are employed for this purpose. The one is known as *root-pressure* the other as *evaporation*.

We begin with the former. The cells of which roots are made up are most ingeniously constructed so as to exert this peculiar form of pressure. Each one of them has at its outer or free end, where it comes in contact with the moist earth, a wall of such a nature that it very readily absorbs water, and allows the water so absorbed to flow freely through it inward. But once in the water it seems almost as if imprisoned in a pump; it cannot pass outward again, only inward and upward. You may compare the cell in this respect with those mechanical valves which yield readily to the pressure of fluid from without, but instantly close when a fluid from within attempts to pass through them. In this way the outer cells of the hairs on the roots which come in contact with the moistened soil, get distended with

water, and swell, and swell, till at last their walls will give no longer, and their own elasticity forces the water out of them. But the water cannot flow back, so it has to flow forward. Again each cell or vessel which the stream afterwards enters, is constructed on just the same general principle as the absorbent root cells; it allows water to pass into it freely from below, but does not allow it to pass back again from above downwards. Thus we get a constant state of what is termed turgidity in the lower cells; they are as full as they can hold, and they keep on contracting elastically, so as to expel the water they contain into other cells next in order above them. By means of such root-pressure, as it is called, raw sap is being forever forced up from the soil beneath into the stem and branches, to supply the leaves with water and food-salts, especially in early spring, when the processes of growth are most active and vigorous.

It is owing to this peculiar property of root-pressure that cut stems "bleed," or exude sap, especially in spring time. The root-pressure continues of itself in spite of the fact that the stem has been divided, and the sap absorbed by the roots is thus forced out at the other end by the continuous elasticity of the cells and vessels. The fact that severed stems will "bleed" or exude raw sap shows in itself the reality of root-pressure.

But root-pressure alone would not fully suffice to raise so large a body of water as the plant required to so great a height above the earth's surface. It is therefore largely supplemented and assisted by the second or subsidiary power of evaporation. This

evaporation, or "transpiration" as it is generally called, is just as necessary and essential to plants as breathing is to men and animals.

We must therefore enter a little more fully into the nature of so important and universal a plant function. You will remember that when we were discussing the nature of leaves, we spoke of making a thin slice through a leaf which showed the blade as naturally divided into an upper and lower portion. The upper portion consisted of very close set green cells, containing a living chlorophyll-layer just beneath it. But the under portion was sparse-looking and spongy; it was composed of cells loosely arranged among themselves and interspersed with great empty spaces. We told you but little at the time of the function or use of this lower portion; we must return to it now in the present connection, as a component element in the task of water supply. The lower portion of most leaves is the part employed in the great and necessary work of evaporation.

For this purpose the tissue on the under side of the leaf is composed of loose and spongy cells which have much of their surface exposed to the empty spaces between them; and these empty spaces are really air-cavities. The object of the cavities, indeed, is to facilitate evaporation. Liquid transpires into them from the various cells through the walls that bound them. How fast water evaporates in the leaves of plants we all know by experience in a thousand ways. We know, for instance, that if we pick bunches of flowers and leave them in the sun without water, they fade and dry up in a very short time.

We also know that if we forget to water plants in pots, the plants similarly dry up and die after a few hour's exposure. Leaves, in fact, are purposely arranged in most cases so as to encourage a very rapid evaporation; and evaporation is one of their chief means of raising water from the roots to the growing and living portions.

If you examine the under-side of a leaf under the microscope, you will find it is covered by hundreds of little pores which look exactly like mouths, and which are guarded by two cells whose resemblance to lips is absurdly obvious. These pores are commonly known to botanists by the awkward name of *stomata*, which is the Greek for *mouths*—and mouths they really are to all external appearance. You must not suppose, however, that they are truly mouths in the sense of being the organs with which the plants eat; the upper surface of the leaf, as we saw with its layer of water-cells and its assimilating chlorophyll-bodies, really answers in the plants to our mouths and stomachs. The *stomata*, or pores, are much more like the openings in the skin by which we perspire; only perspiration, or evaporation, is an even more important part of life to the plant than it is to the animal. Each of the *stomata* opens into an air-cavity; and through it the liquid evaporated from the cells passes into the open air. Many leaves have thousands of such pores on their lower surface; they may easily be recognized under the microscope by means of the curious guard-cells which look like lips, and which give the pores, in fact, their strange mouth-like aspect. What is the use of these lips? Well, they

are employed for opening and closing the evaporating pores, or *stomata*. In dry weather it is not desirable that the pores should be open, for then evaporation should be limited as far as possible. So, under these conditions, the lips contract and the pore closes. Excessive evaporation at such times would, of course, damage or destroy the foliage; the plant desires rather to store up and retain its stock of moisture. But after rain, and in damp weather, the roots suck up abundant water; and then it becomes desirable that evaporation should go on, and the leaves and growing shoots should be supplied with liquid food, as well as with the nitrogenous matter and salts dissolved in it. Hence at such times the pores open wide, and allow the water, in the form of vapor, to exude from them freely.

The object of this evaporation, again, is twofold. In the first place, it supplements root-pressure as a means of raising water to the leaves and growing shoots; and, in the second place, by getting rid of superfluous liquid, it leaves the nitrogenous material and the food-salts in a more concentrated form, at the very points where they are just then needed for the formation of fresh living protoplasm and useful constructive factors of plant-life. But how does evaporation raise water from the ground? In this way. The living contents of each cell on the upward path have a natural affinity for water, and will suck it up greedily wherever they can get it. Thus each part, as fast as it loses water by evaporation, takes up more water in turn from its next neighbor below, and that once more withdraws it from the cell beneath it, and

so on step by step until we reach the actual absorbent root-hairs. Root-pressure by itself could not raise water as high as we often see it raised in great forest trees and tropical climbers; it has not enough mechanical motor power. But here evaporation comes in, to aid in its task: and the real motor power in this last case is the very potent force of chemical attraction.

The stem, then, besides raising the leaves and flowers, for which purpose it is often strengthened by means of mechanical woody tissue, also acts as a conductor of raw sap from the tips of the roots to the leaves and growing points, for which purpose it is further provided with an elaborate system of canals and vessels, running direct from the absorbent root to all parts of the compound plant community.

The third function of the stem and branches is to convey and distribute the elaborated products of plant-chemistry and plant-manufacture from the places where they are made to the places where they are needed for practical purposes.

We saw long since, that starches, sugars, protoplasm and chlorophyll are manufactured in the leaves under the influence of sunlight; and from the materials so manufactured every part of the plant must ultimately be constructed. But we never said a word at the time about the means by which the materials in question were carried about and distributed to the various organs in need of them. Nevertheless, a moment's consideration will show you that new leaves and shoots must necessarily be built up at the expense of materials supplied by the older

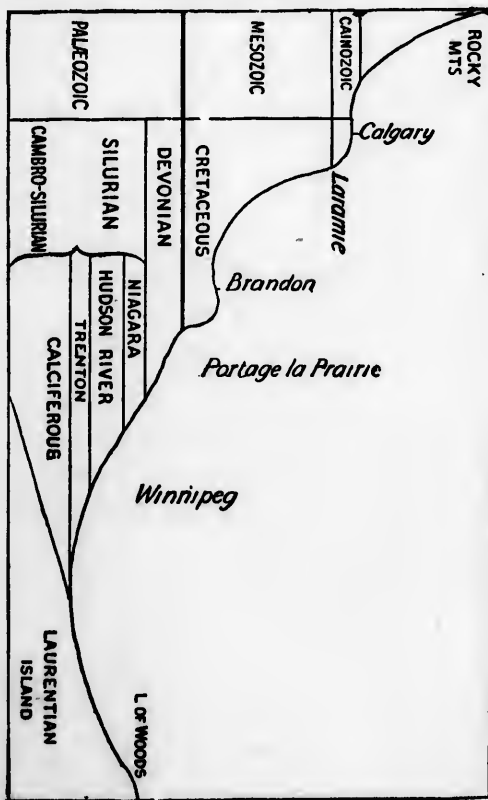
ones; that flowers, fruits and seeds must be constructed from protoplasm handed over for their use by the neighboring foliage. Nay more, the root itself grows and spreads; and the very tips of the roots, which themselves of course can manufacture nothing, must be supplied from above with almost active and discriminating protoplasm, to guide their movements. Whence do they get it? From the factory in the foliage. Thus from the summit of the tallest tree down to the lowest root that fastens it in the soil, there runs a complex system of pipes and tubes for the special conveyance of elaborated material; and this system supplies every growing part with the food-stuff necessary for its particular growth, and every living part with the food-stuff necessary for maintaining its life and activity. An interchange of protoplasmic matter, starches and sugars goes on continually through the entire organism.

This downward and outward stream of living matter, carrying along with it live protoplasm and other foods or manufactured materials, must be carefully distinguished from the upward stream of crude sap which rises from the roots to the leaves and branches. The one contains only such raw materials of life as are supplied by the soil—namely, nitrogenous matter, water and food-salts; the other contains the things eaten from the air by the plant in its leaves and afterwards worked up by it into sugars, starches, protoplasm and chlorophyll.

FORMATION OF SOIL.

The North American continent consisted in early ages of a rocky island, beginning at Labrador, running westward to the great Lakes Huron and Superior, then to Lake Winnipeg, and northward to the Arctic Ocean. It was almost the shape of a V, and was made up of hard rocks—granites, greenstones, and feldspars, and the like—which rose up many hundreds of feet above the sea. This V-shaped continent, with the Hudson Bay in the opening, we call the Laurentian Island. A part of it on the southwest portion, perhaps not quite so old as the rest, and containing many minerals such as gold, silver, copper, and nickel, is made up of the Huronian rocks. During the lapse of ages the creeks and rivers, running from all points of this island to the ocean around it, wore away portions of the rocks and carried the muddy matter to the coast in the form of clay or sand, and deposited it in beds in the water along the shore. In the course of time these beds along the shore became extended far out on the bottom of the sea. Animals and plants along the coast, as they died, became buried in the muddy flats, and as these solidified, the harder remains of the plants and animals were preserved in the rocks, and became what we now know as fossils. From the fossils which we find in the rocks we learn their age, and as the rocks are revealed to us by the cracking of the earth's crust, and the wearing away of the

beds during a number of ages, we are able to distinguish them and to name them. The following is a diagram of our rocks from Lake of the Woods to the Rocky Mountains, and the names which geologists give them. The diagram does not include the soil or drift that covers the whole surface from a point about seventy-five miles west of Lake of the Woods up to the base of the Rocky Mountains:



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From the above diagram will be seen what the surface of the rocks was at the close of the Cainozoic period, though it is to be remembered that, especially in the valley, there may have been much rock deposited which has been worn away by subsequent water and ice action. In looking at this diagram, those who are familiar with geology will see that many rocks are wanting between the Devonian and Cretaceous formations. The Carboniferous or coal-bearing rocks and the New Red Sandstone of Nova Scotia were being formed at the time of this gap, but on account of the rising of the earth's crust at this period in the North-West (though it was afterwards depressed) the land was above the surface of the sea, and so no deposit could be made. Our coal-bearing rocks belong to the upper Cretaceous marked above, and also in some cases to the Cainozoic. We shall now describe the process by which this vast extent of rock was covered by the surface beds of sand, gravel, and clay.

II.

Up to the time when the rocks named in the diagram were formed, the climate in northern regions was very warm. We know this from the fact that the Laramie sandstones have embedded in them leaves and hard fruits of tropical plants, such as sassafras, cinnamon tree, plane tree, and many others. But a cold climate overtook the northern part of our continent. Many ways of accounting for this have been suggested. The most likely explanation of it is that through the crushing and cracking of the earth's crust, the northern part of the continent was raised

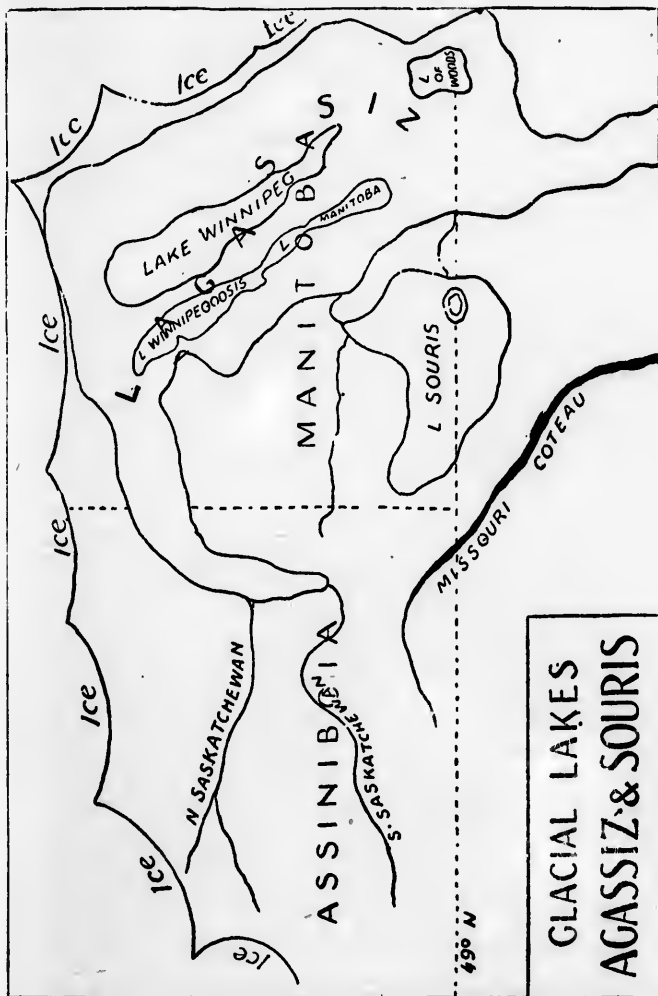
up some thousands of feet above the sea. We see, even in the present day, the rising and falling of the seemingly solid crust. The coast of Nova Scotia is sinking, that of Chili is rising, the south end of Norway is sinking, and the north of that country is rising. Now, judging from what we thus see taking place on the earth in our day, the elevation of the earth for several thousands of feet would produce a colder climate. On Mount Chimborazo, which stands nearly on the equator in South America, every climate from the tropical at its base to the arctic towards its summit, may be passed through. This elevation and its consequent colder climate seems to have been the feature of this time, and the northern part of the continent was covered from east to west with great masses of snow and ice, perhaps several miles in depth. This period of time has been called by geologists the Glacial or Ice period. During it, all the animals were driven southward, the vegetation was killed off, and if any plants survived on the edges of the ice sheet they were all arctic. The water courses which formerly ran to the north, emptying into Hudson Bay or the Arctic Ocean, were all sealed up, and then covered over by ice masses.

III.

At length, after ages of the prevalence of this cold climate, the crust began to sink and along the southern edge of the great ice fields, melting took place in the valleys. The lobes of ice slowly yielded to the heat of the summer sun and slid down the valleys. These lobes we call glaciers. The slope of the

continent had been northward, and as the ice melted the water filled up the channels and spread over their banks, forming great lakes in the hollows, with the vast ice sheet along their northern limit. We are now able to trace the shores of these old lakes. Along the eastern slope of Pembina Mountain, Tiger Hills, Riding Mountain and Duck Mountain, in Manitoba, we find the old lake beaches, and we can trace the eastern limit of the wide glacial lake beyond Lake of the Woods, which was embraced within it. Our present Lakes Winnipeg, Manitoba, and Winnipegosis were all included in it, and where the city of Winnipeg now stands the fresh water of the glacial lake stood five hundred feet deep. This old glacial lake geologists call Lake Agassiz, in honor of the late Professor Louis Agassiz, of Harvard College, who was the propounder of the land ice theory. Another large lake was formed on the higher level, now drained by the Souris River. This was bounded on the west by the Missouri Coteau and the Eagle Hills. We now speak of the area occupied by it as the glacial Lake Souris. On the following map the ice lobes along the north are marked, and the approximate outlines of the glacial Lakes Agassiz and Souris :

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IV.

Let us now see how this accounts for the formation of soil. Whenever the ice lobe or glacier reaches into the valley, the summer heat melts it away, and the mass of ice undermined slides slowly down the mountain slope. As it does so it grinds down the rocks by its tremendous weight. Quartz rocks are crushed to sand, clay rocks and slates to clay; granites on being ground down are washed out, a part being sand from the quartz contained, another part clay from the feld spar of the granite, and the soft black or shiny mica is pulverized among the sand and clay. The great force of the glacier may be seen in flat rocks over which it slides being made as smooth as glass, and in this case where the ice contains embedded in its moving surface sharp pieces of rock, these make scratches over the flat rock which are called "striæ" by the geologists. The mounds of sand, gravel and clay carried down the sides of the glacier are often hundreds of feet high, and are called "moraines." The larger pieces of rock, ranging from a few inches to many feet in diameter, which become rounded by rubbing against each other, and occur in the moraines are called "boulders," or when carried by water-currents or icebergs for hundreds of miles, are known as "erratics." A visit to the Selkirk or the Rocky Mountains will show the traveller the course of a glacier, and its wonderful power of grinding down the rocks into boulders, gravel, sand and clay. From the bottom of the glacier gushes out a stream of milky or muddy water. This forms the

source of a river, and carries with it the debris, which it distributes through the valley where it flows.

v.

Now the glacial lakes, Agassiz and Souris, were all along their northern shores bounded by the glacier lobes. When Lake Agassiz was at its highest limit it poured its waters through the channel of Lake Traverse, still seen at the source of Red River, and found its exit down the Mississippi. This established a strong current southward, and the water of the melting glacier distributed over the rocky bottom of the lake, boulders, clay, and sand in beds, and thus began the formation of the drift or soil. From the west came the Assiniboine, then a mighty river, and poured its waters into Lake Agassiz, somewhere near the site of the present city of Brandon. The Saskatchewan emptied its waters into Lake Agassiz in an arm of the lake which extended west nearly to the present forks of the Saskatchewan, while Lake Souris sent its waters down Lang's valley, Pelican, Rock, and Swan Lakes, and the Pembina River into Lake Agassiz, near where Walhalla now stands in North Dakota. Water flowing in from all these sources, the movement of the materials of the glacier moraines must have been very great, and the soil, hundreds of feet deep in some places, is the result of this. This action of the ice and lake currents no doubt wore away large areas of the solid rock-beds of Silurian and Devonian age, which had been deposited in preceding ages. This is proved to us by the occurrence of limestone boulders in the soil, and by particles of

limestone being found by the use of the microscope in the drift materials of our soils. The rock elevation on the prairie a few miles north of Winnipeg, known as Stony Mountain, is plainly a survival of the glacial period. At Stonewall, north-west of Stony Mountain, the glacial striæ on the rocks are from the north-west, those found east of Stony Mountain are from the north-east. It was evidently the pressure of two glaciers meeting at the south end of Stony Mountain that accounts for its being left in position, when the limestone beds on both sides of it were carried away by the devouring forces of the ice age. In Lake Souris a similar thing is seen. Turtle Mountain is an outlier, left behind by the glacial ice from the north-west. The Missouri Coteau is an immense moraine on the west side of the glacier, and the denuding force swept out the valley of the Souris River, and the region to the east, while Turtle Mountain, which contains a coal bed similar to that of the Upper Souris, was left behind as a memorial of the ice age.

VI.

The glacial lake theory affords us a reasonable explanation of the occurrence of the sand hills at Carberry, Cypress River, and elsewhere. These hills represent an old delta of the Assiniboine River. Just as at the mouth of Rainy River, where it empties into Lake of the Woods, may now be seen sand-hills or dunes for thirteen miles along the coast, formed by the deposition of sand by the river in the slack water of the lake, so the old Assiniboine, where it poured

over the cliff into Lake Agassiz, deposited the sand hills lying along the Canadian Pacific Railway east of Carberry, and to the south. And then again, when the lake had fallen, the Assiniboine, like the unnatural divinity of the ancients, devoured its own children, eating its way through the sand banks it had formed, leaving them both north and south of the river, and clearing them off entirely down to the clay between Brandon and Chater. A similar thing is seen at Walhalla, in North Dakota. Here the Pembina River emptied into Lake Agassiz, thus draining the overflow of Lake Souris. At its mouth sand was also deposited, forming the sand hills along the Pembina River.

VII.

The hills found here and there upon the prairies also owe their origin to the glacial lakes. Bird's Hill, near Winnipeg, is a mass of gravel, sand and other debris running across the prairie for several miles. It is what is called an ozar. This term seems to mean a hill found on the prairie by itself, something after the manner of an oasis in the desert. Its formation is very peculiar. It is believed to have been formed by the falling into the lake from the glacier of a great mass of ice. The ice being covered by gravel and other substance of the moraine seems to have sunk to the bottom. As it gradually melted it allowed the gravel, clay and mixed debris lying upon it to tumble to the bottom of the lake without order or regularity. We thus have a hill without any bedding, but simply a heap of mixed material.

The Grassmere ridge is also believed to be an example of the ozar. To this origin are also attributed Pilot Mound and Star Mound in Southern Manitoba.

VIII.

R. (The great work of the glacial lakes is however seen in their spreading over the lake-bottoms beds of the material supplied by the glaciers. These were often beds of sand ; beds of boulders, clay and boulders mixed, called boulder clay ; and beds of clay, more often called in Manitoba "white mud." As the ice lobes of the glacier melted away from the north of the lakes the fresh water of the lakes found its way northward by the old water courses toward Hudson Bay. This came about gradually, and Lake Agassiz stood for a time at different levels. Its various stages are marked by beaches, which run along the slope of Pembina Mountain and Tiger Hills, and appear again in the neighborhood of Neepawa. These beaches were ten or twelve in number and mark a long period of sinking. At a certain stage, finding a northward exit, the lake ceased to empty down the Mississippi ; then its area became less and less, until Lake of the Woods, Lake Winnipeg, Lake Manitoba and Lake Winnipegosis became the chief bodies of water left by what was once the immense Lake Agassiz. It is a matter of interest to us to consider how long ago the glacial era passed away. From calculations made as to the Niagara Falls, whose geology seems much the same as that of our glacial Lake Agassiz, and from certain flint remains found buried under the clay in Minnesota, there seems to be ground for

thinking that the glacial age ceased from six to ten thousand years ago, and that primeval man shortly after found his way to the dry banks of our lakes and rivers. The drying prairies then became covered with herbage. The black vegetable mould several feet thick is the result of the thousands of years of successive seasons of decaying grasses and other plants.

IX.

From wells and other excavations made in the drift or soil, we are able to trace the order in which the deposits were made. The layers differ greatly in thickness. In digging cellars in Winnipeg, contractors are bound by their contracts to put the foundations down upon the blue clay. In the short distance of one hundred yards several feet of difference is found in the layers overlying this clay. At times in sinking a well the digger finds he may have a layer of boulders of twice the usual thickness to pass through. Sometimes at a particular point some great hole or chasm seems to have existed, and the boulder, or clay, or sand deposit may have filled this up to the depth of thirty or forty feet.

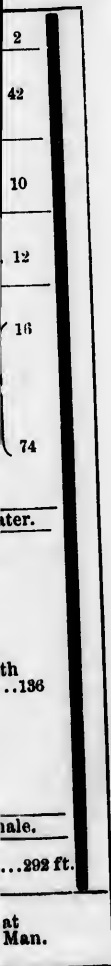
And not only in thickness but also in order great differences are found. From various causes a change of drift material might have taken place. Change of currents, the falling of the lake water, or the scarcity of material might thus have led to the absence of one or more layers. Should the particular bed omitted be one of sand the consequences would be serious to the well borer, who might have his pains for naught. A study of the record of the boring of the three wells is here given as interesting:

Black mould .. 4	Clayey soil..... 3	Loam 2
White mud 8	Dark sticky clay 27	Hard blue clay 42
Blue clay 35	Sand with pebbles 10	
Boulder clay.. 15	Black sticky clay 13	Ditto, with boulders ... 10
Boulders 12	Sand, red to black, with water.. 18	Yellow hard pan 12
Sand with water.. 2	Black clay 10	
	Sand 4	
Depth 76 ft.	Reddish clay with pebbles.. 13	Soft bluish clay..... } 16 74
	Sand, dark and free.	
	Depth100 ft.	
		Sand with water.
		Blue clay with stones.....136
		Gray clay shale.
		Depth....292 ft.
Well in Winnipeg, Man.	Well at Regina, Assa.	Well at Solsgrith, Man.

DRAINAGE.

I.

That the soil may be most serviceable, and in its best condition for the farmer's purposes, it is necessary that it should be loose and open in structure and free from too great an amount of water. The removal of the unnecessary water from the soil is called drainage. This may be accomplished either by open drains running to a neighboring stream or watercourse, or by sunken drains where the slope of the surface is not regular. Where no natural drainage is provided, the water is carried away from the land only by evaporation. This takes a long time, so that the land to be sown in the spring-time is not ready until after the season for sowing is past. Even after the surface water has disappeared, land which is badly drained keeps down the temperature by the constant evaporation of its moisture, and this soil, which is said to be "cold," prevents the roots of the plants from growing, so that later in the season they perish from having their roots too near the surface of the ground. Undrained lands, when composed largely of clay, are what are known as saturated soils. When these dry by evaporation they become baked, and then crack. The cracks in the soil injure the root of the plant, and also allow the moisture of the soil to pass off when it is most needed. When



soils of this kind are drained, the air can pass through the spaces in the earth, and the soil is left in a better state for the rooting and growth of plants. It is easy to prove the advantage of draining by taking two plots of wet land and watching the growth of the same crop on the drained and the undrained parts side by side. It is a mistake to suppose, as some do, that undrained land will be a protection to the crops in dry seasons. The very reverse is the case.

While such large tracts of good land, with natural drainage, are to be had at low rates in Manitoba, it is not likely that expensive drainage processes will be followed. At the same time it is important to understand the principles of drainage, and, in the case of specially selected sites for homes or farm buildings, to know how to drain the land. The drain, being a channel for the carrying off of water, may be made of different materials.

1. *Brush drains.*—These are made by digging a trench and filling it with the leafy branches of trees, and then covering these with earth. This will be of service, but the brush does not last long and so is not profitable.

2. *Stone drains.*—These are made by piling the trench half full of stones taken from the land. This may be successful for a time, but the spaces between the stones become filled with mud, and the drain soon chokes up.

3. *Wood drains.*—Where lumber is cheap, and the drains are not long, box drains of four planks are made. These are serviceable, and last for a number of years, but the cost of lumber in Manitoba is too

great to allow of the extensive use of this kind of drain.

4. *Tile drains.*—The tile drain is made from tiles about a foot or fourteen inches long and three to six inches in diameter. The tile now used is the plain cylinder made from the best brick clay. The clay used must be free from admixture of lime, as if any lime be present it will absorb water and burst the tile.

In laying out a system of drains some skill and experience are needed to gain the best results. The principle to be aimed at is to run a main drain through the lowest part of the field with slope or grade enough to carry away the water to a creek or larger stream. The main drain is usually from four to six inches in size, and side branches of pipes of smaller size are run into the main drain. In this way a considerable distance on both sides is freed from water by the main drain.

II.

A case where draining was found very useful in Manitoba may be given from the Brandon Experimental Farm. A shallow pond of about fifteen acres was formed every year by the melting of the snow and spring rains directly in front of the main buildings of the farm. This did not usually dry up till midsummer, when it was too late to sow a crop for that year. The pond was at a lower level than the surrounding land, so that an outlet of more than eight feet deep needed to be made to drain it. The soil being light, an open ditch of such depth could not be

kept open. It was therefore decided to lay a tile drain from the pond to the Assiniboine River, a distance of 4,300 feet. The mode followed in making this drain may serve for any other needed in Manitoba. Having selected the outlet on the bank of the river, a surveyor was engaged to take the levels, to find the fall between the pond and the river. The line was then marked out by stakes two hundred feet apart, and a plan prepared showing the depth to be dug opposite each stake. As the drain was expected to be dry during the winter, no attempt was made to keep below the frost line, and at the shallowest point the drain was within four feet of the surface. Had the land been full of springs it would not have been dry during winter, and in that case the tiles would require to be eight feet below the surface in the shallowest point, to prevent the freezing of the water and the bursting of the tiles thereafter.

When the ground had been marked out, the surface soil was loosened with the plow, and thrown out with spades. The lower portion of the soil was then removed with narrow draining tools, and the tiles placed on the solid ground at the bottom of the ditch. As it was important that the tiles should be given a uniform flow, a spirit level was used every ten feet. The tiles having been placed in position, the joints were covered with sod to keep sand from filtering into the tiles. They were then covered with the heaviest soil available, and this was pressed solidly around the tiles, after which the ditch was filled up with scrapers.

As the drain passed through several depressions,

which held water during the spring months, branch drains of tiles, three inches in diameter, were laid through these, and connected with the main drain. The lower half nearer the outlet of the main drain was laid with tiles six inches in diameter and the upper portion with four inch tiles. Although the fall between the pond and the river was only two feet to the thousand, the drain was found to work well, and drained the fields sufficiently early in spring to allow a crop of oats to be sown, and to enable the farmer to reap an abundant crop.



ROAD-MAKING.

As roads are essential for the farmer, and since they depend on a proper treatment of the soil, they will now be considered. Good roads are necessary for the farmer's comfort. If the roads are bad the cost of transport of the farmer's produce from farm to market is much increased. With good roads the farmer can afford to sell what he grows at a lower rate and still have a profit. A good road is also a civilizer. Farmer can visit farmer more easily, city and country may communicate more freely, children may reach school more regularly, and the traveller's temper is saved many a jar when the road is good. The requisites of a good road are smoothness, hardness of surface, and a proper slope to drain off the water.

Four classes of roads may be mentioned and considered :

Telford Road.

After the road is drained, graded, and well rolled, on the road-bed are placed squared oblong stones, six inches long by four inches thick, and eight inches in depth. These are laid side by side and make a firm foundation. On this substructure is first placed a layer of coarse broken stones to a depth of four inches. This is well rolled and then covered with a second course of finely broken stones three

inches deep. Sand is then filtered in between the stone until all the spaces are filled. For ordinary country roads in Manitoba the Telford system will probably be found somewhat expensive, but it will stand the heaviest traffic without injury.

Macadam Road.

The earth foundation for this road is prepared in the same way as that for the Telford road. Instead, however, of placing large stones on the soil foundation, broken stones from two to two and a half inches in thickness are used. These are put on in three layers, and each layer rolled before the rest is laid. A thickness of broken stones of about nine or ten inches is sufficient if the foundation is well laid and drained.

Gravel Road.

This road is made by laying a bed of gravel on the road-bed, prepared in the same way as for the more expensive sorts just described. It makes, perhaps, the most serviceable country road attainable in Manitoba.

Common Prairie Road.

This road is made by simply grading up the road-bed, and preparing drains at the side of the road to remove the surplus water.

As the two last named are the only roads likely to be made in rural parts of Manitoba for many years to come, it may be well to describe more particularly the method to be followed in preparing the road-bed.

(a) *Draining.*

Good drainage may be said to be the secret of road-making. By the water being removed, the road-bed rapidly dries up and becomes a hard, smooth plane for the wheels of vehicles. In making an ordinary road it is important to have it of a proper width. This should be from twenty to twenty-four feet, according as the traffic is to be small or great. The line of the side ditches is then laid out. These are dug out with plough and scraper, and care should be taken as to their shape and drainage. They should have a gradual slope to some stream or coulée. They are best when made two feet wide at the bottom, with a slope at the side of one foot horizontal to one foot vertical. By following these directions ditches may be made which will not readily fall in. The soil taken from the ditches is placed in the centre of the road in a rounded form, so that the rain may run off rapidly into the side ditches, and not have time to soak into the soil. On rolling land with porous soil the side ditches are often sufficient to effect drainage, but in flat districts and in stiff clay land both side ditches and a covered drain in the centre of the road are necessary. This centre drain when required is made of tiles or stones, a foot or two below the surface, and running with a proper grade to the outlets which empty into the side ditches or culverts.

(b) *Grading.*

Care must be taken to have the road-bed sufficiently rounded to allow the water to run off easily. To the soil taken from the ditches, is added any additional material taken from cuttings through hills. The road-bed being levelled and the centre somewhat rounded, it is then well rolled with a land-roller loaded with stones, and any hollows left after rolling are filled in with soil. Another rolling should then be given it until the road-bed is level and hard. If the road is not to be gravelled, but to remain what we call a prairie road, it is now complete, but it will require a large amount of repairing every year.

(c) *Gravelling.*

If the material is at all convenient the main roads in Manitoba should be gravelled. The gravel used should not be mixed with too much soil or sand. A small quantity of either will assist the gravel to harden, but too much will leave the surface soft, and ruts will form in wet weather. The quantity of gravel to be used will depend largely on the supply at hand, and the amount of traffic upon the road. The usual amount is six inches on the side, rising gradually up to nine inches in the centre. The gravel should not all be laid on at once. Two or three inches at a time is sufficient, and each layer

should be well rolled before the next is added. The road will thus become solid, and will not settle into ruts when heavy traffic passes over it.

(d) *Culverts.*

Where the road crosses small creeks, or in hollows where there is likely to be a flow of water in spring, culverts, *i.e.*, arched drains for the passing of water under the road, should be built. These are made either of stone or wood. Stone is the more durable, but where not easily obtained, squared logs of spruce or oak serve the purpose. The logs are placed one above the other on each side of the culvert, and a floor of three-inch planks is nailed both on the top and at the bottom. These culverts require to be kept free of all rubbish, for on their efficiency largely depends the condition of the road during high water.



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WELL-BORING.

I.

Closely connected with the formation of the soil and drainage is the subject of well-boring, a most important matter in town and country alike. As seen already, we are dependent for our water supply on wells dug down in the soil to reach the sand or shale bed where the water gathers. The ground waters depend more or less directly on the rain which falls upon the surface of the soil. Let us follow the course of the rain as it falls upon the soil. Rain water is by no means pure when it falls. It has washed out of the air the dust, which contains salty and other earthy substances, the decaying matters from the earth's surface which are vaporized, and multitudes of vegetable germs which may be very hurtful to health. Further, when the rain water reaches the ground it becomes still more impure from the substances it meets there. Perhaps one-half of the rain water which thus reaches the earth runs off in the brooks, then into the streams and great lakes. This part of the water meets in its course the drainage from barn-yards and other sources of sewage. This gives a larger amount of food to the bacteria or vegetable germs already in the water. When the water is carried into cold, deep lakes, the water is greatly purified, but rivers, shallow lakes, bays, and ponds become very impure, and are often dangerous for

How?

? use. The other half of the rain water has a different history. It is absorbed by the soil, and gradually loses, (as it sinks into the earth, on account of lessened nutriment, the increase of carbon dioxide, and decreased amount of oxygen.) its previous bacterial pollution, so that deep springs and wells are, when first opened, free from dangerous qualities. It is to be remembered, however, that wells near barn-yards, closets, or under kitchens, are likely to be much polluted. In Manitoba, especially, the loose, absorbent soil in towns and villages is very likely to conduct the surface washings to the wells. A well-known Canadian writer has said that such wells "are veritable pest-holes, more dangerous to the health than probably all other local sources combined, in those seasons when low temperatures do not prevent bacterial development. They are in reality 'hygienic monsters.'" This is very strong language, and all our people should heed it and keep their wells free from such dangers.

II.

It is important that our people should have their wells properly made. A German writer speaks of two kinds of wells :

Surface 1. *Kettle wells*,—those from which the water is obtained by bucket or pump.

2. *Driven wells*,—those having a tube driven down to the source of water supply.

The kettle wells are objected to because impurities come into them from above. When pumps are put in they rarely have close platforms, and on this

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account it is found that mice, squirrels, gophers, and other animals often fall into them, are drowned, and render the wells unfit for use. Even from the sides of the well soakage introduces impurities. A writer says: "Experienced diggers assure us that no well, even those with the best cement or asphalt walls, can be depended upon to remain absolutely tight." Wells act on the surrounding soil as powerful drains, which receive not only the ground water, but also the surface water. Much danger arises from the relation of the well to the farm-yard and stables. It is not uncommon to put the barns and stables on a dry ridge or elevation to obtain good drainage. It is also natural to select a low-lying spot for the well, and this not far away from the stables, for the use of the farm animals. This makes a natural drainage from the stables to the well which is exceedingly dangerous.

Driven or bored wells are much preferable, in many respects, to kettle wells. They consist of a strong tube completely occupying the boring made down to the water supply. No surface drainage can reach the water supply through the well. It is quite needful, however, to have the bored well free from barn-yard or surface drainage as well as the kettle well. Another great advantage of the driven well in Manitoba is that drippings from alkali beds in the soil are prevented from reaching the water supply and from injuring the water. Artesian or flowing wells occur in many places where borings have been made in Manitoba. These are generally found in valleys, and the forces pressing on the ground water from

both sides of the valley are sufficient to drive it up the opening that is made, and even to cause it to rise in a jet above the surface.

The selection of a spot for digging a well is a matter of importance. It should be done before the farm buildings are given a permanent place on the homestead. One of the troubles in Manitoba is that the water may be alkaline. In most cases it is not so decidedly alkaline as to be injurious, but there is often sufficient to give the water an unpleasant "smoky" taste. The alkalies of the soil are simply the salts carried into it by the drying up of salty lakes, which were originally left by the sea. Most of the salts are soluble and are carried to the hollows and low lying parts of the prairie. In choosing the spot for a well, a gravel ridge or sandy bed, if such can be found on the homestead, is best. Several tests should be made unless the water is of the best quality and in plenty. A few feet in one direction or another may give a good well, or no water at all. The director of the Experimental Farm at Brandon gives his experience in the matter of wells. When living a few years ago in the North-West Territories he undertook to dig for water with a two-inch auger, welded to a long shaft. He sank four wells in a circle, around a diameter of not more than thirty or forty yards, and failed to find any water even at a depth of eighty feet. He was then led to sink a well in the very centre of the circle and found an abundance of water at thirteen feet. On examination he saw that the vein of water on which his last well had struck was quite narrow, and that it ran in between

two of the wells dug in the outer circle, missing one of them by only a few feet. As to avoiding alkali in water, no doubt the driven well is the best expedient for that purpose. A trickling stream in the side of the well from an alkali bed will spoil the purest water of the sand or gravel or shale beneath. While not absolutely certain to prevent the evil, a tube allowing no soakage from the top or side is most likely to give protection to the pure water beneath; besides, as we have seen, having many sanitary advantages.



COMPOSITION OF SOIL.

Farms and gardens depend for their success on the soil and the climate. How to adapt plants to their surroundings is the mark of a skilful farmer or a successful gardener. If any plant is analyzed it is found to consist of materials obtained from the soil or from the air. It is very important then to know what the composition of the plant and the soil is, and also to find what can be done with the soil to make it produce the crops which may be desired. As we have seen, the soil may be said to largely consist of sand, clay and humus. These are mixed in various proportions, and various names are given to the mixed soils. When a soil consists of two parts out of five of sand, with the remainder clay, it is known as loam. If these proportions are reversed it is called sandy loam, and if three-fourths of the soil is clay and the remainder sand it is known as clay loam. Our rich black soil in Manitoba is called vegetable mould. It consists of one half humus, *i.e.*, decaying vegetable matter, and the other half equally divided between clay and sand.

While these are the general constituents of soil yet there are many other substances in the soil which deserve attention. The body of the soil is, however, made up of sand, clay and humus. They may be said to be the support of the plant, in steadying its roots, in keeping them moist, and in preserving them from rapid changes in climate. As

a matter of fact the alumina, which we have seen to /
be the chief part of clay, is not used as a food by any /
of our cultivated crops. Sand, which we saw to be 2
pure silica, is not only found as sand but also
associated with the alumina in clay. Silica is, how-
ever, a food of plants as well as a protector of the
roots. It is found in the straw, awns, bristles
and chaff which protect the grains of wheat, barley,
oats and other grasses. If there is not enough of
silica in the plant the straw will be weak, the chaff
thin, and the plant be more easily injured by insects.
For wheat-growing especially a certain amount of
silica is necessary.

The humus is the great source of nitrogen for the
plant. In our chemical experiments we saw that 3
the gluten of wheat and the legumin of peas and
beans are nitrogenous. To supply this part to
our growing wheat crop, and it is the large pro-
portion of gluten that makes Manitoba wheat cele-
brated, there must be a good supply of humus in
order that the plant may obtain nitrogen. It is now
believed that plants of the pea family obtain some
nitrogen directly from the air.

One of the commonest constituents of soil is lime. 4
The limestones which we saw were ground down by
the glaciers are distributed widely in our soils. Lime
is a very important constituent in those plants like
turnips, which are used for feeding dairy cattle. It
is also useful in improving the quality of the soil.
Very closely associated with lime is magnesia, which
we met in our experiments. It is a large constituent 5
of wheat, barley, oats and Indian corn. But of very

Now, it is quite plain that soil in which these substances are wanting cannot produce grains and fruits of the quality which may be desired. Land, for example, in which there are no phosphates will not grow good wheat; land from which alkalies are wanting will grow but indifferent potatoes, while, for the growth of excellent wheat, the large proportion of silica in the straw shows what it requires. And not only must these substances be in the soil, but there must be moisture to dissolve them, and the soil must be in such a state that the moisture with the dissolved substances may freely reach the roots of the growing plants.

But while these substances are obtained from the soil, it is to be remembered that a large part of the ninety-five per cent. of the plant is derived from the air. This is obtained from the carbon dioxide breathed out by animals and carried by the air to the growing plants. The moisture in the form of water vapor also comes largely through the medium of the air. It is through the leaves, which have been called the lungs of the plant, that these come. On the upper sides of the leaves are layers of cells which may be seen by the microscope. These are full of water and through them the gases and vapors enter and are taken up by the plant. Entering the tree thus and by the roots the substances are carried on from cell to cell in the tree and are deposited where they belong. Thus from air and soil are supplied the food materials of plants, which are worked over by the living organism into cells and tissues which we distinguish by various names.

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The soft, green, pulpy tissue we call cellular, that which hardens into wood, we know as woody. These tissues form plant matter, and the various parts of the plant are needed for the growth of the animal. The young animal needing lime for its bones obtains this largely from milk, the brain and bones require phosphorus and get this from the food supply, the blood needs salt and iron and receives these from the alkalies, chlorine, and iron oxide, while the materials of the plant in its carbon, hydrogen, oxygen and nitrogen go to feed the animal and make up the animal tissue.



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THE IMPROVEMENT OF SOIL.

Knowing now what certain plants require as food. we can see that what is lacking in some soils must be supplied, if good crops are to be grown. We may be sure that if we obtain from the soil the materials which go to make up blood, muscle, bone, fat and milk of animals, and if these are sold and taken away from the farm the soil is to that extent poorer. We shall have to give back to the soil what we thus remove from it, else the soil will become poor and exhausted. The substances we thus use to return to the soil are known as manures. A wise and foreseeing farmer or gardener will always keep before him the aim of supporting and improving the soil. In some countries where prices of farm produce are high, and where competition is strong it will pay to bring from considerable distances what the soil lacks.

The substances most likely to be needed by the soil are three, viz., nitrogen, phosphoric acid, and potash. In Britain, guano, which is the excrement of birds from Sea islands of South America, is brought in ships and added to the soil to supply nitrogen and phosphorus. To the British farmers we also send phosphate of lime found in our Ottawa valley, to be ground down and added to the land for its phosphorus. Bones are obtained from all parts of the

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world and ground up to provide bone dust for the British farmers. But for us in Manitoba these manures are too expensive. We have to rely on materials more easily obtained.

c > Lime is a useful fertilizer. It supplies the plant with calcium which is found among its cell contents. It also acts on the vegetable mould, and unites with the sour acids of the decaying manures and makes the soil fruitful. It takes the place of potash and soda and some of their compounds and allows this valuable food material to be absorbed by the plants. It loosens stiff clay soils and makes them more easy to plow and harrow, while it helps light soils to retain moisture. It also destroys insects and hastens the ripening of plants. From one to two tons of lime is an average dressing for an acre, but hitherto lime has not been found necessary as a manure in Manitoba soils. d Gypsum or plaster of Paris when ground up is added by sprinkling, to grass, turnips, e & potatoes, peas and Indian corn. f (valuable in supplying potash to the soil. Salt when it may be obtained cheaply is a useful manure. It brightens and strengthens the straw of grain and destroys insect life. The plowing in of green crops g > (is one of the most effective ways of enriching the surface soil.

* It is however almost entirely to barnyard manure that our Manitoba farmers confine their attention. The great richness of our soil has induced our farmers to think that even manure of this kind was unnecessary. In Red River of old some of the farmers allowed the manure to accumulate around their

'byres' or stables, and then moved the stables to another spot when the heap became inconvenient. This was a great mistake. If any farm in Manitoba be chosen and one part of a field manured and the other part left without manure, the result will be seen in the succeeding crop very much to the advantage of the manured portion. The practice of burning up straw-stacks is also a very wasteful one. Another reason why our farmers have sometimes neglected to use the barnyard manure is that in our dry climate it is somewhat difficult to get the straw rotted. Manure of this sort is hard to work into the fields, and in the short season of the Manitoba farmer he is little inclined to take the trouble to deal with the manure as it deserves. Should the manure not be rotted, not only will the weed seeds not be killed, but damage may be done to the land by adding the long, unfermented manure. In some cases the soil is kept in such a loose condition by it that it becomes completely dried out, and the crop is injured. It is essential for the full advantage to be derived from manure that it be fermented, for when it is allowed to remain in heaps above the surface, the winds of Manitoba so dry out the moisture that fermentation ceases. The following plan is recommended for fitting the manure for use.

1. Make a depression by the use of scrapers, if there is not one already near the farm buildings.

2. Early in the autumn fill this depression with dampened manure.

3. After a few days fermentation will have begun, and by adding additional manure to it each day, fermentation can be maintained all through the winter.

4. In spring the manure is so rotted that it can be dug out with a spade.

Well rotted manure may be applied to the soil either in autumn or spring previous to sowing the grain. It should receive a thorough cutting up with the disk harrow to spread it evenly and thin, and should be speedily ploughed into the soil before it dries out. Raw, that is unrotted manure, should only be used on land intended for summer fallow. It then has time to partially decompose before the crop is sown. While the proper amount of manure to apply will much depend upon the condition of the land and the crop to be sown, about ten or fifteen loads per acre is thought to be a fair amount for ordinary farm crops.



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SELECTION OF A FARM.

A large portion of Manitoba is still unsettled. Its wild prairies are lying ready for the plow of the farmer. Much land is held by absentees, who are known as "speculators," and large quantities are held by farmers—much more, indeed, than they can ever cultivate. By degrees, as population comes into Manitoba, these broad acres will be occupied. It is a mistake to think, as the early settlers did, that one farm is as good as another. The fact that in one district of Manitoba, one hundred and eighty miles long by thirty miles wide, almost every section has good soil, has led many to think that the whole country is equally good.

Already some farmers have found this to be a mistake. Farmers who, in 1877 or 1892—year when the rainfall was above the average—settled on land which had an inch or two of sandy loam lying on a pure sand or gravel subsoil, did so because the herbage seemed so prolific. In other years of light rainfall they found the rains filter so quickly through the too porous soil that the crops perished from drought. Now, the presence of a bed of sand a few feet under the surface proves very useful in giving drainage to level land, but certainly the soil above it needs to be of considerable thickness to ensure good crops. In testing such farms the use of

a spade here and there over the farm will determine the depth of the soil and the subsoil. Running to the other extreme, some select heavy clay soil. Such land is very liable to be overflowed by streams beside it, and in many such cases settlers have been driven off by the high water. In some districts this soil is so retentive of moisture that none but aquatic plants will thrive.

One district of Manitoba is mentioned by a careful observer, where, after a heavy rain, the water seems all to remain lying on the surface. The soil becomes completely water-logged. On being examined with the spade, both the soil and the subsoil for several feet are found to be composed of a stiff, reddish clay, through which it is almost impossible for the water to pass. In that district repeated attempts to grow grain crops have failed, for in a dry year the stiff clay became baked and the vegetation could not thrive, while in a wet year the crops were killed from insufficient drainage.

In some parts of Manitoba, especially westward, alkali lands are found. These contain quantities of sulphates and chlorides of the alkalis, which are hurtful to the crops. These lands are easily detected by the white, powdery incrustation on the soil. As already stated, these alkali beds are chiefly in low-lying spots, whither the alkali has been carried on being washed out of the soil on the higher lands. By careful working and deep ploughing from year to year the alkali is allowed to wash out of such spots, and, by manuring, this hurtful quality of the land may be removed. In choosing a farm, however, care

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should be taken that too much of the land is not alkaline.

In choosing land for growing wheat, sometimes what is known as scrub-land is selected. This is land whose good quality is shown by the growth upon it of hazel and rose bushes. As it costs a considerable amount to clear this land, it is a mistake to choose it, if large areas for wheat growing are needed. The difficulty is not entirely in the first clearing, but in the second growth, especially if oak and thorn brush is a part of the scrub. As the soil is excellent, however, there are some farmers who are strong advocates of the scrub-land.

Another important consideration in the choice of a farm is, that it should have good surface drainage. In years of heavy rainfall this will be thoroughly appreciated. Our province is, however, largely covered with a network of rivers, creeks, and ravines, so that nearly all parts of it have good natural surface drainage. A water furrow occasionally is all that is needed to carry off surface water. Still, there are exceptions to this rule; and if the land in question is very level, and produces nothing but grass or sun-flowers it will be wise to hesitate before selecting it for grain growing.

As the tendency now in Manitoba is towards mixed farming, *i.e.*, to the growing of stock as well as grain, it is evident that an admixture of land is desirable. The old-time requirement of wood and water is important. The farmer should have not only wheat land but grazing land. Too often in Manitoba mistakes have been made in choosing one single line of

→ farming. To make the farm homelike, not only are waving fields of yellow grain necessary, but animals of the farm make objects of interest in the life of the farmer and his family. The farm should then be chosen with all these different objects in view. Another very important matter in choosing a homestead is, that it should be in a good district, where neighbors are likely to come. Thinking to have wide runs for their cattle and horses, many of the early settlers went miles away from the nearest neighbor. Many of them lived to regret their choice. A farm may of itself be desirable in every respect, but so surrounded by inferior land as to make it difficult to maintain schools, churches, or to have good roads, or municipal government. An experienced farmer of Manitoba has said that he would rather have a poor farm in a good district than a good farm in a poor district. What farm can be more attractive both for beauty and profit than one where there is wood not too far distant; where grazing and hay lands can be had; where the rosebush, silverberry, snowberry, or other well-known high land plants are found?



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BREAKING THE PRAIRIE.

Among the many advantages that Manitoba has for the farmer is the ease with which the soil, which has been lying for centuries untilled and unoccupied, is brought under cultivation. In the Eastern Provinces before a farmer could begin his work a heavy growth of trees was to be chopped and logged, the stumps were to be burnt or uprooted, and the progress was very slow. On the prairies, a single year is all that is required to bring the land into use.

The first operation is called "breaking." This is done by the use of a "breaking plow," which has a sharp share and coulter, and a convex mould-board. The object in view is to cut the growing plants which have become in the course of many years a mat, and to turn the cut surface up to the sun and air, so that with the rain falling upon the thin sod it may rot and become ready for producing a crop.

Breaking is generally done in the month of May or June. In these months the plants are full of sap, and quickly decompose when turned up to the air, while later in the season the roots are more woody, and do not rot so easily. Early breaking also gives time for the vegetable matter to decay before winter sets in. Breaking should not be done by plowing deeply. The soil having lain undisturbed for centuries is not in the best state for producing crops, and should be brought to the surface a little at a time.

This enables the air to bring the soil into a better condition for supporting plant-life. It is also found that the native plants on the prairie have their roots near the surface, and if these roots are cut instead of being plowed up whole, they die much quicker.

Farmers from abroad, not accustomed to breaking prairie lands, often make mistakes in their first attempt to subdue the prairie. They are almost certain to plow too deeply, losing sight of the object to be gained in breaking. Again, new settlers, anxious to obtain a crop in the first year, sow in the same season as the breaking. The return is almost always small, and it is found that when under crop the sod does not rot so rapidly as if it were left bare. Accordingly the second, and even third year's crop is injured by this plan.

Back-Setting.

In three or four months after breaking, the sod, now fairly well rotted, is plowed or turned over again. This process is known in Manitoba as "back-setting." While the plow turns back the partly decomposed sod to its former position, it at the same time brings to the surface an inch or two of new soil to be incorporated with the sod. This gives a good seed bed for the grain, and fits the soil fairly well for growing a crop. After this back-setting the field is well harrowed and left ready for the following spring, when it is sowed broadcast with wheat. Thus, within a year from the time the farmer sets foot upon the virgin soil, he may have a broad extent sown with wheat, and a fairly smooth field covered with the promising crop.

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PLOWING.

The objects of plowing should be well kept in mind. They have been stated to be:—

1. To destroy weeds by burying their tops under the soil and exposing their roots. When the weeds are tall this process is greatly assisted by the use of a large chain, with one end fastened to the plow-beam and the other to the double-tree of one of the horses. The chain will drag in front of the forming furrow and crush down the weeds.
2. To loosen the soil and allow the roots of grain plants to spread.
3. To incorporate some of the subsoil with that above and enable the air and rain to set free plant food locked up in the soil.
4. To provide a well prepared seed bed for the coming crop.
5. To form a loose covering on the top of the soil by which connection is cut off from the soil beneath. Thus, by preventing capillary attraction, the moisture is kept below for the use of the crop in dry seasons. Careful harrowing still further promotes this process.

The plows generally in use in Manitoba are of four kinds. First, there is the plow already referred to—the breaking plow. This has a long

wooden beam to steady it, a convex mould-board to turn the sod over flat, a sharp circular coulter, and wide sharp share to cut easily through the tough sod. Next, is the stubble plow. It is shorter in the beam, which is generally of iron, has a slightly different mould-board of very hard metal, to prevent the sticky soil adhering to it, and thus this plow is used without a coulter. Then comes the sulky plow, which may be like either one of the two just mentioned, but with a seat attached for the driver. The sulky gang-plow consists of two plows joined together, and is also provided with a seat for the driver. Last, there is the general purpose plow, which is only useful in the lighter class of soils.

The proper depth and width to plow will depend largely on the season of the year in which plowing is done, on the crop to be sown, and on the character of the soil. In Manitoba it may be considered a safe plan to gradually increase each year the depth both in fall and summer-fallow plowing. In these cases the additional soil brought to the surface has time to be acted on by the air before the seed is sown. In spring plowing, however, and especially on land with a stiff, clayey subsoil, only well-seasoned soil should be brought to the surface. When the proper depth has been decided on, for any kind of plowing, it should be carefully maintained, as otherwise the sole of the furrow will be uneven and the seed bed irregular in depth. Except in the case of breaking the prairie, all sod should be plowed narrow, and the furrows set up nearly on edge. Stubble should be plowed sufficiently wide to bury all weeds

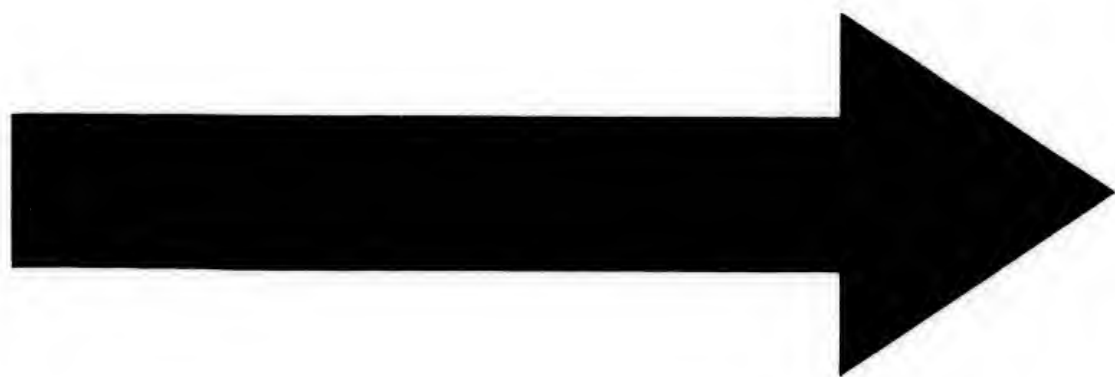
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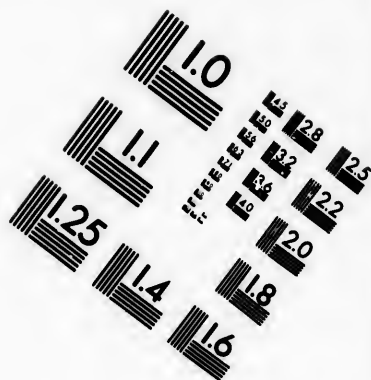
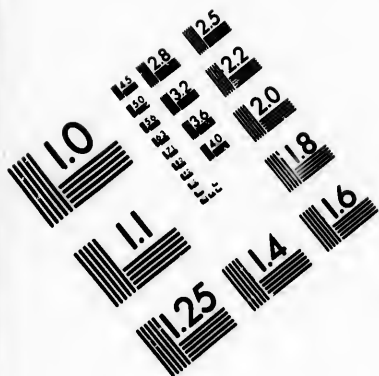
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and waste matter found on the surface. The furrow should be straight and of uniform width, as otherwise depressions will be formed on the surface, allowing some of the seeds to be buried deeper than others, thus making an unequal crop.

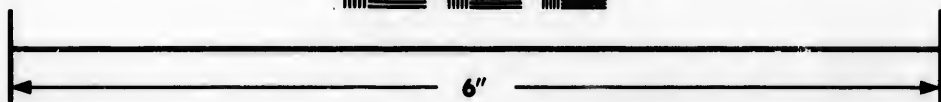
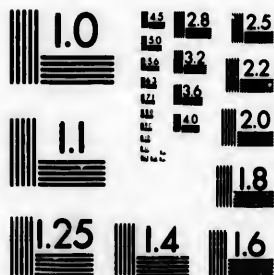
HARROWING.

The objects of harrowing are very evident. To level the roughly plowed soil and complete the seed-bed, to pulverize the soil in order that it may more easily absorb and store up moisture for the use of the plant, and to destroy the growth of weeds, are important advantages gained by harrowing. This operation takes place just before and after sowing, also after plowing or cultivating the summer fallow, to complete the destruction of the growing weeds. In late years many experiments have been made in harrowing grain crops after the plants have reached two or three inches in height. If properly done, and the harrows are not allowed to choke, few, if any, of the grain plants are pulled up, and the weeds are nearly all killed. To be effective, however, the work must be lengthwise of the drill, and before the weeds have taken a firm hold of the ground.





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CULTIVATING.

An implement somewhat resembling a plow, called a cultivator, is now much used in loosening and stirring up the soil in farming operations. The main difference between this process and plowing is that it does not invert the soil. It does not usually go to the same depth as plowing. This process, when applied to long rows of Indian corn, turnips, and the like, is called "horse-hoeing." The objects reached by cultivating are:—

1. It retains the well-aired soil upon the top.
2. When the cultivator instead of the plow is used in spring, it enables the farmer to sow his grain earlier, a most important matter in Manitoba.
3. Summer-fallows are, by cultivating, kept free of weeds at a small cost.
4. The cultivator, by stirring the soil more deeply than the harrow, allows the rains to sink more rapidly into the soil.

Green crops—by which we mean turnips, mangels, and the like—should be cultivated often. The cultivator used in summer fallowing should have broad shares, to cut down all the weeds; that used for the green crops is better with teeth of a special shape which destroy the weeds, and at the same time stir up enough of soil to act as a mulch.

FALLOWING.

Summer fallowing is the cultivation of the soil by the means of plow, harrow, and cultivator during the summer months, in order that it may be prepared for the crop of the following year. Many farmers follow this process without having a very clear idea of its purpose. The general explanation is that the object of summer fallowing is to give the land a rest. This does not seem a very clear reason. The following are the purposes served by summer fallowing:—

1. To kill the weeds which spring up so abundantly on the unoccupied soil.
2. To stir up the soil so that the weed seeds lying in the soil may germinate, and then to expose them to the air so that plant and root may be destroyed.
3. By admitting air and moisture, to hasten the decay of the unrotted stubble, which sometimes lies for years, in our comparatively dry climate, without becoming a part of the soil.
4. To bring to the surface, pulverize, and aerate a portion of the raw subsoil.
5. To thoroughly pulverize the soil, so that it may lie upon the top like a cushion or mulch and retain the moisture, and thus, should the following year be one of drought, give the growing plants the moisture they require.

The following is the method of summer fallowing recommended by Mr. S. A. Bedford, Director of the Brandon Experimental Farm, and found well suited to the conditions of Manitoba:—

The stubble land is plowed about the 15th of June slightly deeper than it has been plowed previously, care being taken to bury all the weeds. It is then immediately harrowed lengthwise of the furrow, after which it is left undisturbed until tiny weed plants are seen bursting through the surface of the soil. The ground is next harrowed crosswise, thus destroying the young weeds and leaving the ground in good condition for another crop of weeds. This third crop of weeds is generally destroyed by the cultivating process, which we have described. After this time the season is so far advanced that any additional weeds that may grow up are killed by the winter frosts before they can ripen seed. It is very important to notice that the fallow must be so constantly worked in summer that the weeds may be kept down. A badly cared for summer fallow may do more harm than good. It is to be remembered that should only a few large weeds be left to ripen, their very size and strength will enable them to produce more seed than perhaps the whole field would have grown had the weeds been crowded.

That summer fallowing is useful in Manitoba for preserving moisture to the soil is shown by Mr. Bedford's experience at Brandon. He says: "In digging a drain across the Experimental Farm last year I found that stubble land was quite dry for seven feet deep, while summer fallowed land adjoining was moist from about

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two inches below the surface down for seven feet. In explanation of this I cannot do better than quote the words of Prof. Saunders at last year's meeting of the Central Farmers' Institute: 'Soil allowed to stand for any length of time forms what may be called a capillary structure—a fibrous mesh like a cotton wick—and this allows the moisture in the land to find its way to the surface, and being acted on by the sun and air it becomes thoroughly dry.' It thus appears that the harrowing and cultivating breaks up the connection of this capillary structure with the air, the loose upper soil acting, as we have said, as a non-conducting medium. The consequence is that we have the moisture of two seasons for one season's crop—a great advantage to this Province, where the rainfall is generally light."



SOWING.

The plan of sowing the seed broadcast by hand, that has been the farmer's method for ages, has in our generation almost passed away. This is the age of machinery, and the laborious and inefficient methods of the past must be left behind. Broadcast sowing by hand deposits the grain at uneven depths and produces an irregular crop.

The principal machines used in Manitoba for sowing grain are of four kinds: First, there is the Gatling gun sower, a machine worked on the centrifugal principle, flinging the seed in all directions. This is a very rapid sower, but the work is badly done, and the machine is not to be recommended. Second, the broadcast machine is a very close imitation of hand sowing, but the grain is more evenly distributed than it can be by hand, and without manual labor. In fields too rough for the drill this is perhaps the best machine that can be used, but broadcast sowing is open to the objections, that some of the seed, falling in hollows, is buried too deeply and never germinates, or, if so, becomes a feeble plant. Other portions of the seed are not buried deeply enough, and so are blown away by high winds, or dry out in a season of drought.

Two other kinds of sowing machines are classed as grain drills. The first of these is the hoe-drill. This is the well-known machine with a number of hollow

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iron tubes placed about seven inches apart, which, as they are drawn over the ground, press into it for two or three inches and allow the grain to run down the hollow of the tube. As the grain is deposited at the base it is covered by the falling in of the loose soil. The newly introduced shoe-drill seems the best sowing machine yet devised. It proceeds on the principle of a sleigh runner, and the grain is dropped in the mark or drill left by the runner. The first shoe-drills with iron wheels, which, followed the drills and pressed the soil over the grain, were commonly known as press-drills. More recently the shoe-drills are supplied with chains, which drag behind and cover the grain.

Grain drills are strongly recommended for sowing. They deposit all the seed in the moist earth at an even depth, and as a result germination is rapid and even, while wind storms seldom uncover it. Sown by this process the grain all comes up and ripens uniformly. Four years' experience at Brandon has shown that wheat sown with a drill yields on an average five bushels an acre more than broadcast sowing, and besides results in the grain samples being more uniform.



ROLLING.

This is a process employed for smoothing and solidifying the soil by means of a heavy cylinder of wood or iron, drawn by horses over the soil. By means of the roller the clods are broken up, and in the case of clay lands this is very necessary. By this process also the soil of lighter land is packed more closely around the grain plants, and the moisture is thus retained. Rolling also serves to level the land and make an even surface for the working of mowers and binders. In Manitoba care must be taken in the use of rollers, else much harm may result. Stiff clay land rolled, when saturated with moisture, will "cake," or form a crust on the soil, preventing the young plant from forcing its way to the surface, and causing the land to dry out quickly in seasons of drought. On light soils there is danger of rolling the particles of soil so finely that severe wind storms may blow it away from the plant, expose the newly formed rootlets, and thus kill the plant. To avoid this risk the rolling is now generally deferred until the wheat plant is three or four inches high. This for the time flattens the young blades of grain, but does not permanently injure them, and the additional advantage is gained that the particles of fine soil being protected by the grain plants do not drift with the wind.

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ROTATION OF CROPS.

We have seen that different plants take different substances from the soil. If one crop should be grown upon the same plot of ground continuously it would exhaust particular parts of the soil and greatly reduce the yield. In case some other crop were taken it would remove less of the particular thing that the former used, would draw upon the other parts of the soil, and the fertility of the land would be preserved for many years more. If, however, it is desired to grow one special crop, which may be found very profitable—such as garden vegetables, near a large city—the strength of the soil can be maintained by adding special fertilizers to supply what the crop had taken away. The manures, however, available in Manitoba are chiefly of the more general kinds, such as barnyard manure. In this case it is the right course to save the soil as much as possible, and for this purpose a rotation or succession of crops is plainly advisable. A work on agriculture for Ontario schools gives the following as the advantages of crop rotation :

1. It economizes the natural supplies of fertility contained in the soil. The lying idle, or being waste, of most parts of the soil is thus avoided.
2. It economizes the manures applied by making use in due time of all their fertilizing ingredients.

3. It helps to enrich the surface soil. The plants of the pea family take much from the air. This adds to the soil, while a crop of another kind would not. Some plants have more roots and rootlets than others, which on their decay help to enrich the soil.
4. The labor of the farm can be carried on with more comfort and with greater economy. When several crops are grown, each ripening at a different time, it is easier to care for each by gathering one after the other as they ripen, and the saving of wages will result, as the work is better distributed.
5. A regular succession of crops is helpful in keeping the soil free of weeds. A rotation should include a hoed crop, such as potatoes, turnips, or the like, and this will give special means of killing the weeds. Besides, certain weeds thrive best along with certain crops. Thus, if one crop is followed it gives better opportunity for particular weeds to strengthen and take possession of the soil.
6. The increase of destructive insects is checked by a rotation of crops. Most insects have special plants on which they feed. If the insect of one year finds its food lacking in the next it will perish, and the farmer reap the benefit.
7. Rotation is a necessity for economically feeding the animals of the farm. Variety of food is as necessary to the horse or the cow as to man. A well chosen succession of crops provides the changes required by the stock upon the farm.

It must be borne in mind, however, that special circumstances may modify the rotation. For instance, if swine or sheep are more profitable than cattle, at any particular time, then the farmer must raise the crops suited to the animals he is feeding. Or should barley or flax be in great demand when wheat is at a low price the farmer may very properly change his line of succession of crops. In addition, the farmer might very well have more frequently what his special soil favors. Heavy clay soil might have wheat or grass more often repeated, while other spring grain, roots and fodder might come more frequently on light and open soils. Should a farm have been neglected, and the present occupant inherit a rich crop of weeds, such as French weed or Canada thistle, he may resort to frequent hoed crops, and may frequently summer fallow. While, therefore, we strongly recommend a rotation of crops, it must be remembered it is not to be a tyranny which cannot be broken through, but rather a general direction to be departed from whenever circumstances require it.



WHEAT.

As supplying the principal food for human beings, and being the most reliable farm product of Manitoba, wheat demands special attention. It is a cultivated form of one of the grasses closely related to our couch grass, but has for ages been known as the favorite product of the farm. For convenience this important cereal is divided into a number of classes, depending on the proper season for sowing it, on the color and quality of its kernel, the color of the chaff, or the presence or absence of beard on the head, and the like. As to the time of sowing, varieties in the Eastern Provinces are divided into spring and fall wheat. In Manitoba, as shown by many trials at the Experimental Farm and elsewhere, it has been found impossible to grow fall wheat with success, owing to the character of our winter. We accordingly sow nothing but spring wheat. Of this, there are the white and red varieties, so called from the color of the kernel or berry. White Fife and White Connell are familiar illustrations of the one, and Red Fife and Red Fern of the other. Color is, moreover, often affected by the soil. Light, reclaimed scrub land often changes the color of the dark red wheats nearly to white, and stiff clay loams give white wheats a much darker hue. Examples are known of pure Red Fife being sown on scrub lands, and the crop containing twenty per cent. of white wheat. It has

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been noted already that the value of wheat depends on the quantity of gluten which it contains. The best Red Fife wheat contains fourteen per cent. of gluten, while Clawson's, a very soft variety of wheat, contains only eleven. In consequence of this, Manitoba hard wheat, which is chiefly Red Fife, sells in the markets of the world for from ten to fifteen cents a bushel more than the other varieties. In looking at some of the beautiful white wheats from elsewhere, it is hard to realize that our wheat is so much more valuable. As to the division into bearded and beardless wheats, the presence or absence of the beard on the wheat does not seem to affect the quality of the kernel, but it is found that the straw from the beardless varieties is more readily eaten by farm animals, and in addition the bearded variety is certainly more difficult to bind with a machine, especially if the crop be a heavy one.

As to time of ripening, wheats differ very much. In our latitude it is very important that a variety of wheat, to be desirable, should ripen early enough to escape in an average year the fall frosts. In selecting seed this should always be borne in mind.

On wheat being marketed, it is now, in Manitoba and the North-West Territories, classed into grades. These grades are fixed each year by a board of experts appointed by the Government. The best wheat is judged by its color, fulness of kernel, freedom from touch of frost, and weight. While sixty pounds is regarded as the standard for a bushel by measure, Manitoba wheat often runs up to sixty-four and sixty-six pounds, and has reached sixty-nine pounds. The

best wheat is graded as No. 1, hard; other grades, such as No. 1 or 2, northern, and the like, are fixed. This is done each year by a Government board. Varieties of wheat, as we know them, originate by sports or irregular forms that occur according to the course of nature. If these are taken and propagated separately, new varieties are thus produced. At the Experimental Farm, Brandon, most interesting experiments are carried on in cross-fertilization. Suppose one variety has strong straw, a thick chaff and a good full kernel, but is late in ripening; another variety is taken not so fortunate in the former respects, but earlier, the stamen of the early variety with its pollen is taken with a pair of pincers and bound in the same head with the pistil of the later variety. The product will be something of an average of the two varieties concerned. In this way new varieties are obtained. We may mention some of the best known varieties of wheat. Red Fife, a beardless wheat, with white chaff and red berry, is a variety said to have been obtained from the hold of a vessel trading to the Baltic. It was grown a number of years in Ontario, but it did not obtain its prominence until introduced into Manitoba. While a little later in ripening, it has wonderfully suited our climate and soil. An authority on wheat, Mr. W. W. Ogilvie, stated in a letter written in 1888, that Manitoba and the North-West Territories can produce better Red Fife than any other part of the world.

The chief recommendations of the Red Fife are:—

1. Its suitability, especially from the amount of gluten which it contains, for milling purposes.

No other known variety of wheat is its equal in this respect.

2. Its constitutional vigor, which enables it to grow and produce a crop of grain even under unfavorable conditions. In years of exceptional drought, when other varieties of wheat shrink and shrivel up under the burning sun and absence of rainfall, the Red Fife grows almost uninjured.
3. Its freedom from the attacks of hurtful fungi. When some older varieties of grain, as seen at the Experimental Farm, Brandon, are so smitten with rust, as to be quite red in appearance, this variety will scarcely be affected. Smut, it is true, is sometimes seen on Red Fife, but it is much less subject to its ravages than the softer varieties of wheat.
4. Its productiveness. Of the large number of varieties of wheat tested at the Experimental Farm, Brandon, Red Fife leads the list for giving the largest yield.

White Fife.—This beardless variety of white wheat is a vigorous grower. It is not subject to rust, and is even more free from smut than Red Fife, to which it is about equal in productiveness. Returns for four years show a difference of about one bushel per acre in favor of Red Fife. While the white variety ripens about the same date as the red, it is said to have a less proportion of gluten, and its white color is against it in the Manitoba market.

Red Fern.—This is a bearded variety, with a dark red berry. It ripens on an average five days earlier

than either White or Red Fife. Its yield is, however, much less; it is more liable to rust, is weaker in the straw, and its dark colored kernel shows the effect of injury by fall frost very plainly.

Ladoga, another variety of bearded wheat, is about ten days earlier than Red Fife. It has fully as large a percentage of gluten, but produces a flour with a slight tinge of yellow, which is objectionable. In addition to being weaker in the straw than either of the varieties of Fife wheat, it is not nearly so great a producer.

There are many other varieties of wheat which might be grown in Manitoba, but the four mentioned are likely to take the lead.

Soil Suitable for Wheat.

The best samples of wheat and the largest crops are produced in Manitoba on strong clay loam lands or on rich sandy loam. An abundant supply of humus is desirable for successful wheat culture. Wheat requires a fine, firm seed-bed, clean culture, and early sowing, as it is not injured by a slight spring frost, and requires more time than any of the cereals to ripen. Its position in a rotation is on "back-setting" as the first crop on new land, or newly plowed rotting sod, directly after summer fallow, or the first crop after field roots.

Sowing.

Wheat should be sown just as early as the land can be worked without clogging. It should be sown by drill, and from one and a-half to one and three-quarter bushels of seed per acre. The sowing ought

to be about one and a-half inches deep in the early part of the season, to two inches deep later on. If sown before the land is dry, especially on clay land, or if sown too deep, germination is delayed, and the crop is injured. Tests have been made of sowing wheat broadcast and plowing it in, but with poor results.

Wheat-harvesting.

To obtain the highest yield, wheat should not be reaped before the heads have turned to a straw color, and before the kernel has become quite firm. As, however, a week's time is very valuable in the harvest season, and is often sufficient to save the crop from injury by frost, experiments were conducted for the purpose of ascertaining whether wheat could not be cut at least a week before being fully ripe. These tests extended over three years, and the result showed that the loss sustained by earlier cutting was very small. The sample was slightly shrunken, which might injure it somewhat on the market, but the good qualities of the wheat were not affected, and the risk from frost was of course lessened.

Wheat should be bound in medium-sized sheaves, and stoked north and south, so as to ripen evenly on each side. As to stacking, it is found from actual test that the quality of grain stacked for a month before threshing is much better than of that threshed from the stook, and there is the additional advantage of less risk from wet weather.

OATS.

The oat crop is, next to wheat, the most important in Manitoba, the last government returns showing that over four hundred thousand acres were sown with this cereal in 1894. Oats can, for convenience, be classed in varieties, according to color as black or white oats; or as to the growth of the grain upon the stalk, those on the side of the stalk as side oats, or those spreading in all directions, as branching. In our Province white oats alone are used for milling purposes, as the people object to the black hull, or any part of it, appearing in the meal. A better price is accordingly paid for varieties suitable for home use. For the farmer, therefore, the white oat will be preferable. As the husk, or the outer shell of the oat, is discarded in the making of oatmeal, thin-husked varieties are preferred. As light weight oats are considered to have a larger proportion of husk than heavier varieties, a plump, heavy oat is the favorite.

The proper position in a rotation for the oat crop is to follow a crop of wheat or turnips. Oats sown after potatoes or on summer fallow, if the soil is rich, are apt to grow too rank, and the crop to become lodged or badly rusted. As this grain is somewhat tender in its first stages of growth, it should not be sown before all danger from severe frost is past, the latter half of May in an average season being about the

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date for the central and southern parts of the Province. Considerable success has been met with in sowing this grain broadcast and plowing it in, but this method is only suitable for the lighter soils. On prairie land the grain is thus buried too deep, and does not sprout for a week or ten days after its time. Drill-sowing is decidedly the best mode of sowing oats, for they are slow to germinate if they are too near the surface. The proper amount of seed will depend largely on the character of the soil, but on rich land two bushels of seed per acre has been found none too much. Oats should be harvested when nearly all of the head is of a straw color. If much delayed, the grain in the upper portion of the head soon falls out, and it will do this if the cutting of the oats is put off until the head from crown to base is fully ripe. It is found also that by cutting the oats a little on the green side the straw is more palatable to cattle, and contains more nutriment.

On the Experimental Farm, Brandon, some hundreds of varieties of oats have been tested, but two or three have proved themselves exceptionally well adapted for this Province. These are as follows:—

1. *Banner Oats*.—This variety was introduced some years ago by Messrs. Vick, the seedsmen. It is a white oat, of medium weight and length of berry, thin in the hull, a vigorous grower, not liable to rust, stiff-strawed, and prolific. The head belongs to the branching variety. The average yield of this oat for some years on summer fallow was eighty-four bushels an acre.

2. *Rosedale Variety*.—This is a half-sided oat; that is to say, not very branching, but not a side oat. It is a white variety, and very prolific.
3. *Black Tartarian Oat*.—Of all the black-hulled oats this is perhaps the best. It has a long, thin berry, either dark brown or jet black; the straw is very coarse and liable to rust, and the grain grows on one side of the head. The Black Tartarian is quite prolific, and the grain is considered excellent for feeding horses, but is unsuitable for making oatmeal.



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BARLEY.

The barley crop, though an important one in the eastern provinces of the Dominion, is one of secondary importance in Manitoba. Although with us not largely in demand for malting, yet barley is excellent for feeding purposes, and the soil and climate of this Province are well adapted for its growth. Barley will grow on lighter land than either wheat or oats, but it will give very large returns on a rich black loam which has not too much clay. This grain requires clean culture, and is often sown after oats in this Province. This is a mistake, and no doubt accounts for the light returns usually given by this crop. It should follow a root crop, or be sown on summer fallow or backsetting. The returns will then be far in excess of those obtained in Ontario. Barley should not be sown on fall plowing, as the soil will have become so dry by seeding time as to delay germination, and thus give the weeds an advantage. The mode of culture found most successful in our Province is to plow the land in the last of May, harrow, and sow with a drill at once. In this way the grain is deposited in the moist soil, and germination is rapid and uniform. The grain also has thus full possession of the land before the weeds can start. The varieties of barley are generally distinguished by the number of rows of grain on the head, according as they are two, four or six-rowed. The two-rowed varieties are in general demand in England for malting purposes, and the six-rowed in America. The two-rowed varieties, as a rule, weigh the

heavier per bushel, but the six-rowed have stronger straw, and for that reason are the more desirable for this country, where we usually have a rank growth. Two-rowed barleys also have varieties, the English two-rowed having a long, narrow head, and the Duck-bill a somewhat shorter head. Six-rowed barley has a very short and wide head.

Of those cultivated in Manitoba three varieties deserve mention :—

1. *Prize Prolific*.—This is a two-rowed English variety. It often weighs fifty-two pounds to the bushel, and is a great producer, having yielded on an average of four years in our Province fifty-nine bushels an acre. One disadvantage of it, however, is that the straw is decidedly weak, especially in a year of average rainfall.
2. *Gold-thorpe*—representing the Duckbill, or American type of two-rowed barley, is an excellent variety in every respect. On trial it has averaged fifty-nine bushels an acre.
3. *Odessa*—which is a short-headed, six-rowed variety, imported from Russia, is perhaps the most prolific and vigorous barley grown in the Province. Besides its great yield, it has a good upright growth.

Harvesting.

Barley should be harvested as soon as the kernel is formed, and before it is discolored by the weather. Discoloring of the grain may be prevented by proper stooking. The sheaves should be stacked just as soon as it is cured, and not left until spoilt by exposure to the weather, as is too often the case in this Province.

PEAS.

This cereal is, as a rule, not much grown in Manitoba. Why this is so, it is rather hard to see. On the Experimental Farm, Brandon, peas have proved a most successful crop. Peas delight in a strong soil, which, however, must be kept completely free from weeds. In the rotation the position found favorable for peas has been directly after root crop or summer fallow. In preparing for a crop of peas, the land is ploughed in spring to a good depth. It is well harrowed and then sown with a drill. The rate of sowing is about two or three bushels to the acre, according to the size of the seed, the larger the size of the grain the more seed being required. The varieties found most suitable to our Province are those with from medium to small-sized grains; the larger Marrowfat peas have not proved prolific. The probable reason for the little attention given by our farmers to peas, is the difficulty, in a country where labor is scarce and expensive, of harvesting the crop. This objection has been quite overcome by sowing together one-sixth oats and five-sixth peas. On growing, the oats support the peas, and the combined crop is readily cut with the binder. It is then stoked and threshed like any other grain.

FLAX.

This grain has been under cultivation in the eastern provinces of the Dominion for several years, but is only now attracting general attention in Manitoba. In the East, flax is grown for the sake of the fibre of the straw, which is converted into linen cloth; but here, the seed only is utilized. It commands a good price for the manufacture of linseed oil. The soil best suited for the growth of flax is a rich and rather strong clay loam. The plant, in the younger stages of its growth, is not vigorous. On this account great care is to be taken not to sow it too early, as an early frost is very damaging to it. Clean culture also is needed for flax, and it grows best on summer fallow, newly broken sod or backsetting. The seed is small, and thirty or forty pounds per acre is thought to be sufficient. Flax seed is sown with a drill, on land which has been harrowed very fine. If this precaution is not taken, the seed being very small will not germinate, if buried too deeply.

The crop is cut as soon as the bolls, or small round pods, are brown. If care is used it can be harvested with the ordinary grain binder, and stooked until cured. It may then be threshed in an ordinary threshing machine like other grain. During the past year the flax on the Experimental Farm, Brandon, produced about twenty-one bushels of seed per acre. On account of wheat being so low priced, flax in this case proved more profitable than wheat.

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TURNIPS.

Although not yet largely grown in Manitoba, field roots are well worthy of our notice. In other parts of the Dominion, where the stock industry has a firm hold, the cultivation of root crops receives much attention. As it is becoming more and more plain that our prairie must devote itself more to "mixed farming," the increase of cattle raising will certainly lead to a much larger production of root crops. This will also result well for agriculture proper, as the growth of a crop of field roots not only produces a large quantity of cattle food, but, if properly treated, the land is freed from a large proportion of its weeds. In consequence of this, the proper place for root crops of all kinds on the rotation is between two grain crops.

There are many varieties of turnips; the best have all sprung from a Swedish source. Of Swedish turnips the Purple Tops are those that have succeeded best on the Experimental Farm, Brandon. The rich, black, sandy loam so prevalent in Manitoba is in every way suited for the growth of turnips. In preparing the land it may be ploughed either in autumn or spring. If ploughed in the autumn it should be done deeply, well harrowed and rolled, so as to retain the moisture in the land. Spring ploughing should be shallower. Only well rotted manure is to be used in preparing for turnips. This should be applied in the previous year, as otherwise, if added in spring, it will dry out the

crop should the rainfall be light. After the soil is thoroughly harrowed the seed is sown about the 20th of May, in drills, on the level, about thirty inches apart. When firmly established, the young plants are thinned to between twelve and fourteen inches apart in the row. Weeds are kept down with horse cultivators during the growing season. Before winter the turnips are pulled, their tops cut off, and the roots stored in a frost-proof cellar. The tops should be gathered and thrown upon the manure heap, as otherwise lying on the fields they afford a shelter for the eggs of moths which produce the cut worms of the following year.



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MANGELS.

These are used principally for milch cows, and as dairying is becoming an important industry in our Province, no doubt more attention will be given to the growth of mangel wurzels. They are excellent for preserving the health of the cows, and for keeping up the flow of milk. In this Province the mangels grow to an enormous size, and the yield is often one thousand bushels an acre. The variety most suitable for our climate is the Long Red Mangel Wurzel. The soil for mangels must be both deep and rich. As the seed requires to be sown early in spring, the land should be prepared in the previous autumn. The seed should be sown here about four pounds to an acre, on the 15th of May, in double drills, on the level, thirty inches apart, and the young plants on being thinned left at from twelve to fourteen inches apart. The treatment of mangels during the season of growth is the same as that of turnips. Being somewhat tender, the mangel roots must be harvested before severe frost.



CARROTS.

Carrots are largely used for horses, and are found very beneficial to them during our long winters. For the growth of carrots the ground is prepared and the seed sown, from two to three pounds to the acre, in the same way as for mangels, except that the drills are only eighteen inches apart. The young plants require thinning by hand, and are left about six inches apart in the row. Carrots are somewhat difficult to gather, on account of their long roots. The labor of gathering can be greatly lessened by plowing a furrow on one side of the drill.

POTATOES.

The potato is one of the most important crops the Manitoba farmer grows. The eatable part of the potato, known as the tuber, is not a root proper, but an underground stem. The rich, black soil of Manitoba is peculiarly favorable to the potato. The plowing for a potato crop should be deep, and the land should be well worked, Barnyard manure, ashes, lime, and plaster are the fertilizers used for potatoes. They should be used in spring, though different soils need different manures. The furrows for planting are made with the plow, about three feet apart, and from four to five inches below the surface soil. Sometimes the "tubers" before plowing are cut into pieces, each piece containing one or more eyes; at other times, when the potatoes are small, they are

planted without being cut. Before the plants appear above the ground a thorough cross harrowing of the field will kill the first crop of weeds, and will also hasten the growth of the plants. The cultivation of the potato field is done by the use of the horse-hoe.

Potatoes are usually dug in Manitoba by the use of plow and harrow; and it should be remembered that they must not be exposed to the weather very long, as sunlight is very injurious to the tuber. Potatoes should be kept in a dark cellar, and the temperature of the cellar ought not to exceed 45°.

The great enemy of the potato is the Colorado beetle. It has become a pest in Ontario, has reached the Maritime provinces of the Dominion and is not unknown in Manitoba. While its ravages in our province have not been extensive, yet it threatens damage, and should be met with promptitude and determination. The great remedy for its destruction is Paris green, an arsenic compound, which can be obtained in our shops. This is a very poisonous substance, and care must be taken not to sprinkle it on any vegetables that are to be eaten. Two ways of applying Paris green have been followed in dealing with potatoes. Twice in the season the potato plants are sprayed with a mixture of Paris green and water in the proportion of one ounce of pure Paris green to ten gallons of water. Some prefer, however, to dust the potato plants with the poison. This is done by mixing one part of Paris green with from eighty to one hundred parts of land plaster or fifty parts of flour. The dusting should be done in the morning while the dew is yet on the plants.

FODDER PLANTS.

In addition to grasses, which are chiefly used for the food of the animals of the farm, there are other plants suitable for feeding the stock upon the farm. Those known as fodder plants are annuals, that is, they require to be sown every year.

(a) *Indian Corn.*

Indian corn is the most important of these in Ontario, and it is gaining ground as a fodder plant in Manitoba. Fodder corn is used green to supplement a scant pasturage in late summer and autumn. It is cured in small stacks and fed to horned cattle during winter. It is one of the best known plants for the production of milk. Every dairy farm should use it. There are many varieties of Indian corn in general cultivation. These vary very much in size and appearance from the native squaw corn of Manitoba, with its ear little longer than one's finger, to the Mammoth, Southern Horse Tooth variety. As unripe corn contains a very large percentage of moisture, only early varieties are suited for Manitoba. In addition to being early any variety suited for this Province should have a fair amount of fodder. A variety called North Dakota Flint Corn has proved with us the best for fodder. The conditions favorable for the

growth of Indian corn are a well-drained and rich sandy loam, and for the best results the field chosen should have a southern slope to allow of full exposure to the sun. The place of corn in a rotation is after a root or barley crop, and its cultivation is often undertaken with the express purpose of cleaning the land from weeds. With proper treatment this can be done as effectually by planting corn as by summer fallowing, and in addition a profitable crop be reaped.

For Indian corn the land is plowed deeply in spring and is well harrowed. The seed is then sown about the 20th of May in drills from thirty-six to forty inches apart, and the plants in the rows from five to nine inches distant from one another. During growth the land is kept clean by harrowing and cultivating. The crop, which can be cut either with a grain binder or corn knife, must be taken off before severe frost.

(b) *Millet.*

This is an annual grass with heads similar in shape to Timothy, but larger. As both seed and plant are rich in qualities useful for food they should not be used alone, but to supplement other classes of food. As millet can be sown after the state of the native hay meadows is known, this crop is useful to supply the lack of a short hay crop. The varieties in general use in Manitoba are

the Common, the German, and the Hungarian, commonly known as Hungarian Grass. The Common is earlier in ripening than the German, and the German than the Hungarian. Indeed, the Hungarian, though the most prolific, is too late in ripening to be of value in Manitoba. The seed of millet is quite small, and should not be buried too deeply in sowing. The land ought to be plowed but a short time before the seed is sown, and should be immediately harrowed and sown if drying out is to be avoided, which would prevent the seed from sprouting.

Millet can be sown from the 20th of May to the 15th of June. For fodder it should be mown before the seed has formed, else the hay will be woody and unsafe to feed.

(c) *Other fodder plants.*

Oats, or oats and peas mixed, when cut just before they are ripe make excellent food for cattle, and are useful, either green or dried, as hay. At this stage of their growth they are very full of sap, and should be bound in small and loose sheaves. If this be not done there is danger of injury from mould at the centre of the sheaf. The best stage at which to cut these fodder plants, in order to gain their full use, is when the uppermost grain of the oats is changing color, both grain and straw being then at their best for this purpose.

GRASSES.

The grasses are invaluable to the agriculturist. Besides supplying hay and pasture for the animals of the farm, grasses form an important part of a good rotation. When plowed up, their decayed roots are available for plant food, and on lands liable to injury from drifting winds they form a mat which prevents the soil from being blown away. The abundance of natural hay throughout the prairies has kept the question of cultivated grasses largely in the background, but in recent years many of the natural hay meadows have failed to give a profitable crop. This, combined with the larger attention given to stock-raising in Manitoba, has made it necessary to cultivate a number of varieties of grass for use as pasture and fodder. At the Experimental Farm, Brandon, a very large number of the grasses grown in the eastern provinces of the Dominion have been tested, but our sharper winters and light rainfall are fatal to a large proportion of them. We shall only deal with those that have proved promising. Grasses are divided up according as they serve for hay alone, for both pasture and hay, or for pasture alone. For hay a grass should be palatable to cattle, and also sufficiently tall to make it profitable for mowing. Pasture grass need not be tall, but should be dense, so as to afford a large quantity of food, and should be sweet and nutritious during a greater part of the growing season.

Timothy (Phleum pratense).

This grass is one of the most largely grown in the province, although even its cultivation is quite limited, and confined chiefly to soils abounding in humus. It is a tall grass with a somewhat coarse stalk and long head. It is found growing wild in some countries, but only on moist and rich vegetable moulds. This makes it unlikely to succeed on light soil. In cultivating it in Manitoba this experience is confirmed, for with us it is only successful on rich lands abounding in moisture. A decided improvement has been noticed in this province in growing Timothy since a smaller quantity of seed to the acre has been used. By this means the number of plants in a given area has been lessened, and the proportion of moisture to each plant increased. Although Timothy cannot be called the best of pasture grasses, yet in a damp season it affords fair pasturage, and remains green long after the native grasses are dried up or ripened.

Austrian Brome Grass (Bromus inermis).

This grass is an importation from Europe and is found growing naturally on the high prairies of Russia. From having been under cultivation for a number of years in Austria it has received its name. Under favorable circumstances it grows as tall as Timothy and has many and abundant leaves. The

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head, unlike that of Timothy, is spreading, with pendant seeds. Though not very fully tested thus far, it seems acceptable to all classes of live stock. Unlike Timothy it thrives on dry light soils, sends out rootlets which take full possession of the ground, and is therefore well adapted for standing a season of drought. It yields a heavy second crop after being cut for hay, and makes good fall pasturage. Timothy and this Brome grass may be said to be the most promising grasses for cultivation on the prairies. We have been unable to find a clover suitable for hay in Manitoba. This is unfortunate, as the clover plant has a very beneficial effect upon soils, and a hardy variety would be most valuable to the province.

In addition to the imported grasses the Experimental Farm, Brandon, has been for several years testing the native grasses of Manitoba. In the autumn of 1888 the seed of about thirty varieties of these grasses was collected from the prairies and from the edges of the scrub land. This seed was sown in small patches in the following spring. About twenty of these sprouted, of which five have proved quite promising. They are all perennials and bear fair crops for at least three years from one sowing. They vary greatly in quality and productiveness, but, as was to have been expected, are all quite hardy.

The three most suited for our wants as hay grasses are as follows :

American Rye Grass (Elymus Americanus).

This is a tall bearded variety of grass, a rank grower, and quite promising for hay, but not for pasture.

Bald Rye Grass (Agropyrum tenerum).

This, as its name implies, has a bald, rye-like head. It is one of the most promising grasses we have for high land, and produces, under favorable conditions, a heavy crop.

Drop-seed Grass (Muhlenbergia glomerata).

This, at first glance resembles Timothy, but on closer inspection the head is found to be compound, or made up of smaller heads. The yield of hay from this variety is small, but the quality is excellent. Like our other native grasses, which either dry up or ripen with the first severe frost, this grass is not suitable for fall pasture, though excellent for summer use.

Of pasture grasses and clover the following may be mentioned :

Canadian Blue Grass (Poa compressa).

This is an imported grass, which is quite short, but grows very thickly on the ground. It has a branching head and a decided bluish green color. It makes good pasturage especially in spring and autumn, when our native grasses are at their worst. It grows very well in central Manitoba, if not eaten down too closely in the autumn.

Hard Fescue Grass (Festuca ovina, var. duriscula).

This is a hardy pasture grass, which we have imported and tested. Its growth is quite different from that of the Canadian Blue Grass, it being taller and much more bunchy. It should not be sown alone, but mixed with other varieties so that all the ground may be occupied.

White Dutch Clover (Trifolium repens).

This plant is rapidly becoming acclimatized in Manitoba, and is already quite hardy if given a very slight protection. It is a short clover, with a spreading habit, useless for hay, but excellent for a mixed pasture, and a good bee plant.

Cultivation of grasses.

As a rule the seeds of grasses are sown with a grain crop in spring. The seed is either mixed with the grain and both sown from the same drill spout, or a separate grass drill is attached to the grain drill. Light seeds have to be sown by the hand broadcast. When sown with a grain crop the young grass plants make very little growth the first year, and if the season is very dry they are killed.

A better plan, and the one becoming more general in this province, is to prepare the land as for summer fallow, and sow the

grass seeds alone during August. The young plants then have full possession of the soil, are not crowded out by the grain crops, and should any weeds come up they are killed by autumn frosts before they have seeded. This plan has been followed at the Experimental Farm, Brandon, and has never failed to give a good crop.



WEEDS.

In our first series, in the Carmen Hill Convention we have a discussion upon the noxious weeds. There, eleven hurtful weeds are mentioned, and the plans taken for their destruction are plainly stated. Every year, however, is bringing to Manitoba new dangers. As seed grain of various kinds is imported from eastern localities, as flower seeds are sent by friends from Britain or from different parts of the Dominion, or even as the seeds of plants in Manitoba are blown by high winds from one part of the Province to another, the farmer finds himself suddenly met with a patch of some new weed, and is called upon to attack and destroy the pest. In many cases he is unsuspecting. This will not do. He must regard any new plant that appears as doubtful, particularly if its rounded or narrow pods, or the pungent taste of its leaves, show it to belong to the mustard family. If bunches of new plants are found upon the farm, especially on the field where new seed has been sown, they should be pulled up with the greatest care and allowed to die. If before the farmer discover the new plants any of them have gone to seed, then they should be taken out without breaking the seed cases and carefully burnt. Do not forget the proverb, "A stitch in time saves nine," and in this case a great many more than nine.

In addition to the noxious weeds mentioned in the

first series, the following, of each of which we give a short description, threaten to become dangerous to Manitoba farmers:—

1. *Tansy Mustard* (*Sisymbrium canescens*).

This plant has the usual features of the mustard family. It is slender, about a foot high, and often having very small white or yellowish flowers. The leaves are twice parted, and the divisions are small and toothed. The pods are in long racemes, oblong or rather club-shaped, but not longer in the cell than the spreading pedicels. The seeds are irregularly in two rows. Closely related to this is *S. incisum*, which is found in the Red River valley.

2. *Worm-seed Mustard* (*Erysimum cheiranthoides*).

This plant is minutely roughish, branching, and slender. The leaves are lanceolate, not clasping, and scarcely toothed. The yellow flowers are small. The pods are small and short, from one-half an inch to an inch long, very obtusely angled, and with ascending or spreading pedicels. Seeds are in a single row, in each cell.

3. *Tumbling Mustard*—*Indian Head Tumble Weed* (*Sisymbrium sinapistrum*).

This troublesome cruciferous plant, which when ripe breaks from the root and is driven over the prairie by the wind, as a tumble-weed,

is from two to four feet high. Its flowers are very small, and pale yellow. The pods are awl-shaped and scarcely stalked. It is an unsightly branched weed, and should be destroyed by being gathered and burnt.

4. *Hedge Mustard (Sisymbrium officinale)*.

This large branching mustard is closely related to the one preceding. It has very small, pale yellow flowers, and awl-shaped pods, which are close pressed to the stem, differing in this from the Tumbling mustard. The leaves of this mustard are closely saw-toothed or cut, the pointed teeth being turned to the base of the leaf, as is also seen in the dandelion leaf. This plant becomes a Tumble weed.

5. *Hare's Ear Mustard (Erysimum orientale)*.

This plant, which is stout, and from one to two feet high, needs careful watching. Its crowded bright orange flowers are large, growing on very short pedicels in the simple, minutely-roughish, hoary stem. The leaves are lanceolate, somewhat toothed; and the pods, nearly erect, are from three to four inches long and exactly four-sided.

6. *Fa'se Flax (Camelina sativa)*.

The name of this plant would lead us to regard it as a dwarf flax; but it belongs to the mustard family. We must be careful to distinguish it from the wild flax, with its

blue flowers, found on our prairies. This plant has small yellow flowers, but its pods are rounded, pear-shaped, and usually notched at the apex. The pods have somewhat the appearance, in their grouping, of the fruit of flax, and hence probably the common name. The leaves are lanceolate and arrow-shaped.

7 *Ball Mustard (Neslia paniculata).*

This is a mustard which is becoming troublesome in Manitoba. The flowers are small and yellow, and have the usual form of the Cruciferae. The fruit is a globular pod, as large as fine shot, but slightly flattened. Each pod is on a pedicel which stands upon the side of the stem. The pods on their pedicels along the stem form a panicle, which distinguishes this species.

8. *Pepper Cress (Lepidium intermedium).*

This plant, commonly known as pepper grass, is quite common in Manitoba. Like the other members of the mustard family it promises to give trouble, and should be destroyed. Its leaves all have a tapering base, the upper being linear or lanceolate, and the lower and even middle leaves being cut in and divided. The flowers are small, white or greenish. The pods, which are roundish, are much flattened, contrary to the narrow partition.

9. *Great Ragweed (Ambrosia trifida)*.

This is a coarse, homely weed, from three to twelve feet high, with opposite lobed or dissected leaves, and inconspicuous greenish flowers. The leaves are large and deeply three-lobed, and the edges are serrate. The plant, which flowers in late summer and autumn, belongs to the Composite order, and has its sterile heads in racemes or spikes. It is becoming troublesome in Manitoba.

10. *False Ragweed (Iva xanthiifolia)*.

A smaller plant than the preceding. The false ragweed has roughish stems, with opposite, doubly-cut leaves. It belongs, like the last, to the Composite order, and has its fruit in paniced spikes. This weed is becoming very abundant in the Red River Valley.

11. *Blue weed (Echium vulgare)*.

This roughly bristled weed grows on an erect stem, mostly simple. It has showy blue flowers, which fade as the plant grows older. Its fruit consists of ripened nutlets.

12. *Stickseed (Echinosperrnum Lappula)*.

An erect, rough, hairy, and grayish herb from one to two feet high. Corollas are small, and from blue to white in color. The fruit is of nutlets, each with a margin of slender, distinct prickles. These prickly seeds are quite troublesome where sheep are grown.

See First Series, "Our Canadian Prairies," pages 84-95. There the names of eleven other noxious weeds are given:—

Common Wild Mustard, French Weed, Shepherd's Purse, Couch Grass, Wild Oats, Black Bindweed, Canada Thistle, Common Tumbleweed, Western Tumbleweed or Pigweed, Common Purslane, and Russian Thistle.

The danger of allowing noxious weeds to grow, and methods of prevention and extermination, are there fully considered.



DISEASES OF CROPS.

No farmer can succeed who is not watchful and intelligent. His growing crops should be the object of constant solicitude. The careless farmer hurries through the work of seeding, pays no attention to his grain fields, and is unaware that the growing plants have enemies, which should be met and destroyed, if possible. First among these we may notice certain plants of a very low order, which grow upon the grain plants as parasites, suck out their sap, and do much damage. Plants of this kind are often known as fungi, or fungous growths. They do not have real flowers, have no proper stamens and pistils, and belong to the division spoken of in our first series as Cryptogams. These plants spread in millions by minute spores, or plant germs, which are carried about in the air, float in the water, lodge in the soil, and are so vigorous that they are ready in warm, moist weather to find a host or entertainer in a plant which affords shelter. These spores of fungi do not not always grow on the same plants. Special spores make hosts of special plants. When the spore finds its proper resting place then it sends out a number of fine threads, which are sometimes called spawn. These threads penetrate the host plants, suck out their juices, and grow with great rapidity. They often enter by the pores or openings on the under side of the leaves of their hosts, and as they grow they form vast numbers of new spores, which

they throw out into the air. It is fortunate that there seem to be provisions of nature for checking these enemies of the crops in their rapid growth. It is only during moist and warm weather that the spores can grow; and it is when there is a rank and unusual growth of the host that they thrive. If the host plants are weak and sickly the parasite then secures a stronger hold. It is thus plain that good farming by drainage, cultivation and proper manuring, making healthier plants and giving a steadier growth, will prepare the crops for resisting these enemies that threaten them. Fortunately for Manitoba, up to the present time there have been few enemies to the crops, but we may count, as the land in places becomes worn out, as importation of seed from the eastern provinces takes place, and as careless farmers allow their plant enemies to thrive, that there will be an increase of the plant-diseases against which we must guard. The most dangerous enemy of the crops at present is the disease known as *smut*. This is simply the growth of a parasitic plant (*Tilletia caries*, or some of its relatives) on the wheat, oats, barley and other kinds of grain. Besides this common smut, known as Hard Smut or Bunt, there is another variety known as Loose Smut.

Smut is propagated by its spores. These do not grow when they are dry, as when we find them among wheat in granaries, but when thrown into the soil they soon spring up. In growing they send out fine threads which penetrate the young wheat plant in the soil. These continue to grow as the plant grows, withdrawing the moisture and sap from the

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plant, and, finding their way to the head of grain, replace the substance of the grain by black powdery dust which has a disagreeable smell. These are the spores of the plant. The replaced grains, now filled with spores, are called smut balls. They are comparatively harmless when unbroken, but when they are opened the spores are scattered abroad. They injure the flour when they are ground up with the wheat, both by making it a darker color and by an unpleasant odor given to it. The Hard Smut does not injure the whole ear, but only some of its grains. Loose Smut, on the other hand, beginning at the bottom of the ear, works its way up, destroying both grain and ear. It is most hurtful to barley and oats. The injury done to grain may be estimated by the fact that the presence of the parasitic spores reduces the price of grain by ten or fifteen cents a bushel. It is said that the loss to farmers in the Northwestern States in 1893 by this pest was one million five hundred thousand dollars. In Manitoba a few years ago the loss was proportionally great, but such general and effectual steps have been taken by our farmers to overcome it that the loss now is comparatively small.

To meet this troublesome disease in the grain the preventive is to sow grain entirely free from the spores of smut. It is true that spores of smut from a previous crop, or carried by the wind from some neighbor's field, may bring this troublesome trespasser where it is not expected.

The farmers of Manitoba have almost without exception made use of a most effectual remedy for smut,

viz., Copper Sulphate, commonly known as bluestone. A solution of this salt is made by dissolving a pound of bluestone in three gallons of water. The liquid is then sprinkled over ten bushels of wheat, care being taken to stir the grain during the operation. Lest unbroken smut balls be left in the grain, which might not be penetrated by the liquid, it is advisable to clean the wheat carefully before treating it. This can be done successfully, as the smut balls, being lighter than the wheat, will readily be blown out. The bluestone preventive for hard smut in wheat is also effectual in destroying loose smut in other grains, but the hull, or outside covering of the kernels of oats and barley, being thicker than that of wheat, these grains have to be dipped in the liquid for a few minutes, the solution in this case being only half as strong as that used for wheat.

The second enemy of the cereal crops is rust. It, like smut, is a fungus parasite (*Puccinia graminis*), which attacks wheat, oats and barley. Instead of being confined to the head of the grain, it is found on the stem and leaves. In color it is reddish, hence the name rust. Early in the season it appears under the form of common rust, but later it reaches a second stage, when it is called black rust or mildew. The spores of this enemy of our grains seem to be always floating about in the air. Should the days in summer be hot and moist these parasites fasten themselves to the leaves of the grain plant. The stalks of grain soon indicate by their color that they are affected, and the erect head shows that the grain is not filling as it should do. When harvest comes it is found that the

heads of the rust-stricken crop are only partially filled, and any grain they may contain is light in weight, and inferior in quality. There is no known remedy for rust, but risk from its attack is lessened by early sowing, and by sowing only those varieties of grain specially free from its attacks. The difference between the several sorts of grain is very great in regard to rusting. In some seasons White Fife Wheat and Banner Oats may be sown nearly free from damage by rust, while close by Gehum Wheat (an East Indian variety) and Black Tartarian Oats are red in color. The plan is followed each year at the Experimental Farm, Brandon, of sowing a plot of wheat each week for six successive weeks, and it has been found that the two last sown are always rusted, while the first four are generally free from injury. Experience shows that early sowing, and the choice of good varieties, are the only preventives of rust. When the crop has been severely affected by rust, it should be cut as soon as possible, as every day it stands makes it of less value.



INSECTS.

Entomology

The study of insects is most interesting. Many persons think an insect is simply an object to be killed, and thus without thought destroy what may be of service to them. It is true that many insects are injurious, but on the other hand many are beneficial. Even when hurtful insects are to be destroyed they should not be tortured. It is said that Nero, the cruel tyrant of Rome, early showed his bad disposition by pulling off the legs and wings of flies. No boy or girl should be cruel in regard to any kind of animal life. Life, if we look upon it aright, is a valuable — yes, a sacred thing. We remember Cowper's lines :

“I would not enter on my list of friends,
 Though graced with polished manners and fine sense,
 Yet lacking sensibility, the man
 That needlessly sets foot upon a worm.”

In the cultivation of fields and gardens it is necessary to know what insects are useful and what are hurtful. The intelligent farmer or gardener will make the matter a study, in order that he may learn how to preserve those which are helpful to him, and find ways of preventing the ravages made upon his crops by insect enemies. If any one doubts the importance of the study of insects let him ponder the fact that in 1857 Canada lost eight millions of dollars through the destructive work of the wheat midge, that the United States in 1884 suffered to the extent

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of four hundred millions of dollars from the ravages of insects, and in 1891 three hundred millions. This shows the importance of the subject of entomology—the scientific name given to the study of insects.

In examining an insect it will be seen to be cut, as the name means, into three parts or divisions. There are head, thorax, and abdomen. Let every scholar examine a fly, or ant, or bee, and see this to be the case. It has also one pair of feelers, three pairs of legs, and usually two pairs of wings. The scholar can see the difference between the three insects named in regard to any of these points. Insects breathe through fine tubes that open to the air and run winding through the body. Many insects have compound eyes, though some have simple. Insects have jointed limbs. Every scholar should look at all these parts of an insect through the magnifying glass. Should any have access to a microscope the parts of a fly or bee are very beautiful and well worth study. Insects have no backbone and are known as invertebrates. They belong to a division Arthropoda, which receives its name from all its members having jointed feet and jointed legs. Insects have many interesting animals among their close relations. Belonging to the Arthropoda, besides the insects, are the crustaceans, which include crabs and lobsters; there are also Myriapoda, the centipedes or hundred-legged worms, and the Arachnida, or spiders and scorpions. A person on looking at any of these can see the jointed character of their limbs. It is very important to notice that among insects there are two distinct kinds of mouths. Beetles, and the young

of other insects, have a biting mouth, with upper and lower jaws shaped for the purpose of masticating, as it is called. Butterflies and the troublesome little plant lice, which destroy our flowers, have a mouth formed for sucking, not for biting. The way in which insects reproduce is a matter of great importance to the farmer or gardener. The insect goes through four stages; and very few know that the grub or worm that does the damage in the field or garden is the same animal in another state as the moth or butterfly. The passing of the insect through these four stages, when it does so, is called its metamorphosis. We must describe these stages. They are an egg, larva, pupa, and full grown insect or imago. Take, if you can find it in the dry ground in summer, the egg sac of a grasshopper. The insect lays this in the ground. It does so by means of a sharp egg placer which is attached to its body, and if you find the egg sac it will be full of a number of little white eggs, like grains of rice. Insects lay their eggs in all sorts of places. Some lay them in the blossoms of flowers, some as before said in the ground, others under leaves or in a place where they may have shelter. When the egg hatches the larva appears. This is a little worm or grub. Its chief object is to grow, and it eats most ravenously. It lives in the larva stage, in most cases, for a few weeks, but its life is one of great damage, especially to the gardener. The next stage is that of the pupa or doll. The little worm for a week or two becomes dull and rests from its destructive work. In some moths the worm or pupa winds itself around with a

web of fine threads called the cocoon. Some insects, such as the grasshopper, do not go through these changes. They are small and wingless, something like what they are to be in their grown state. In these cases the young are called the nymphs. The following represent the names given to the three stages of Larva, Pupa, and Imago, in the different insects mentioned:

	<i>Larva</i>	<i>Pupa</i>	<i>Imago</i>
Borer, Grub.		Pupa.	Beetle.
Maggot.		Pupa.	Fly.
Caterpillar or worm.		Cocoon.	Moth.
Caterpillar or worm.		Chrysalis.	Butterfly.
Nymph.		Nymph.	Grasshopper.

It will be well to know something of different families of insects. It may be noticed that it is very often by the wing that we divide up the insects into these groups:—

1. *Bee and ant family (Hymenoptera).*

wasps It includes also the wasps, saw-flies, gall-flies, and the Ichneumon flies. The Ichneumon fly has many species. It has a long, narrow body, long feelers which have more than sixteen joints, veined wings, and a long, straight egg placer. It is a parasite, and lives on the eggs and pupas of other insects. The Ichneumon flies are thus most valued allies of the farmer, in checking the excessive growth of hurtful insect life. A writer has said: "Without the aid of the Ichneumon flies it would in many cases be impossible for the agriculturist to hold his

own against the ravages of his minute insect foes. Any one who has watched insect life, even in an ordinary garden during summer, can hardly have failed to notice the busy way in which the parent Ichneumon fly, small and four-winged, with constantly vibrating feelers, searches for her prey, as the gardener's friend, and destroys the pupa of the cabbage-butterfly caterpillar."

2. *Beetle family (Coleoptera).*

2 (This is a very large order, having, it is said, no less than eighty thousand species. To it belongs the potato beetle. Some household pests, which destroy furniture and carpets, are very small beetles. The fire-flies, the weevils which are destructive in some countries to the grain, and the ladybirds, friendly to the gardener, as feeding on plant lice, are all found in this family.

3. *House fly family (Diptera).*

3 } These have suctorial mouths, and only two wings. In their larval stage many of them feed on decaying matter. They are thus most useful to man, in destroying what would be hurtful to him. They have been called the scavengers of nature. To this group belong the house fly, as well as the wheat midge and Hessian fly which did so much damage years ago to the crops in the eastern provinces of the Dominion. The

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horn fly, which appeared in Eastern Canada in 1892, and annoys cattle by settling at the base of the horn and sucking the blood from the wounds, may perhaps reach Manitoba. The sheep tick, the horse, ox and sheep bot are four troublesome flies of this order, the first being a degraded form without wings. Here also belong the cabbage maggot and the onion fly, injurious to the plants which have given them their names. Though its place is disputed, the common flea, so great a pest to animals, is classed in this order.

4. *Butterfly family (Lepidoptera).*

This very extensive order contains also the moths. Moths and butterflies, though very beautiful in appearance, when in the larva stage are voracious feeders. They are then called caterpillars, and many of them are especially enemies of the fruit grower and gardener. As fruit growing has not yet reached a very advanced stage in Manitoba we are free from many of these enemies to plant life found in Ontario. However, to this family belong the Cutworms, the most troublesome insect pests of Manitoba. These are the larvæ of the owl or night moths, of which there are said to be about four hundred species in North America. The larva, which when disturbed curls itself up into a ring, is about an inch and a half long, and is known as the cutworm. It is smooth,

naked, and has a greasy looking appearance. The head is shining and sometimes of a different color from the rest of the body. The body color varies, but it is some shade of green, gray, brown or black, the most common in Manitoba being of a dull earth color. The cut worms are chiefly night feeders, lying most of the day hidden just below the surface of the soil. The moths appear in midsummer. Most of them have the front wings of a mottled gray appearance, with some spots; the hind wings are of a much lighter color. The expanded wings measure from one to three inches across. The moth selects as the favorite spot for laying her eggs fields or gardens containing decayed weeds, turnip tops, or other rubbish, or a summer fallow which has been allowed to grow up with weeds. The moth or cut-worm is thus nature's avenger, who visits punishment upon the slovenly or careless farmer or gardener. The cut-worm may be destroyed by baits of cabbage leaves and the like poisoned with Paris green placed near attacked plants. Paris green sprayed upon trees threatened by the "climbing cut-worms" will be successful. The canker worm, which destroys fruit in the Eastern Provinces, the army worm, which in some parts of this continent devours every green thing, such as crops of wheat, oats and grass, and the cabbage worm, all belong to this large and rather injurious family.

5. *Dragon fly family (Neuroptera).*

This is a large and very varied order. To it also belong such different insects as May flies, white ants, lace-winged flies and bird lice. The mouth is of the biting type, and the wings are very full of veins. This order is not very injurious. The bird lice are parasites, which do not suck the blood of their victims, but feed upon the wool or feathers of their hosts. They lay their eggs on the hair and epidermal scales of the animals which they infest. Though in most of their divisions confined to birds, yet there is one species which infests the horse, another the sheep, another cattle, one the dog, and one the hen.

6. *Aphis fly family (Hemiptera).*

This is largely a degraded family. The larva and pupa do not differ much from the full-grown insect, though in some cases the imago is winged. The mouth is suctorial. In one subdivision of the family the insects are entirely wingless, and live as parasites by sucking the blood of other animals. To this family belong the black flies and mosquitoes, as well as the Aphidae, or plant lice, and the scale insects. The plant lice are greatly sought for by ants. The cunning ants are said even to carry the Aphidae to their nests and keep them there to supply the sweet liquid, and thus have them, as we do cows

to supply milk. In this group is also found the Phylloxera, which has done such damage to vineyards in Europe, and the red cochineal insect of Mexico, which supplies the carmine dye. The musical Cicada is found here, and the vast number of insects known as bugs are also included. These include the chinch-bug, which has done such harm to the crops in the Western States, the squash-bug, with its offensive odor, and the bed-bug, the plague of careless housekeepers. Under this order are also placed the disgusting lice, which are increased by the filthy habits of those infested by them, or by association with people of dirty and slovenly modes of life.

7. *The grasshopper family (Orthoptera).*

In the insects of this order the first pair of wings are straight, narrow and thickened, while the second, folded like a fan, are papery. They do not pass through the four stages of development, and their mouths are of the biting type. Locusts, crickets, cockroaches and springtails belong here. Though Manitoba has had no grasshopper plague since 1876, yet old residents can remember the enormous damage done by the grasshoppers or more correctly locusts, for several years before that date. During the present century the locusts have come at intervals some half a dozen times. The species which

attacked Manitoba was *Caloptenus spretus*. Some parts of our territory also suffered from the Rocky Mountain locust. Bred in the arid regions of Utah and the desert of the far western American States, the locusts came in clouds northeastward. They were so dense in their flight that they darkened the sun. If a cloud came between them and the sun, they descended pell-mell and occupied the prairies or scattered grain fields. They then voraciously devoured the crops. After this they deposited their eggs in bare spots on the prairie, and in the following spring the ground seemed to vomit up myriads of tiny grasshoppers. These minute creatures would in hordes enter the fields of grain, while yet in the blade, and devour every plant, leaving the green field in a few hours an expanse of bare, black soil. Farmers sought, by digging trenches, by introducing machines spread over with tar, and by other means, to check their ravages, but it was almost unavailing. For nearly twenty years there has been no return of the locust to Manitoba. This, along with the fact that the extent of cultivated land has vastly increased, leads to the hope that we may not be visited again by this troublesome pest. There is a native grasshopper, which ordinarily does no great amount of damage to the crops.

The following are popular ways of classifying insects :—

A. ACCORDING TO USEFULNESS.

1. *Beneficial.* The bee (honey); silkworm (silk); cochineal (dye); ichneumon fly (feeds on hurtful insects).
2. *Noxious.* Those affecting products of the field (midge, chinch-bug, potato beetle, etc.).
3. *Neutral.* Those neither injurious nor beneficial (firefly, cricket, ant).

B. ACCORDING TO THEIR MODE OF INJURY.

1. External feeders, such as Caterpillars, etc.
2. Internal feeders, - " Borers, etc.
3. Underground feeders " Cut Worms.
4. Granary pests, - - " Pea-weevils, etc.
5. Household pests, - " Flies, etc.
6. Parasites upon domestic animals, such as Fleas, Lice, etc.

The remedies for meeting injurious insects may be noted :—

1. Use of insecticides, such as Paris green and kerosene emulsion (a mixture of soap, coal oil and water).
2. Poisonous gas, generated in tents placed over shrubs and trees affected by scale insects.
3. Entrapping the insects.
4. Using barriers to check the progress of the injurious insects, such as chinch-bugs, army worms, grasshoppers, and the like.
5. Protection of insect-destroying birds and beneficial insects.

6. Using parasites, which cause insects to become diseased, such as certain bacteria that may be scattered among the insects to be destroyed.
7. Agricultural remedies, such as rotation of crops, varying the time of sowing, using good seed, using fertilizers; cleanliness in fields, *i.e.*, removing of rubbish and drainage; and summer fallowing.

As to the precise way of meeting special insects, and applying the poisons, we refer any who may wish further information to the work, "Insect Foes," by Professor Panton, of the Agricultural College, Guelph, Ontario. We are indebted to Professor Panton for suggestions in this sketch.

We would advise teachers and scholars to make a collection of the insects of Manitoba. Our moths are especially beautiful. If possible, the larva and pupa stages should be preserved as well as the full-grown insect. To those teachers who wish full information as to how to collect, prepare and mount insects for this purpose, we recommend a little work, "Entomology for Beginners," by A. S. Packard, published by Henry Holt & Co., New York.



BIRDS.

Birds rank along with flowers as among the beautiful things in nature. Birds are also of much importance in the economy of nature. By the farmer, as is well known, the robins, blackbirds, ricebirds and crows, along with others, are regarded as injurious to his growing crops. It is easy, however, to make mistakes in this matter. Many birds supposed to be altogether injurious devour great numbers of hurtful insects, and are thus the farmer's friends. Certain birds destructive in some places and at certain seasons are harmless under other circumstances. The ricebird, sometimes called the bobolink, comes to Manitoba and is welcomed; in the Southern States it does a damage to the rice crop of over a million dollars a year. The crow, which is so troublesome in the Indian corn field, and to drive away which scarecrows must be erected, when the season advances becomes the farmer's best friend in destroying large numbers of cut-worms. Among the birds against which boys think it right to wage war are the hawks and owls; and yet it is coming to be seen, especially on our prairie farms, that these are very helpful to the farmer.

In order that we may see the uses of birds, we shall describe the different divisions of birds, and name those valuable to us. Much difference of opinion exists as to how to classify birds. We follow the older classification, as being simple and more convenient.

1. BIRDS OF PREY (*Raptores*).

These include owls among night birds, and falcons, eagles and hawks among the day birds. Owls hunt in the early hours of evening and early morning. They are almost entirely beneficial to the farmer, killing little else than vermin. Owls destroy rabbits, squirrels and various species of mice. They feed on frogs and cray fish also. Some of them devour grasshoppers, beetles and crickets. Hawks do the work during the day that owls do in the morning and evening. They eat mice, birds, snakes, frogs, fish, grasshoppers, crickets, centipedes, spiders, earthworms and snails. This is surely a diet sufficiently varied. Both hawks and owls are very fond of the gophers or ground squirrels which are so great a pest to the farmer's crops on our high prairies. In some parts of Manitoba and the North-West Territories, in dry years, the gophers make agriculture well nigh impossible. It is well, then, to save the hawks and owls, though some species of the former may take an occasional chicken or duckling.

2. PERCHING BIRDS.

These include the great mass of our birds. The singing birds almost without exception are perchers. Though not very scientific, for convenience we have divided the perching birds into four divisions, according to the shape of their beaks :

(a) *Coni-rostris*.—These are birds having cone-shaped, strong beaks, which are very useful for crushing hard seeds. To these belong the crows, finches, starlings, larks, buntings, linnets, sparrow, canaries and grosbeaks.

Though his relative the raven is a great robber, the common crow, while an occasional wrong-doer, yet destroys great numbers of mice, grubs, caterpillars and grasshoppers, as well as carrion. Almost all the birds of this division are useful in destroying insects.

(b) *Denti-rostris*.—These all have toothed beaks, which is a proof of their loving an insect food. Besides being a large division, this group contains the farmer's most valued assistants in destroying insect life. We may mention a few of the individual birds of this division best known in Manitoba :

Kingbird.—This bird is known as the tyrant. It is blackish above, darker on the head ; crown has a flame-colored patch : below, it is pure white : breast is of a leaden color, wings dusky and tail black. A bird collector examined the stomachs of twelve kingbirds and found as follows : "Four had each eaten seven beetles ; four, four dragon flies ; one, a bee ; one, six crane-flies ; one, a large moth ; one, a butterfly, and three a few raspberries." Surely no farmer will allow a kingbird to be destroyed. This bird is a very common summer resident of Manitoba wherever there are trees.

Catbird.—This bird is worthy of notice. It is dark slate color; crown of head and tail black; about eight inches long. Though it has some fine notes, it seems, being a close relative of the mocking-bird, to imitate the cat. This has raised a prejudice against the bird. That it deserves protection is seen in the remark: "In the garden it is one of our best friends, destroying a very great number of injurious insects." But for its cat-call this bird would take first rank among our songsters. It is a well known summer resident of Manitoba.

American Redstart—This is a common inhabitant of the woods and thickets of Manitoba during summer. It is lustrous blue black; belly white, sides of the breast, etc., fiery orange, the female having the flame color of the male turned to yellow. Its length is about five inches. It destroys great numbers of flies.

Wilson's Thrush.—This bird, which is found in summer in Manitoba, is one of the great number of thrushes, to which also our American robin belongs. Wilson's thrush is a clear yellow olive; crown, glossy blue black. It is between four and five inches long. Its song is a high-whistle, somewhat like "Veery, veery, veery." Its food is largely insects.

Blue Birds, Fly Catchers, Orioles and Black Birds all belong to this division. The black birds are especially trying to the farmer in his ripening grain fields; but this whole group

of birds are worthy of the farmer's attention, and should be preserved.

(c) *Fissi-rostres*.—These are birds with gaping beaks. Three examples of them are well known to us in Manitoba, and are of service to the farmers as insect destroyers. These are the night-hawks, whip-poor-wills, and swallows.

Night-hawk.—This bird needs no description. We are all familiar with its swimming, darting, and crossing from side to side in the evening. Its rapid motion and gaping mouth are full of danger for the moth or other insect.

Whip-poor-will.—Though very hard to be seen, yet its cry is well known. It resembles the night-hawk, and it is a deadly enemy to insect life.

Swallows.—Swallows of different kinds are well known by their manner of flight. Our common house swallows become somewhat troublesome in their persistence in building under the eaves of barns and dwellings. An examination of the gizzard of one shot in Manitoba "showed it to contain, besides flies, a large number of water beetles." The uses of the swallow are well shown by this examination.

(d) *Tenui-rostres*.—Birds of this division are known by their slender beaks. Humming birds, creepers and wrens are here included. The wrens are brownish, about five inches long, and though so small are noted for their

"hopeful sprightliness," and indeed are said to have "scolding propensities." The Western House Wrens are abundant in Manitoba. They are useful birds, however, for as one has said, "they are industrious insect hunters, prying into many out-of-the-way corners, which no other bird would stop to examine."

3. CLIMBERS (*Scansores*.)

To this division belong parrots, woodpeckers and cuckoos. The woodpeckers of many different species are well known by their bright colors and climbing habits. While some of the woodpeckers take insects on the wing or from the bark of trees, and others of terrestrial habit find their food in ant-hills, the general habit of the family is to obtain the insect larvæ by extracting them from rotten trees. One woodpecker's gizzard examined was full of black ants, another of wood ants, while a third examined in Manitoba contained the following: eight larvæ of a spruce borer, five larvæ of another species of the same, five larvæ of a pine borer, one larva of a moth, one other larva, and a small quantity of wood. Boys should certainly not shoot woodpeckers.

4. SCRATCHERS (*Rasores*.)

This large class contains two main divisions. The first of these is the pigeons. The wild pigeon is found to some extent in Manitoba, and in former days came in great numbers. It is supposed to be the wood pigeon, from

which all the varieties of pigeons kept by us have descended. It is said that tame pigeons turned back into a state of nature will in the course of time return to the form of the wild pigeon again. The wild pigeon lives on nuts, berries and seeds, and when these become scarce it disappears with them. The other portion of the class is called the Gallinaceous or poultry division. To this belong our domestic fowls, including hens, peacocks and turkeys. These will be treated of elsewhere. Here also we find pheasants and partridges.

The pheasant is not found in Manitoba or the Northwest Territories, but in British Columbia the English Pheasant has taken hold and fine specimens have been brought to the eastern side of the Rocky Mountains. The common partridge or gray Ruffed Grouse is common in the woods and bluffs of Manitoba. It lives on catkins, horsetail tops, rose pips and the like. Its drumming noise and whirring flight are well known to sportsmen.

Manitobans are, however, proud of their prairie chickens. Few of our people know that there are two distinct species of these—one native and the other a recent intruder. The native prairie chicken or sharp-tailed grouse (*Pedicoetes phasianellus*) has a crest of narrow feathers, and a bare space on each side of the neck; the tail is short, of sixteen feathers, the two middle projecting an inch beyond the rest. The prairie chickens have the strange habit of

meeting at gray dawn in companies of from six to twenty and indulging in what is called "the dance." The food of this native bird is largely rose pips, but it also adds grass, berries, and now and then grasshoppers. It is quite omnivorous, eating insects, leaves, grain, and fruit—though the rose pip is the staple. As the country settles up, its food becomes scarce, and we are sorry to say that our prairie chicken is dying out.

The intruder which is taking the place of the prairie chicken is more commonly known as the prairie hen or pinnated grouse (*Tympanuchus Americanus*). It has on each side of the neck the long pointed feathers which give the name to the species. The intrusion of this grouse into the North-West is somewhat remarkable. Little more than twenty years ago, according to Dr. Coues, the great authority on birds, the prairie hen, though then so abundant in the prairies of Illinois, was not known in Minnesota and Dakota. The first record of its appearance in Manitoba is in 1881. Since that time it has greatly increased, spreading from the neighborhood of Winnipeg to Portage la Prairie and other points in the province. The explanation of this intrusion is the spreading of agriculture in the North-West. The prairie hens are evidently following the grain fields, in which they delight. In the autumn they frequent the stubble fields. They do not take to the woods in winter, as the native

prairie chicken does, but find shelter in the willow bushes and scrub. It seems likely that they will entirely replace the sharp-tailed grouse.

5. RUNNERS (*Cursores*).

To this division belong ostriches and a number of extinct birds, which are foreign to Manitoba, and so do not concern us in our present studies.

6. WADERS (*Grallatores*).

In this class we find a large collection of wading birds of very different habits. These are plovers, cranes, herons, snipes, sandpipers, and rails. Many of them, besides being vegetable feeders, are also fond of insects, and may be looked upon as friends of the farmer.

7. SWIMMERS (*Natatores*).

In this large and very interesting family are the geese, ducks, divers, gulls, pelicans and swans. These migratory birds are of great use for food, and add interest to life in the remote or secluded districts to which the sportsman goes. The common wild or Canada gray goose is known in all parts of the prairies, and often breeds along our lakes and rivers. More common than the Canada goose, however, are the snow geese or white waxies. They are seen in large numbers in Manitoba in the spring on their northern migration. They usually remain two or three weeks on the gravel ridges, to "take in sand" and food before proceeding

to their more northerly hatching grounds. On their return in the autumn they generally pass us without resting. All the goose family are feeders on insects and shell fish as well as on vegetable food. As to ducks, Manitoba is the sportsman's paradise. Our lakes and ponds are their breeding places. Our commonest species are the mallard, with head and neck green, succeeded by a white ring; the green-winged teal, with head and upper neck chestnut and a glossy green band on each side, and rich green wings; the blue-winged teal, with head and neck of a blackish lead color, and wings sky blue; the bald-pate or widgeon, with bill and feet grayish blue and top of the head whitish, belly pure white; also the shoveller and pintail, recognized by the facts embodied in their names: besides, we have the blue-bills. The above may be taken as our best known wild ducks, though there are many other species found at times. Pelicans, with their large yellow sacs, are well known in Manitoba; and Shoal Lake, east of Lake Manitoba, was formerly a great breeding ground for them. The whistling and trumpeter swan are also found, though not abundantly. All the swimming birds may be looked upon by the farmer as his friends, as all destroy greater or smaller numbers of insects.

We have said enough in our sketch of birds to show that they should be protected. Admitting that some of them may invade at times the barnyard or the

grain field, yet as insect destroyers they deserve our gratitude. Birds should be preserved by strong laws passed in their favor. Not only should it be a penal offence to shoot geese, ducks and prairie chickens out of season, but when birds which are not killed for food are shot either by boys or men there should be a heavy fine. As Manitoba becomes older the insects not now found here will come in from the eastern provinces. It will thus be the path of wisdom to encourage the birds, so that they may be the defence of our grain fields, gardens and orchards, even though they take a small toll from us for their services.



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ANIMAL HUSBANDRY

At the present time the greater portion of our population in Manitoba lives by the production of the one product for which the province has become justly famous, No. 1 Hard Wheat. But we cannot continue to export this cereal without exhausting our wonderfully rich prairie soil. For instance, it is estimated that one ton of wheat contains seven dollars' worth of fertilizing elements, that is to say, that a farmer selling ten dollars' worth of wheat disposes of about two and a half dollars' worth of the fertility of the soil, which is his capital. Now in contrast to this it is said that cattle, reared on the farm and sold, would not carry off quite half as much of the strength of the soil as wheat, swine still less, while the same value of butter contains scarcely a trace of the fertile part of the soil. Prof. Robertson declares that it would take over one hundred tons of butter at four hundred dollars a ton to carry off from the soil as much of its fertile elements as one ton of wheat.

The permanent success of agriculture in this country, as in every other, must depend on Farm Stock or Animal Husbandry. We must produce animals to convert the by-products, such as straw, bran, oil cake, etc., and the coarse grains and fodders into more concentrated and marketable forms. By so doing we will not only have left upon the farm, in the shape of barnyard manure, the elements most necessary for keeping up the strength of the soil, but will reduce

transportation to a low figure, and enable the farmer to reach a more profitable market with his produce.

In wheat growing we place ourselves in competition with the least skilled laborers in the world, such as the natives of India and the serfs of Russia, who can live on the poorest diet and exist with the scantiest clothing. With them we can hardly hope to compete. In the production of butter, cheese, bacon, etc., on the other hand, which requires education and skill, we come into competition only with the more advanced nations of the world. Agriculture—especially the care of farm animals—unlike some professions and trades admits of no set rules being laid to be learned in a given time. Knowledge of the subject must be gained little by little. Those who take to farming late in life seldom become good judges of animals; the most successful cultivators of Animal Husbandry are those who have been trained to it from infancy. A high authority has said: "A proper knowledge of the habits and treatment of the animals of the farm is without doubt the most important part of a farmer's education." We may add that while it is the most important and most difficult part, it is to many by far the most interesting. If it is true that upon Animal Husbandry depends the permanent success of agriculture, it is further true *that pure bred stock is the basis of live stock husbandry*. The chief ground for this statement is that unimproved stock has not the power to make the most economical use of the food and care bestowed upon it. For example a common ox will consume more food and take a longer time to attain a good weight than a well-bred

animal will do, and then will not yield so valuable a carcass, not having an equal amount of meat on the more desirable parts. Take a common pig and one that is well bred. Place them in separate pens, side by side under similar conditions, and feed them exactly the same quantity and quality of food. The common pig will still be poor and greedy, when the pure bred is ready for the butcher.



BREEDING.

It is a most important part of the farmer's work to place and continue the very best breed of animals on the farm. A few dollars saved in getting a poor or ill-bred animal is in the end a loss. The farmer's herd will depend for years to come on the animals he procures from which to breed, and a low-priced animal is generally one of poor quality. The reason for great care in selecting breeding animals is seen in the first important law laid down by the breeder: "Like produces like," which William Warfield, an authority on "Cattle Breeding," calls "the pole star of the breeder's career." The resemblance of the members of a family to each other is a constant reminder of this maxim. The doctrine of heredity, as laid down by Darwin, is the "perpetuation of like characteristics in parents and offspring."

There is, however, a powerful law which seems to work in a contrary direction. This is that of variation or spontaneity, by which each animal seems to develop peculiarities of its own—characteristics not possessed by parents or ancestors. For instance, by heredity a flock of Southdown sheep very much resemble one another, while by variation each sheep has some peculiarity of its own; and while one unaccustomed to sheep might think all sheep exactly alike, the shepherd knows them one by one. Heredity is found to be a stronger force among pure breeds, or in the

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species of animals still in a state of nature, as for example, the deer. Variation is stronger among the unimproved classes or mongrels of our domestic animals.

The tendency of an animal to revert to type, that is to show peculiarities which its parents did not possess, but which belonged to its line generations before, is called Atavism. It is most common among cross bred animals, or classes made up of one or more breeds of unlike characteristics. An instance of this is seen in the dark or smutted nose which occasionally occurs in short-horn cattle, the ordinary color of the nose being a deep orange. This strange variation is said to be a reversion to a Galloway cross made years ago. The reversion to type seems to show how strong the law of heredity is. The environment—that is, all the circumstances by which an animal is surrounded—has a constant influence upon its development. The food, care, shelter, climate and treatment modify and change animals greatly. On the rich pastures of a level plain, favored by a mild climate, animals will develop great size and strength; whereas, on bleak, rugged, mountainous pastures, exposed to severe temperatures, size will diminish, but the animal will become hardy and vigorous. The massive English cart horse is a native of the midland counties, while the diminutive ponies of Shetland, probably descended from the same stock as the cart horse, are found on the bleak hillsides of the northern islands of Scotland.

Animal forms are much modified to fit the conditions in which the individual must live. In the race horse,

reared in plenty, we have an outward conformation which indicates speed, endurance and courage, a fine clear cut head with wide forehead, prominent intelligent eye, expansive chest, light barrel, strong back, powerful quarters, hard muscles, straight and long legs with stylish carriage. The race horse is an example of what care and training can do for an animal. On the other hand, in our shagganapi, or Indian pony, we see the big, ill-shaped head, small eye, narrow chest, ugly form, hollow back and crooked legs, as the result of hardship and neglect. In such a climate as that of Manitoba, if we are to maintain the high character of the different breeds of animals, there must be the greatest care to have a good environment for our stock.

Pure bred animals are those which possess certain well defined distinctive characters, and which have been bred from a well selected line for several generations back. The longer any animal has been bred pure the greater will be the power to transmit its characteristics to its offspring. This power is called prepotency, and a thorough knowledge of this force is of use to the breeder. Herd book, stud book, stock book or record, are terms variously applied according to the variety of animal to which they pertain, and are records of the breeding, genealogical tables, or, as we call them, pedigrees, of the individuals included in a breed. While in man genealogies trace back on the father's side, in animals they are followed along the female line.

Very few men have the necessary knowledge, skill, patience and perseverance to become successful

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breeders of pure bred stock. In almost every case it has been the genius of a man here and there that has developed and fixed the improved qualities of the breed of his fancy. While this is true, yet every farmer may, by care in obtaining well bred animals and by having a fixed purpose, accomplish much. First, he must make up his mind what he wants to breed, fix an ideal in his mind and not rest quite satisfied until he has reached his ideal. He will take advantage of the laws of heredity and the power of prepotency, by using only pure bred males of desired types, remembering always that defects are as surely transmitted as good qualities. He must employ the process of selection by "weeding out" all animals having hereditary defects or poor qualities. A pedigree alone is not a sufficient warrant for the use of an animal. An inferior individual, or one of weak constitution, should never be used for breeding purposes, no matter how good a pedigree it may have. For obtaining the best results, breeding animals should have shelter sufficient to provide warmth and comfort, pure air, abundance of wholesome, nutritious food, and a never-failing supply of pure water.

A few terms are used in connection with the breeding of animals, which it is well to understand. The term Pure Bred is applied to all animals a record of whose breeding or pedigrees is kept by a responsible association formed for the purpose. The name Thoroughbred is frequently used with the same meaning as pure bred, but should be reserved as the title for the purest bred of all our domestic animals, namely, the English thoroughbred or race-horse.

Cross bred refers to the progeny of two or more pure breeds. Grade is the term applied to animals produced from common stock on one side and pure stock on the other. Mongrel is a mixture of several breeds. Scrub is a name which refers to the fact that an animal has no good points. One of our local writers says: "The scrub animal is too well known to need any definition; we have him, like the poor, with us always."



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FEEDING OF FARM STOCK.

We have already seen that the bodies of animals and the stems, leaves and roots of plants are made up of almost exactly the same elements. It is the function of plants to absorb the inorganic matter from the soil and air, and convert it into organized vegetable structure. The animal then makes use of the vegetable tissue as food, and will in consequence be largely built up of the same substances. Food for plants thus requires to contain all the elements of which the plant is composed; and in like manner food for animals must supply what goes to make up the animal body. The animal body consists of four principal substances: water, ash, fat, and nitrogenous matter. These exist in different proportions according to the age of the animal, and use for which it is kept. Water, an essential part of the animal economy, constitutes from forty to sixty per cent. of the whole. The ash, or mineral ingredient, only makes up four per cent., and occurs mainly in the bones. Fat and carbohydrates, chiefly composed of carbon, hydrogen and oxygen, include starch, sugar, etc. The supply of fat varies greatly in quantity, and is consumed in furnishing heat and energy for the body. The proteids or flesh formers are as we have seen, nitrogenous, that is, contain nitrogen in addition to the three elements found in carbohydrates. The proteids enter largely into the composition of the

muscles, tendons, nerves, horns, hair, wool, blood, and the albumen of the body.

As food contains these different elements in varying proportions, the importance of studying the composition of foods in order to provide the animal with the proper material for its maintenance is apparent. For example, wheat straw, which contains only three per cent. of protein would not be suitable food to feed a race horse; nor would a diet of turnips, which are made up of eighty per cent. of water, rapidly fatten an ox. That food supplied to animals should be palatable and easily digested is also of importance in economic feeding. A rich June pasture composed of a variety of grasses may be taken as a perfect ration, providing all the elements necessary to build up the frame of growing animals and to produce milk, beef, or mutton of the best qualities. Analyses have been made and exact tables prepared of food stuffs now in use for the purpose of fixing on a *perfect* ration for winter feeding of animals, which will produce the best results, at the least cost. To obtain such a ration, varying with the seasons and with the market values, is a difficult though important undertaking.



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FOODS.

We may next examine the foods which best suit our farm stock in Manitoba. Hay—dried grass—whether wild prairie grass or cultivated varieties, when cut at the proper time, and well cured, without being bleached by the weather, contains almost as much nourishment as the green grass, and ought to form a large and important part of the ration of horses, cattle and sheep. Oats, when cut on the green side and gathered in sheaves, make good food for horses not doing heavy work, and for cattle and sheep. Wheat straw, though very deficient in nutrient and unpalatable and indigestible when fed alone, can be used with advantage along with ensilage or roots, which aid in digestion, while the addition of concentrated foods, such as chopped wheat or oats will supply necessary fat and heat.

All the straw produced on a farm should be used either as food or bedding, so that the fertilizing elements contained in it may be returned to the soil. Ensilage is fodder preserved in a succulent state in a silo. A silo is an air-tight box of less than nine feet by nine, with a depth of twenty feet. Into this, green corn or other fodders, after being run through a cutting box, are placed. Fermentation takes place, and as it is within the close box where there is a limited quantity of air the ensilage turns out sweet and sappy, though slightly browned by the fermentation. All farm animals relish it. It contains from seventy to eighty per cent. of water, and is no doubt

the cheapest and best succulent food for cattle that can be produced in this country. Turnips, mangels, sugar beets, and carrots are exceedingly useful as juicy food, aiding the digestion and assimilation of other foods. They also keep the blood cool, increase the appetite, and assist the animal to consume larger quantities of concentrated food. Grains—barley, oats, and wheat—whenever cheap enough, make excellent food for farm stock. It is better to crush all grains fed, and to feed dry. Crushing the grain destroys many weed seeds, which might otherwise pass through the animal system uninjured and be carried out to the fields again in manure.

Peas and corn are not yet grown in Manitoba in sufficient quantities to need consideration, though no doubt their use will increase. Flax seed is being now grown quite largely in Manitoba. In small quantities, ground or boiled as a jelly, it is very useful as a tonic or regulator. Flax seed is very rich in carbohydrates or in fat and heat producing elements. Of by-products we have already spoken of straw. Bran, the outside skin of the wheat grain, is very rich in ash, protein, and fat-producing elements. It is one of the most useful of foods for young stock, developing frame and muscle. Shorts, the inner skin of wheat, is a rich food suitable for milch cows and pigs. Linseed cake, the residue left when the oil is extracted from flaxseed, is very rich in protein. Only small quantities of this highly concentrated food can be put in the ration. In Britain the manure from stock highly fed on this oil cake is said to be worth as much per ton as the original cost of the cake.

MANAGEMENT OF STOCK.

(a) Horses.

Breeding stock, in order that its offspring may be strong and vigorous, should have plenty of exercise. In winter the brood mare should be steadily worked, or allowed to run out some hours each day, care being taken that she has no heavy snow drifts to flounder through. The food of breeding animals should be nourishing and wholesome, and free from dust. Hay and oats is the regulation diet for the horse, but oat sheaves or cut straw mixed with a little ensilage and chopped oats makes good food. Bran is always good, either dry or in mash as occasion demands; and as variety is beneficial chopped wheat or barley may also be fed in smaller rations. On account of its small stomach it is important that the horse should be watered before being fed. A horse when heated should never be allowed to drink cold well water until after being cooled off. A lump of rock salt is a useful thing to have constantly kept in the manger. Attention should be given the colt's feet; they ought to be kept trimmed in proper shape. Colts should be halter-broken while young, and in being trained to harness they should be handled with gentleness, firmness and patience.

(b) Cattle.

Nature intended the cow to suckle her calf.

In many of the beef breeds this plan is followed, and without doubt when the calf is to be slaughtered for veal it is the best way. For general purpose cattle, however, the cow is milked by hand, and the calf "raised on the pail." In this case, several times a day for the first two weeks of its life, the calf should be fed on whole warm milk, for the next four weeks skim milk may be added in a gradually increasing quantity, until skim milk alone is used. Care should be taken to see that the pails and vessels from which the calf is fed are properly rinsed out and scoured clean from any impurity. Sometimes putrifying remnants of food are allowed to remain on pails from which young animals are being fed, and disease and death at times ensue.

If a heifer calf is intended for the dairy, she should be kept growing steadily, but not allowed to get very fat, as this is a habit not desirable for dairy purposes. On the other hand, if young cattle are intended for beef they should be kept fat and forced along till ready for the block at two or three years old. Experience shows that in rearing calves there is greatest success when they are given a large empty stable, kept airy and sweet, away from the flies, scorching sun or drenching rain. It is well to feed them, as soon as they will take such food, a little sweet hay and some chopped

*(c)**(d)*

oats. This plan is preferable to allowing them to run out upon the grass. In winter, cows should be fed three times a day at regular intervals and watered twice, care being taken that the water is pure. Salt should always be within reach. The cows should be kept quiet and as comfortable as possible, and always be gently handled. They ought never to be dogged or run home from pasture. Boys sometimes thoughtlessly do much damage to cattle by rough treatment.

(c) *Sheep.*

These useful farm animals stand the cold well, and ought to be provided with roomy, well-ventilated sheds, in and out of which they can go at pleasure. They will thrive on chaff piles, but need sheaf-oats or a little bright hay near spring. Sheep require a considerable attention at lambing time. With this exception they are managed with less labor and care than any other farm stock. Their fleeces are shorn off in April or May, and at that time they are treated to a bath in some of the insect destroying compounds.

For fattening—any of the concentrated foods are useful, and roots, which are very palatable to sheep, are of much service. Salt should always be available.

(d) *Swine.*

Swine have a very voracious appetite, and can consume any kind of food. It is, however, a

mistake to suppose that swine can thrive unless they have good, nutritious food. Nothing is so good as milk for the little pigs. By the time the young are eight weeks old they must be supplied with other food. Skim milk, with the addition of a little shorts or meal, may form the main ration, with grass, weeds, house refuse, etc. Care should be taken that pigs are not forced to eat very sour decomposing swill. The pig is urged to eat until it weighs about two hundred pounds at six or eight months old, when it may be killed for use. Breeding stock is kept on less fattening food, and in order that it may not become too fat, is given a good deal of exercise. Sheaf-wheat or whole grain scattered on clean ground causes swine to hunt for food. Roots, such as mangels and sugar beets, are much relished, and may well form a considerable portion of the winter ration. In winter, pigs must be kept dry. Dryness is more important than warmth, for while a pig can endure a good deal of cold it will suffer if compelled to live in a damp atmosphere. If properly housed and treated a hog is not nearly so filthy an animal as he is reputed to be. If provided with a sleeping apartment and a clean bed swine will take great pains in keeping it orderly and clean. One thing, however, the pig cannot resist, that is to wallow in the mire, and the filthier and more sticky the pool the better.

(e) Poultry.

While this department of animal husbandry is probably the most neglected on the average farm, it is capable of being made one of the most interesting, and very much the most profitable for the capital invested. On most farms in Manitoba the care of the poultry is left with the women-folk, it being generally considered beneath the dignity of the men to deal with such insignificant things. This is a great mistake, and it is an evidence of the skill and good management of the women that they are able to make a good profit with the very unfavorable conditions under which they have to work. It seems hardly fair that while the horses, cattle and swine each have separate buildings provided for them, the fowls are often left to find for themselves some unused corner, or may be permitted as a special favor to roost over the cows. Provide the hen with suitable quarters, keep her warm, clean and dry, provide a regular supply of proper food and water, breed with intelligence for the ideal you have in view, and she will not only return a handsome profit, but will be a source of real pleasure and entertainment. Teachers are reminded that all children naturally love chickens, and it will be well in all our schools to have the scholars interested and instructed in the poultry of the farm.

Fowls are kept for egg production and for table use. Of the many different breeds some are

best adapted for one purpose, some for the other, while again others combine many of the qualities of both, and may be called "general purpose" fowls. An egg is in itself a perfect food, containing all the elements in the proper proportions for the maintenance of life. Eggs are always in demand, although the price varies very largely during the different seasons of the year. During the months of May, June and July the price drops down very low indeed, often to six and seven cents a dozen. Why is this? Simply because that is the time under ordinary management that everybody's hens are laying, and the supply exceeds the demand. Now it should be the aim of poultry keepers, in order to make the most profit out of their hens, to induce them to lay most eggs when eggs are scarcest, and when they will bring a higher price. This can be done without very greatly increasing the cost of production, and an abundant supply of eggs may be obtained during the winter months, when from twenty-five to forty cents a dozen may be easily got for them. Such results as this cannot be without the application of knowledge and skill.

In considering the conditions necessary for profitable winter laying, it may be pointed out that the hen does best in early summer when she has the liberty of barnyard and fields. But this may be continued if the conditions favorable to health and egg production are

supplied. The digestive apparatus of the fowl is very interesting. When the food is swallowed it is carried down the throat to the crop, which is a first stomach in which hard substances, such as gravel, are taken to grind the food. Then the food passes on to the second stomach, and from this to the third stomach or gizzard, which has very strong muscles intended to grind down the hard food. After this the digestion is much as in other animals. Now when it is considered that the hen eats grain, which is so hard to digest, it will be seen that she needs variety and abundance of food, plenty of egg shell making material, the necessary grit or hard substance to help in grinding the food, dust baths, and a world of sunshine and pure air. The more fully these conditions are supplied in winter the more likely will the hen be to respond by producing a liberal supply of eggs. These conditions must, however, for success be taken in connection with the breed, age and condition of the hen.

The pullet from six to eight months old makes the best winter layer, so that one of the first things to attend to is to have early hatched chickens. All chickens should be hatched in April or May, and not later than June. Quiet, well-behaved hens of medium weights should be chosen for sitters. Prepare comfortable nests in quiet, secluded quarters, away from annoyance from other birds, and scatter insect

powder about the nest and hen. It is well to use china eggs for a day or two to make sure that the hen will continue sitting. After she has become accustomed to the nest, then place under her, eggs, from nine to eleven, according to the size of the hen, carefully selected, of uniform size and shape, of the variety you have chosen. After this the nest should be disturbed as little as possible, and near it should be placed a convenient dust bath and a supply of food and water. If any eggs should get broken, carefully wash the remainder with lukewarm water. After the chickens are hatched do not disturb them for twenty-four hours; then give the hen by herself a liberal amount of soft food and plenty of water. Start the chickens on dry bread crumbs or bread soaked in milk and squeezed dry; feed a little at a time every few hours; give water or milk to drink, and dust insect powder in their feathers occasionally. If the chickens are kept growing as fast as possible, the pullets will begin to lay at six or seven months old, and the cockrels will be ready for the market in four or five months. Hens should not be kept over two years old. They may be sold or killed for market just as they begin to moult, that is, to shed their feathers, as they are generally in good condition at that time. All fowls moult annually. It is a trying time for them. They will not lay during the moulting season, and should be kept well and cared for that they may get through

it as quickly as possible. In selecting hens for breeding, from six to twelve of the very best should be chosen, these being those that lay the most eggs of the largest size. These should be kept in a breeding pen by themselves, well supplied with food and water. The male birds, except the one selected for breeding, should not be allowed in the pen, as they eat the most of the food, destroy the quiet of the pen, and teach the hens to break the eggs and eat them—a very bad habit.

In regard to winter laying, Mr. A. G. Gilbert, Manager of the Poultry Department, Experimental Farm, Ottawa, says: "In the summer when the hen can roam at large, she supplies herself with all the necessary egg producing material, but when she is confined to limited space in winter she must be furnished with all she has been accustomed to help herself to when abroad. This is the whole basis of winter laying. Let the hens be supplied in the house as nearly as possible with what they can pick up outside."

The same writer recommends a warm mash for the morning made up of kitchen waste, meat scraps, pieces of bread, vegetables, etc.; also bran, shorts or meal of any kind; a portion of oats at noon and of wheat at night, the grain to be scattered in the cut staw on the floor to be worked for. The mash should be fed in narrow troughs. He also recommends, whenever possible, the feeding of green cut bones

in the proportion of one pound to every sixteen hens. He says: "Green bones, cut up, not ground up, are the best and cheapest egg making material to be had." Layers must be kept busy, for lazy hens will not lay. A turnip or cabbage or the lungs of an animal, hung up so that the hens have to jump to reach it, gives them good exercise, and supplies needed food in variety.

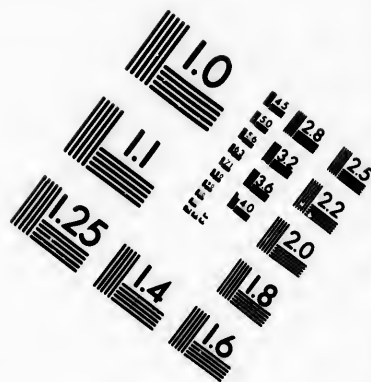
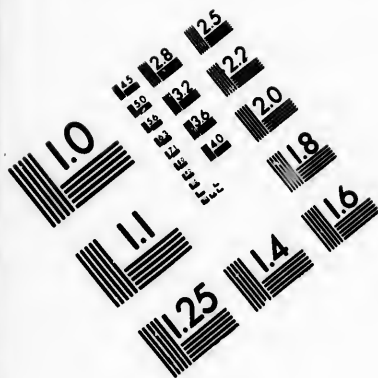


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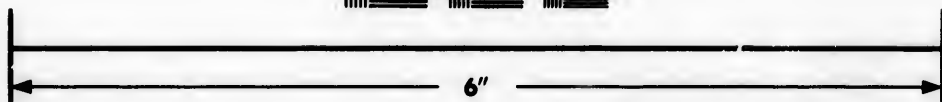
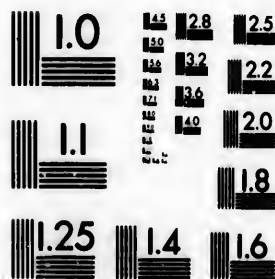
HORSES.

Not only the horse, but our other domestic animals belong to the sub-kingdom, Vertebrata, which includes only animals having a backbone. The vertebrate animals are divided into seven or eight classes, of which the more important are the Fishes, Amphibians, Reptiles, Birds and Mammals. Our domestic animals belong to the last two of these. The Mammals are those which suckle their young; so that the Horse, Cow, Sheep and Pig all belong to this class. The classes are divided into orders, and the Horse and Pig, though so unlike, have been by many placed under the order of Thick-skinned animals, while the Cow and Sheep are found among the Ruminants. The classes are divided into genera and the genus *Equus* includes not only the horse but the ass, quagga and the zebra. Our horse, then, is a species of *Equus*, and the species is further divided into breeds of which we shall speak. We shall confine ourselves to the leading breeds of horses, though there is no creature more deserving, on account of its intelligence, beauty and utility, of full treatment.





**IMAGE EVALUATION
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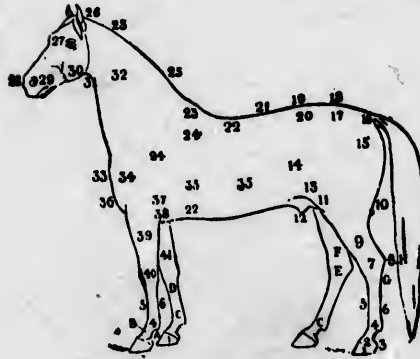


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PRINCIPAL PARTS OF A HORSE.

Taken from "Farm Live Stock of Great Britain," by Wallace.

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|---|---|
| 1. Hoof. | 26. Poll. |
| 2. Coronet. | 27. Forehead. |
| 3. Heel. | 28. Muzzle. |
| 4. (a) Fetlock or Pastern Joint; (b) the Pastern. | 29. Nostril. |
| 5. Cannon-Bone. | 30. Jaw. |
| 6. Back Sinew or Tendon. | 31. Throat or Windpipe. |
| 7. Hock. | 32. Neck. |
| 8. Point of Hock. | 33. Point of Shoulder. |
| 9. Second Thigh. | 34. Shoulder. |
| 10 to 20. Quarter. | 35, 35. Front Ribs and Short Ribs forming the Barrel. |
| 10. Haunch or Lower Buttock. | 36. Chest or Breast. |
| 11. Stifle. | 37 to 34. Fore Arm. |
| 12. Sheath. | 38. Elbow. |
| 13 and 14. Flank. | 39. Arm (so called), or Fore-arm. |
| 15. Hip Joint. | 40. Knee. |
| 16. Root of Tail or Dock. | 41. Chestnut. |
| 17. Rump. | |
| 18. Croup. | |
| 19. Loins. | |
| 20. Point of Hip Bone. | |
| 21. Back. | |
| 22, 22. Girth or Chest Measurement. | |
| 28. Withers. | |
| 24, 24. Shoulder Blade. | |
| 25. Crest. | |

SEATS OF COMMON DISEASES.

- | |
|------------------|
| A. Side Bone. |
| B. Ring Bone. |
| C. Wind Gall. |
| D. Splint. |
| E. Spavin. |
| F. Thorough-pin. |
| G. Curl. |
| H. Capped Hock. |

The following are the points of value in a good horse:—

Head.

Forehead, wide, indicating brain power, courage and good temper.

Muzzle, fine in horses for the sake of beauty.

Nostril, large, to assist in breathing under fast or heavy work.

Jaws, wide, to give ample room for larynx, and to allow a graceful setting of the head.

Eye, large, prominent, with an intelligent docile expression.

Ears, well placed, erect, thin, and sensitive.

Neck.

Of medium length, full and muscular, with elegant sweep.

Forequarter.

Shoulder-blade, oblique and long in a running horse, having arm on an angle with the shoulder-blade.

Point of shoulder, large but smooth.

Elbow, straight, neither turned in or out.

Forearm, long and muscular, to give strong sweeping action.

Knee, broad sideways, wedge-shaped, and neither bent forward nor backward.

Cannon-bone, large, flat and flinty. (By flinty-bone is meant bone of fine texture like ivory, as in the case of the deer, in contrast to that of the ox.) Back sinew, strong and clean.

Fetlock, good sized and clean.

Pastern, at an angle with the ground.

Feet, round, good-sized, with open heels and open coronets.

Middle-piece.

Withers, not too high; if the shoulder-blades are right the withers will be so also.

Chest, rather deep than wide in the race horse, so as not to interfere with action; wide and full in draught horses.

Back ribs, deep, to hold "bread basket," lighter, however, in the race horse.

Back.

Short rather than long, strongly attached to loin. Loin, wide and smooth; slightly arched, showing strength.

Hindquarter.

For speed, long thighs, very long lower thigh bone; for draught, long thighs, not so long lower thigh bone.

Quarters, full and well rounded.

Stifle, strong.

Hock, good sized, clean and flat.

THE THOROUGHBRED.

The English Race Horse, or Blood Horse as it is sometimes called, is a runner, not a trotter. It is the oldest established pure bred animal we have. Its record is found in the stud book of Great Britain which was started in 1791. When William the Conqueror invaded England he found a useful, hardy race of native horses occupying the midland counties.

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His cavalry were mounted on horses from Italy and Spain, and their blood no doubt became mingled with that of the native horses. In addition to this, importations of horses were from time to time made into England from Spain, Turkey and Arabia. Charles II. imported what are known as the "Royal Mares," and about the beginning of the eighteenth century three celebrated Eastern sires were introduced into England. These importations mingled more or less with the native horses laid the foundation of the modern



THOROUGHBRED STALLION,
The Property of J.G. Rutherford, M.P.P.
Portage La Prairie, Man.

Thoroughbred. England has been for six centuries fond of the race-horse, and in the modern Thoroughbred has a horse that for purity of breed, endurance, resolution and speed is unexcelled by any other breed in the world. Many people hold very wrong ideas about the merits of the Arabian, thinking him to rank at the head for fleetness and endurance. This is a mistake, as our Thoroughbred is far ahead of the Arabian. On account of the purity of breeding, and

the severe course of selection to which this horse has been subjected on the racecourse—and this is a very different thing from the less careful treatment to which the draught horse has been subjected—the English Thoroughbred is remarkable for its prepotency, or power of transmitting its special qualities; and there is scarcely a breed of horses which does not owe to the Thoroughbred some of its improved qualities. It is almost needless to describe this beautiful creature. His clean, well-formed head, large intelligent eyes, the erect, thin, sensitive ear, slender, graceful neck, fitting smoothly into the elegantly sloping shoulders, the deep chest, full girth, and light middle, make him notable. The strong, level loin, powerful quarters, with muscles like iron, the legs well placed, possessing a bone flat and of a flint-like quality, the strong, well-shaped knees and hocks, the pasterns just long enough to give the desired spring or cushion without being weak, and the feet neither too flat nor yet contracted, with open heels and coronets, and the hoof of that tough, fine texture so desirable in all horses—all these are the outstanding features of this princely horse.

THE STANDARD BREED.

This name is given to the American trotter. It is comparatively modern, having been bred by the Americans with the desire to obtain a road horse whose chief quality would be speed. The gait, either trot or pace, which characterizes this breed has been acquired, and become established by breeding and selection. In general form the Trotter much resembles

the Thoroughbred, to whom he owes much of his great powers of endurance, courage and speed, many of the best English race horses having been imported and crossed with native stock. Usually, however, the Trotter is rather heavier than the race horse. The breed is now a distinct one, and has several noted strains, such as the Hambletonians, Mambrinos, Clays, Morgans, Bashaws and Pilots, from among which all great performers come. No improvement in the speed of trotting could now be made by the use of the Thoroughbred. In the endeavor to gain speed, beauty and style have been somewhat lost sight of, yet many horses of this breed possess symmetry and beauty of form to a remarkable degree, while their performances upon the track are simply marvellous, and in this respect they are unapproached by any other breed.

THE HACKNEY.

This breed has made rapid advancement in public favor during the last four or five years, on account of its showy and attractive qualities for carriage purposes. It has existed as a distinct type for centuries in England in the counties of Norfolk and Yorkshire, but has been improved by the introduction of thoroughbred blood. The Hackney has long been used as the road horse of the English farmer, and is noted for his ability to travel either in harness or under saddle, long journeys at good speed, and on occasion take his place at some of the lighter farm work. The Hackney is not a large horse, averaging sixty-two

inches ($15\frac{1}{2}$ hands), but to quote from a recent English work, "he should be a powerfully built, short legged, big, broad horse, with an intelligent head, neat neck, strong level back, powerful loins, and as perfect shoulders as can be produced." Action is the thing to be most desired in the Hackney, and in order to gain perfection in this, freedom of the shoulder is absolutely essential if we would obtain the high electric knee action, together with a powerful sweeping

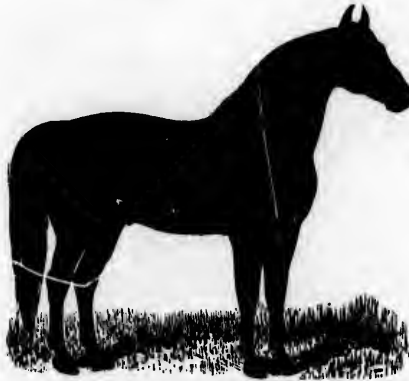


HACKNEY STALLION
The Property of A. J. Moore.
Swan Lake, Man

forward movement. Hock action should be as sharp and free as that of the knee. The Hackney is particularly noted for his intelligence, docility and even temperament, being thus well suited for carriage purposes. Of the Orloff, or Russian Trotter, we need hardly speak. Not possessing the elegance of the Hackney, nor the speed of the American, he is never likely to be introduced in this country, although some specimens of this breed created a considerable interest at the World's Fair in Chicago.

THE COACH HORSE.

Of the coach horse there are several kinds, all possessing similar characteristics. In Canada we have representatives of the Cleveland Bay, the Yorkshire, and of French and German coach horses, each having a separate stud book, and its own admirers. In England prior to the introduction of railroads, this was the horse used for stage coach work. Subsequently



COACH STALLION.
*The Property of Knittle Bros,
Boissevain Man.*

however this horse became almost extinct, but within recent years a demand has arisen for a large, powerful, level-gaited horse of this type, the more perfect specimens being used for the heavy carriages of the English aristocracy, and those of less quality finding a place in the express and light van work of the cities.

The Thoroughbred has been used to improve the quality of the Coach Horse; the latter is however of

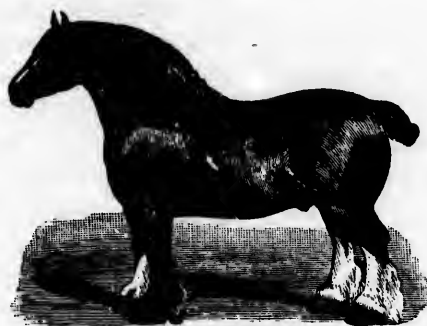
a larger, heavier type, the hind quarter being noticeably long and level. Horses of this breed make useful farm horses, when the distance to market is considerable, owing to their ability to draw a good load and return home at a spanking pace. As a breed they are not generally considered to possess the power of strongly transmitting their qualities, when crossed with ordinary stock. We must speak a word for the Saddle Horse. While riding has long been one of the favorite pastimes of the English gentry, and of late years growing in favor in Canada and the United States, yet there is no distinct breed of saddle horse. Most of the horses used for this purpose are cross-breeds, from Thoroughbred sires, and Hackney, Trotting, and Coach or common mares. In Kentucky they have what they call the Gaited Saddler, which seems to possess much Thoroughbred blood. In all horses of this class the more Thoroughbred blood they possess the better.

PONIES.

Of ponies we have the Shetland, the Welsh, and our mongrel called the Shagganappi. The Shetland from the exposed hill sides of the northern isles of Scotland, are very hardy and vigorous, making excellent pets for children. Our Shagganappi is the result of many years of neglect and hard usage as a cart horse among the natives of the prairies. Whi e usually unsightly, occasionally a good-looking pony bears this unwieldy name. There is always a tendency among ponies to increase in size, under favorable conditions of care and food.

THE CLYDESDALE AND SHIRE.

The Clydesdale and Shire are the two leading breeds of draught horses. Both are descended from the native horse of the lower and more fertile counties of Great Britain, notably Lanarkshire in Scotland, and Lincolnshire in England, and these improved by the use of imported heavy horses from the low lying rich pastures of Flanders. These heavy horses were



CLYDESDALE STALLION
The Property of J. E. Smith
Brandon, Man

used in early days when warriors wore heavy armor, as war horses and pack horses. In general characteristics these two breeds resemble each other so closely, especially among the best specimens of each breed, that it requires a skilful judge to distinguish between them.

Among the more ordinary animals, the Shire is probably the heavier with correspondingly less quality and more sluggish action. Until the establishment of separate stud books, within recent years, these rival breeds were very much interbred, many of the

best horses of each breed possessing strong infusions of the blood of the other. Among Clydesdales, two sires whose influence has done much to improve the breed, are specially worthy of mention, Darnley (222) remarkable for his superb quality, and Prince of Wales (673) noted for his wonderful action. These draught breeds are known for their size and strength, being used for heavy dray purposes in cities and for agricultural purposes on stiff clay soils. While their great weight makes trotting hard upon them, yet they possess fine action both in knee and hock. In actual practice the walk is their proper gait, and they cover ground very rapidly with a long, clean, swinging stride. To sustain the weight of the body the bones of the legs should be of good size, flat and flinty, with feet in proportion, not flat but well rounded, with open heels and coronets. The "feather" or fringe of long, silky hair on the back of the legs from knee to fetlock is a distinguishing characteristic. In both breeds bay is the predominating and favorite color. These breeds are very prepotent, and have done much to improve or grade up the common stock of the country.

PERCHERONS AND SUFFOLKS.

The Percheron and French draught breeds, though extensively imported into the United States, have never become popular in Canada. Their use has now been almost entirely discontinued, because they do not produce satisfactory results when crossed with ordinary stock, or in other words do not transmit their good qualities. As a breed they are not so

massive as the Clydes, but are more active, though not such fast walkers. They are clean-legged, and in color generally greys or blacks. The Suffolk Punch is one of the oldest pure bred horses of Great Britain, having been bred in purity for centuries. In color it is uniformly chesnut or sorrel, not so massive as the Clydes or Shires, but round-bodied, compactly built, short-legged, and rather light boned in proportion to weight. This breed is largely used in its native country as agricultural horses, but does not seem to gain in public favor on this continent.



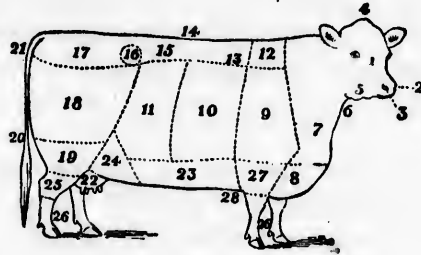
CATTLE.

Among the most useful of farm animals come the various breeds of cattle. They all belong to the species *Bos taurus*. The ox was among the animals first trained by man for bearing burdens. Still, in newer parts of the country he fulfils this purpose. It is however for the supply of beef that cattle are of greatest value, and for the production of milk that we use the cow. The two purposes of beef and milk supply seem to require distinct forms of cattle for their highest success. Accordingly, apart from breed, it is convenient to divide cattle into the beef and dairy type respectively. It is very important that our people recognize this distinction. The export trade of beef cattle from Manitoba is becoming very large, and as the distance to the seaboard is great it will be necessary for success that our farmers obtain for this purpose the best breeds of the beef type. On the other hand the government is doing much by grants to encourage cheese factories and creameries. In order that this industry may be largely successful those engaged in it should take pains to have the best breeds of the dairy type cultivated in the country. It is only by intelligent selection and much care that the great capabilities of Manitoba, both for beef raising and the dairy, can be fully utilized.

The diagram on the next page will assist the scholars in following our description of the various breeds of cattle :

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PRINCIPAL PARTS OF A COW.

- | | |
|-----------------------|--------------------|
| 1. Forehead and Face. | 15. Loins. |
| 2. Muzzle. | 16. Hooks. |
| 3. Nostril. | 17. Rumps. |
| 4. Poll. | 18. Hind Quarters. |
| 5. Jaws. | 19. Thigh. |
| 6. Throat. | 20. Twist. |
| 7. Neck Vein. | 21. Tail. |
| 8. Chest or Brisket. | 22. Udder. |
| 9. Shoulder. | 23. Under Line. |
| 10. Fore Ribs. | 24. Flank. |
| 11. Back Ribs. | 25. Hock. |
| 12. Top of Shoulders. | 26. Legs. |
| 13. Crops. | 27. Forearm. |
| 14. Back. | 28. Heart Girth. |

The ox is a ruminant, *i.e.* chews the cud. The stomach is divided into four parts, the first or paunch being very large, receives the bulky food, as it is hastily swallowed without being masticated. It here becomes mixed with saliva, and is returned to the mouth in pellets called the cud, while the animal is at rest, to be thoroughly chewed before being passed on to the true stomach. The tongue of the ox is very long, and the surface rough, so that with it the food

is taken into the mouth. Incisor or front teeth are present only in the lower jaw. Unlike the horse the ox is not made for speed, but as having great strength is well adapted for draught purposes.

THE BEEF FORM.

In breeds grown purely for beef, the object is to produce the most meat of the best quality with the least waste or offal, out of the least food in the shortest possible time. To secure this, a smooth compact form is essential, forming, with head and legs off, a nearly perfect parallelogram.

The *face* should not be too long, but broad between the eyes.

Mouth, large.

Nose, dewy.

Eyes, full and soft, denoting mild temperament, necessary to early maturity and aptitude to fatten.

Neck, broad and full at the neck vein, where it joins the body, tapering neatly toward the head—in the male broad and muscular with considerable crest on top.

Shoulders, smoothly laid, wide apart at the top.

Legs, short and well placed, of fine hard bone. Coarse heavy bone denotes poor feeding qualities. Bone is considered as offal.

Ribs, well sprung, giving wide flat back, leaving no hollow behind shoulder blades or in front of hooks.

Chest, full, wide, deep and carried well forward, giving room for the vital organs, lungs and heart.

Fore and hind flanks, full and deep.

Hind quarters, wide, lengthy and level.

Thighs, broad and thick, well down to hocks.

Inner thighs, or *twist*, full and well let down.

Tail, set on level with the back.

Back, straight, broad, level, well covered with flesh.

Skin, moderately thick, loose and mellow to the touch.

Hair, soft and abundant.

The general outline should be smooth and pleasing, and when ripe for the block the animal evenly covered with elastic flesh, without patchiness or flabbiness.



SHORTHORN COW DAIRY TYPE
The Property of R. L. Lang
Oak Lake Man.

THE DAIRY FORM.

The dairy form, on the other hand, is angular or wedge-shaped, clean in appearance, and the animal of a nervous temperament.

Face, long and clean cut, broad between the eyes.

Mouth, large.

Nose, dewy.

Eyes, full and bright.

Neck, long and thin (frequently "ewe-necked" in the female, though crested and more muscular in the male).

Shoulders, sloping, coming close together at the top.

Legs, short, fine-boned.

Ribs, broad, wide apart and long, but not sprung.

Chest, full, wide and deep. To have room for lungs and heart is just as important as in beef form.

Hind quarters, wide, long, deep, but bare of flesh.

Thighs, thin and wide apart, leaving room for the udder, which should extend well up behind, and well forward.

Milk veins, large and tortuous, running far forward.

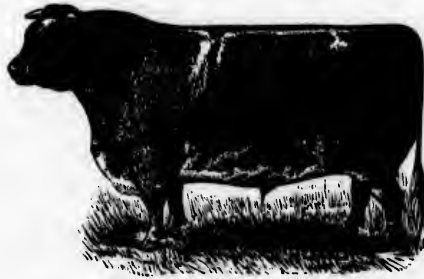
Backbone, strong, open-jointed, and quite prominent.

Skin, of medium thickness, loose and pliable; when showing a rich yellow tinge under the hair is an indication of richness of milk.

Nature designed that the cow should give but sufficient milk to nurture her young; man by skilful manipulation has developed the modern dairy cow, capable of producing marvellous results. Reliable tests have shown cows to produce 20,000 lbs. of milk in a year, or 90 lbs. in one day; others have produced 1,000 lbs. of butter in a year, and 5 lbs. in a day, while cows yielding 2 lbs. of butter a day are by no means uncommon. In contrast to this it may be stated that the average Manitoba cow does not produce 130 lbs. of butter a year. The Holstein cow, figured on page 206, gave in one day on the Winnipeg Industrial Exhibition grounds, July, 1895, and this under unfavorable conditions, 72 lbs. of milk, and 3.27 lbs. of butter in one day. The cow should give milk at least ten months of the year. As milk can only

be obtained by the consumption of food, the cow in order to produce large yields must have great assimilative power; she must be a large eater, have a large stomach, and great lung power. As the nervous system has great influence over the organs of milk production, it is most important to keep the dairy cow free from all disturbing or exciting influences.

We are now ready to consider the leading characteristics of some of the best known breeds.



SHORTHORN BULL, BEEF TYPE
The Property of **PURVES THOMPSON**
PILOT MOUND, MAN.

THE SHORTHORN OR DURHAM.

This is the most widely distributed of all breeds, and no breed has done so much to improve the cattle of the civilized world as the cosmopolitan Shorthorn. It possesses to a wonderful degree the power to "neck" or blend with almost all other breeds and grades of cattle, and to adapt itself to all climates and conditions.

It is well here to call attention to "the apostle" of the art of improving the domestic animals of the world—Robert Bakewell, who lived between the

years 1725 and 1795, at Dishley in England. Previous to that time no systematic plan had been adopted to improve live stock. Bakewell began experimenting with sheep, leaving us the improved Leicester, whose blood has done much to improve nearly all our mutton breeds of sheep. Afterwards he applied his system of "in-and-in" breeding, and scientific selection to the Longhorn breed of cattle, which has however since become extinct. Two brothers, named Collings, living in the County of Durham, heard of Bakewell's methods, and applied them to the Shorthorns, or as they were then called, Durham and Teeswater cattle, with such success that their herds soon became famous. Of all the breeders of Shorthorns after these brothers, the names of Thomas Bates, the Booths, and more recently Amos Cruikshanks, who has lately died at the ripe old age of eighty-three, stand out prominently. These men founded distinct types, modelled after their own ideals, which remain till this day. In color the Shorthorn is red or white, or red and white or roan. The horn is short, flat, and generally curving inward and downward, and of a creamy color. In general conformation this breed conforms closely to the model of the beef type and is noted for early maturity and aptitude to fatten. Some of the breed still retain the original deep milking qualities of the Teeswater cattle. These are by many regarded as the real general purpose cattle, that is cows that give a profitable supply of rich milk, while the steers are readily fattened into large profitable carcasses of prime beef.

THE HEREFORD.

As its name implies, this is an English breed. It is one of the most valuable beef breeds, picturesque in its uniform markings; face, underlines, and brush of tail being white, the rest of the body deep red. The head of the Hereford is somewhat heavier and the horn longer than that of the Shorthorn. In general characteristics it fills the parallelogram of the beef model, but is more inclined than it should be to unevenness and patchiness, especially upon the hindquarters. The Herefords are a hardy breed, and good grazers. Fifty years ago this breed was largely kept for supplying oxen for which they are peculiarly adapted, on account of their sloping shoulders. Benjamin Tomkins, who died in 1815, occupies in the improvement of the Hereford the place corresponding to that of the Collings in Shorthorn history.

THE WEST HIGHLANDER.

The Highland cattle of the west of Scotland are a distinct breed with marked characteristics. Their long shaggy coverings of hair serve to protect them from the fierce storms of their native hills. They are a most picturesque breed, with horns very long and wide spreading. In shape they much resemble the Devons, but are smaller. Their beef is of the highest quality.

THE DEVON.

This breed, natives of Devonshire, are a small, round bodied and symmetrical group of beef cattle. They are uniformly of a ruby red color, with graceful

horns of considerable length curving upwards. Neat about the shoulders, the Devons are enabled to walk freely and fast, and thus make good oxen. The breed though much esteemed in its native locality, has never gained much popularity on this continent. The Sussex cattle closely resemble the Devons, and call for no separate description.



*POLLED ANGUS COW.
The Property of J. D. McGregor.
Brandon Man.*

THE POLLED BREEDS.

The production, from animals so well provided with horns as the ox, of hornless varieties shows what power the breeder can exercise over the form of animals. For safety, if not for beauty, some breeders prefer the hornless or polled varieties of cattle. This preference shows itself in the somewhat painful process of dehorning cattle now in vogue in some places. Most famous of the hornless varieties is the Polled Angus, noted for its beef-producing qualities. It is uniformly black in color and has a fine, sleek skin. It is strongly persistent and prepotent, and in being crossed with other cattle, its offspring are usually

hornless, and black in color. Hugh Watson of Forfarshire, Scotland, was the Collings of this breed, but Wm. M'Combie of Tillyfour (1805-1880) made the breed known to the world. During recent years no variety has been able to compete successfully in the English shows with the Polled Angus. Compared with the Shorthorn the best specimens are rounder and smoother in general outline, deeper in the body, and on shorter legs. They mature early, weigh very heavily, and produce carcasses of beautifully marbled beef.

THE GALLOWAYS.

This is another black polled breed belonging to Scotland. It can be distinguished from the Polled Angus by the shaggy coat of glossy hair, the shorter head and rounder poll.

The Galloway is not so deep in body nor so symmetrical as the Polled Angus. The cross of the Shorthorn with the Galloway produces the celebrated "blue-greys," which are considered to yield the best beef obtainable in Britain, and which is known as "prime Scotts."

The Red Polled cattle of Norfolk and Suffolk are claimed to be a first class, general purpose breed, but they are not being introduced into Canada. The Polled Durham breed is an American innovation of recent date, obtained by careful breeding and selection from "sports" or hornless specimens of Shorthorns.

DAIRY BREEDS.

Having so fully described the dairy type of cattle, we now notice shortly their leading varieties.

THE AYRSHIRE.

This is a native of the county on the west coast of Scotland, whose name it bears. The original type has undergone great improvement by the introduction of the blood of the Teeswater breed and probably of that of the Jersey. The modern Ayrshire is one of our best dairy breeds, of smallish size, but much more symmetrical than the Jersey, and capable of feeding into compact carcasses of beef. Its horn is strong and generally curving forward and upward.



AYRSHIRE BULL
The Property of Steele Bros.
Glenboro, Man.

Ayrshires are red and white in varying proportions, with dark colors not uncommon; frequently the extremities are black. The lighter colors are now the more fashionable. The milk of the Ayrshire is said to be particularly adapted to cheese making on account of the small size of the fat globules which it contains.

THE JERSEY.

This is the great butter breed of cattle. Upon the little island of Jersey it has maintained its purity far longer than any of the British breeds, as the importation of foreign cattle was prohibited. The Jersey

herd book was established in 1838. Jerseys were first imported into America in 1853, and are now probably the most numerous and popular breed of dairy cattle in the United States. We quote from the herd book some of their distinguishing points :

Muzzle, dark, encircled by light color.

Horns, small, crumpled ; yellow, with black tips.

Ears, small and thin, and of a deep yellow color within.

Chest, broad and deep.



JERSEY COW
The Property of JAMES BRAY.
LONGBURN MAN.

Hide, thin and mellow, and of a yellow color.

Hair, fine and soft, and of various whole colors—fawn, silver grey, dun, cream, or white, and rarely more or less black.

The face is generally concave or dished, the head deer-like and very pretty ; the female is generally "ewe-necked." The Jerseys do not yield very large quantities of milk, but it is often extremely rich in color and flavor ; and the fat globules being large makes creaming and churning easy. Somewhat similar to the Jerseys are the Guernsey cattle. They

are not so symmetrical as the Jerseys, being coarser and more loosely put together. They are somewhat lighter and more broken in color. Few Guernseys are found in Canada.

THE HOLSTEIN.

The Holstein-Frisian or Dutch cattle, imported from North Holland, differ in many respects from other dairy breeds. They are very large-sized being almost equal to the Shorthorn in this respect. They



HOLSTEIN COW.
*The Property of James Glennie
Longburn Man.*

are black and white in color. The horn is usually crumpled and waxy with black tips. The Holsteins are large and hearty eaters and produce great quantities of milk. There are other breeds of cattle, such as the Swiss, the Dutch Belted, the Kerry, and what is called the Quebec Jersey. These are small breeds of special purpose dairy cattle of some local reputation, but none of them are equal to the three above-mentioned prominent breeds.

SHEEP.

Of all our domestic animals, the sheep and especially the lamb has been most honored by the poet and artist, the lamb being used in song as well as on the canvas, as the harbinger of spring. The lamb has ever been the favorite of children. The lamb however is not only the emblem of the poet or the painter, but it is one of the greatest wealth-producers of the farm. Although in Manitoba the raising of sheep has not been greatly followed, yet there is no doubt it will in a short time become one of our staple industries, the more so that many parts of the province are very suitable for the growth of sheep. The trouble of building and maintaining good fences, and the fact that there has yet been little thought of an export trade in sheep, have no doubt deterred many from sheep raising. If, however, the Spanish proverb is true, that "wherever the foot of the sheep touches the land is turned into gold," we may expect our farmers to enter upon the sheep industry. Sheep thrive on steep and bare hillsides, where other animals would starve, the formation of their mouths being such that they bite very close to the ground. This they can do because the upper lip is deeply divided, and the front teeth of which, as in the ox, there is only a lower set, are very sharp, forming a little scoop. In biting, the sheep not only cuts off the herbage close to the ground, but loosens the roots, thus causing the grasses to spread and thicken.

Sheep eat a great variety of grasses, herbs and weeds. Besides this they fertilize the soil while pasturing upon it in a more complete and thorough manner than any other variety of farm animals. The sheep, like the ox, is a ruminant, that is, chews the cud, and is provided with four stomachs. Wool and mutton are the farmer's reward for raising the sheep. The production of wool in our climate where warm clothing is so essential, will no doubt in time become a great industry. A well known writer has said: "On the skin of most animals is placed a covering of feathers, fur, hair, or wool. They are all essentially the same in composition, being made up of animal substance resembling coagulated albumen and sulphur, silica, carbonate and phosphate of lime, and oxides of iron and magnesia. Wool is not confined to the sheep. A portion of wool is found also in many other animals, as in the deer, elk, the oxen of Tartary and Hudson Bay, and in several species of dog."

In connection with wool, one of the most important features in increasing it in quality and quantity is the presence of the peculiar substance called yolk. "Yolk is not the mere perspiration of the animal, it is not composed of matter that has been accidentally picked up and that has lodged in the wool; but it is a peculiar secretion from the glands of the skin, destined to be one of the agents in the nourishment of the wool, and at the same time by its adhesiveness to mat the wool together, and form a secure defence from the wet and cold. The yolk being a true soap, soluble in water, it is easy to account for the comparative ease with which the sheep that have the natural

proportion of it are washed in a running stream. When this natural quality is found, the wool is soft and oily, and plentiful and strong."

The health and condition of the sheep has much to do with the growth of its annual fleece of wool, any period of unthriftiness showing itself by a weak spot in the wool that was grown during that time.

Attention is called to the wool, because in Manitoba even now, when the wool is low in price, the fleece of a good sheep should almost pay its expense for the year, leaving the lamb crop as a clear profit.

The age of a sheep is reckoned from the time of first shearing, it being called a lamb until the time it is about a year old, then a shearling, a two-shear, etc. The age may be told by the teeth as in other animals.

Sheep increase in number rapidly. A flock of one hundred ewes will, in a fair year, produce one hundred and fifty lambs under good management.

Sheep are classed as long, middle, or short-wooled, the Merino being the example of the last.

THE MERINO.

The Merino is the breed cultivated in Southern Europe, Australia, and also in large sections of the United States. It is what is called a wool sheep, and is not considered a mutton breed. It is poorly fleshed upon the most valuable parts, being narrow-backed and what is known as "cat-hammed." In appearance the Merino is a most peculiar breed of sheep, having heavy horns, great folds of loose skin about the neck, and a close, almost black, appearance of the

fleece. On opening the wool it presents a most beautiful quality in color and fineness, and the wrinkled skin adds surface. At present, however, this fine wool is not in demand, and does not fetch as good a price as the medium wools. The Merino is consequently being crossed with mutton breeds in order to give weight and quality to the carcass.

SHEEP IN CANADA.

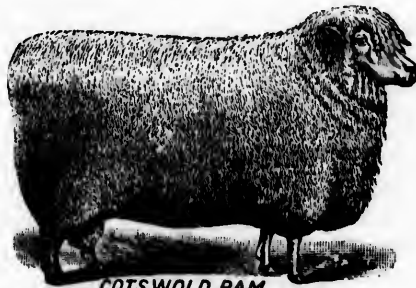
The medium and long-wooled sheep are the most common in Canada. The former, known as medium, are mostly brown-faced, very active in habit, and furnish the highest class of mutton, while the long wools are white-faced, not so active in habit, more suited to heavy and luxuriant pastures, but somewhat coarser in flesh.

THE LEICESTER.

As for most of our improved breeds of horses and cattle we look to Great Britain, so for the more useful breeds of sheep. Although it was with sheep that the great breeder Bakewell first began his experiments, pedigrees of sheep were not publicly kept until quite recently, in fact until the demand for some such record of the purity of breeding was demanded by Canadian and American importers of the improved breeds. Now, however, nearly all breeds have flock registers.

Bakewell improved and evolved by a course of careful breeding and selection from the Midland counties of England, the Leicester sheep, whose blood has been used to improve the qualities of almost every

other modern breed of mutton sheep. Much the same terms might be used to describe a model mutton sheep as we employed to describe beef cattle, except that in sheep, on account of the thick wool, most of the points must be determined by handling more than by sight. The Leicester is a large, square-framed handsome sheep, having a white face with black nostrils and lips. It is perfectly hornless, without wool over the forehead, and has a fleece long and rather open, with wool of a close spiral. Of the slight difference between the Bakewell and the Border Leicester, now the more popular and widely distributed, we need not speak.



COTSWOLD RAM.
The Property of Wm Grosvenor,
Swan Lake, Manx.

THE COTSWOLD.

This is one of the oldest breeds of British sheep. Indeed it gave its name to the hills of its original home—*cot*, a sheepfold; and *wold*, the open country, in this case hilly. It is a big, upstanding sheep, with a longer neck and more elegant carriage than the Leicester. The fleece is long and open, the wool

not so close a spiral as in the former breed ; the face generally white, though sometimes a little gray, and always having a heavy tuft of wool over the forehead.

THE LINCOLN SHEEP.

These much resemble the Leicester, but are considerably heavier, being the largest of all British breeds. The fleece is very long and heavy, weighing as much as thirty pounds in some cases, measuring twenty inches long in the longest parts. The wool is very bright, receiving in England the name of lustre wool.

THE SOUTHDOWN.

As the Leicester holds the place of honor as the great improver of the long wools, so the Southdown ranks first among the medium wool or Down breeds. A Mr. Ellman was the great improver of this breed, followed by Jonas Webb, who continued the work of Ellman and did much to make the breed popular. It is told that while passing through a great Parisian international show, held under the auspices of the Emperor Napoleon III., the emperor in his rounds paused to admire Mr. Webb's Southdowns, and enquired to whom the sheep belonged. "They are yours, your majesty," promptly replied Mr. Webb, "if your majesty will accept them." The gift was accepted and a splendid present of solid silver plate came shortly after from the Tuileries to Babraham, Mr. Webb's house.

The original home of the Southdown was the chalk hills of the southern counties of England. As far as

is known the improvement has been made entirely by selection, the introduction of foreign blood not having been found beneficial.

Of this breed the face and legs are lightish brown. The countenance is fine and indicative of high breeding. The ear is small and rounding, and the head perfectly hornless. "The carcass," as an English writer says, "is faultless, being beautifully drawn, oval on the top from set of neck to the tail, thoroughly filled up behind the shoulders, and square and massive from chest to twist. The fleece presents a solid, firm appearance, opening in cracks down to the skin when the animal turns."



SHROPSHIRE RAM
The Property of J.A. S. Macmillan.
Brandon, Man.

THE SHROPSHIRE.

This was the first of the breeds of sheep to establish a Flock Book, and yet it is a breed that has been improved or made within comparatively recent years. It is perhaps more universally popular than any other at the present day, possessing as it does many of the most desirable qualities of both the long and short woolled sheep. It is a thick, heavy animal of

rapid feeding qualities. Its wool is fine and valuable, with the quality of mutton little inferior to that of the Southdown, while it is considerably heavier. The fleecce is longer and somewhat more open than that of the Southdown. The face should be rich brown in color, well covered with wool down over the forehead, in front of the eyes and under the cheeks.

THE OXFORD DOWN.

This is a made or selected breed, but is nevertheless one of the best and most thoroughly established. In general characteristics it much resembles the Shropshire, differing in the following points: Head longer and thinner, with more of a Roman nose; Ears long and thin, and the top knot longer, more like the Cotswold, from which it is descended on one side. Closely related to the Oxfords are the Suffolks, and Hampshire Downs, which differ from them only in minor points.

THE DORSET HORN.

This is a well-established variety, but it has only recently been introduced in Canada, there being but one flock in Manitoba. The chief characteristic of this breed is that they will produce two crops of lambs in a year, a valuable feature for a farmer in the neighborhood of a good lamb market. The Dorset Horns are a smaller breed of low, thick-set sheep with very white faces and white noses, and unlike any of the other British breeds of which we have spoken, possessing, especially in the case of the rams, great, heavy, spiral horns.

OTHER BREEDS.

The Cheviots are a breed of white-faced mountain sheep of desirable qualities, and with the Blackface and many other like breeds fill a place in Britain which no others can. None of them have, however, been introduced to any extent into Canada.



SWINE.

The hog, if not the most beautiful or picturesque of our domestic animals, is certainly one of the most useful. The horse is kept for his movement, the cow for milk and beef, the sheep for mutton and wool, the hog for meat only. It has been said that the chief end of the pig is to eat and grow fat. In all animals a certain amount of food is necessary to maintain life, to keep up the heat of the body and to replace the waste or worn out tissues. The food consumed beyond this amount goes in the farm animals to produce flesh, milk and wool. The hog can assimilate more food beyond the amount necessary to maintain life, than any other animal, or to put it in another way, can produce more meat out of a given amount of food than any other animal. The hog has a good appetite, is a large eater and relishes a variety of food of a much more concentrated nature than that most suitable for cattle and sheep, as, unlike these animals he has only one stomach and that a very small one. The natural food of the pig is grass, leaves, fruits, nuts, roots and grubs, and his snout is made to enable him to root in the ground for the latter delicacies.

The hog is not a native of this continent. Our modern breeds of swine result from the blending of two older species. There are the European (*Sus scrofa*), a domesticated race descended from the wild boar, and the Chinese (*Sus Indicus*), a

much more refined type of Asiatic swine. As the hog multiplies very rapidly, and responds readily to feeding and care, any desired type can be obtained in much less time than is the case with other animals. It is, however, a fact that a perfect hog of any breed is almost as great a rarity as a perfect horse. Some years ago when pork was heavily salted and put through a long course of curing, which made the lean meat hard and unpalatable, great size, with much fat and little lean was sought for. Wide "table backs," heavy hams and shoulders, and rapid fattening qualities were found to go with short bodies and short noses. Now, however, with the introduction of "mild curing" processes, which leave the lean meat sweet and juicy, less fat, more lean and longer, leaner sides are demanded by the market. This leads, of course to the development of a type of hog to suit the want.

As in the case of other classes of stock, England has been the improver of swine. Half a century ago in England the blood of the Chinese hog was infused (chiefly by the use of an Italian breed—the Neapolitan—which had already been improved by the use of the Chinese), into the native stock, and the breeding of improved swine began. We still obtain the foundation stock of most of our breeds from England, although the United States has originated several distinct breeds of swine.

THE BERKSHIRE.

This has long been the most popular breed of swine in Canada. In color the Berkshire is black,

with white markings on the face, feet and tail, has a good coat of fine, silky hair; skin is smooth and free from deep wrinkles; and stands well on short, straight, strong legs of fine, clean bone. The head is wide between the eyes, denoting intelligence. The face is slightly dished, the nose medium in length, cheek clean, and jowl not too heavy, connecting smoothly with the neck. The ears are almost erect; the neck short and broad; the back long, broad, straight and slightly arched; ribs well sprung and deep, letting the sides well down; flanks

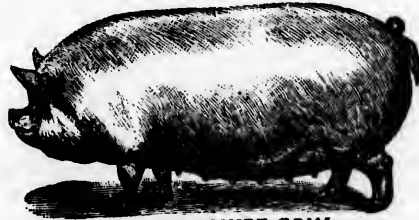


BERKSHIRE SOW.
The Property of R. McKenzie
High Bluff Man.

full; shoulders smooth, wide on top, with wide chest; hams wide and thick, extending well up on the back and well down to the hocks. In disposition the Berkshire is quiet and gentle, fattens rapidly at any age, and matures early. When properly fed the fat and lean in this animal are nicely intermixed, and the meat is of a superior quality. The Berkshires breed well, have strong constitutions, and being very prepotent, have done much in improving other breeds, as well as in grading up common stock.

THE YORKSHIRE.

This is a large, white breed from the north of England which conforms somewhat more closely to the fashionable long bacon type now in demand, than does the Berkshire, being much longer in the body and narrower in the back in proportion to size. It is the largest of British breeds, attaining often an enormous weight. Besides being larger than the Berkshires, the Yorkshires are heavier in



YORKSHIRE SOW.
The Property of Hon. Thos Greenway
Crystal City, Mar.

the bone, inclined to be long-legged and not so good in the hams. They are of a more restless nature, and produce a greater proportion of lean meat to fat. They have vigorous, robust, constitutions, are prolific breeders, and being one of the oldest pure breeds, impress their characteristics very strongly when used for crossing purposes.

THE TAMWORTH.

Another large English breed, which within the last few years has gained a considerable recognition as a producer of long lean sides of bacon, is the

Tamworth. In conformation it resembles the original wild boar, in the long, narrow head and the narrow back. It is red in color and has an erect ear and long nose. This breed is somewhat slow in maturing. The advantages claimed for the Tamworth are great length and depth of the sides (now considered the most valuable meat), the narrow back, the large proportion of lean meat to fat, the light head and its prolific character and robust constitution. Its chief use seems to be for crossing with short-bodied, finely bred sorts to produce the style of pig demanded by the packers.

THE POLAND-CHINA.

This breed is an American production, being made up of several breeds, of which probably the Berkshire was the most important, and which in color it now most resembles. It is most popular in the great corn-growing districts of the United States, and constitutes a large proportion of the millions of hogs annually going into the Chicago stock-yards. Compared with the Berkshire, the Poland-China is shorter-legged, finer boned, heavier hammed, and has ears drooping forward. The Poland-Chinas mature early, are so quiet and easily fattened, that the breeders claim that they have forgotten how to squeal. They produce good-sized litters.

THE CHESTER WHITE.

As the name implies, this is a pure white breed. It is also of American origin, being the oldest pure breed originated on this Continent. It is a large and prolific

breed, much resembling in general form the Poland-China, but is perhaps somewhat larger, deeper-sided, and heavier-boned. The ears droop forward.

THE DUROC JERSEY.

This is another American breed, very closely resembling the Chester Whites, except in color, which is chestnut or red. The Duroc Jerseys are not extensively bred in Canada, there being only a few herds of them in Manitoba.

THE SUFFOLK, ETC.

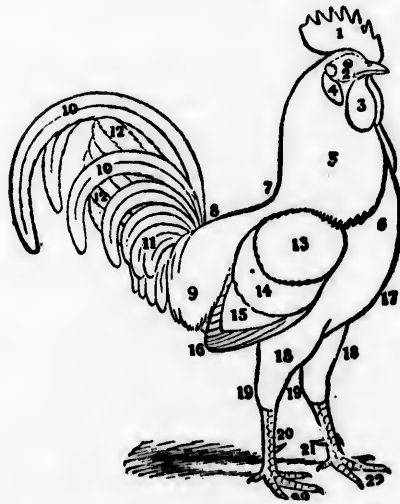
The Suffolks and Small Yorks are small, white breeds, bred very fine, and are real little dumplings of fat, with noses turned up like a pug dog's. They are not of the type now in fashion, and being delicate and hard to rear, especially in Manitoba, are not very popular.

THE ESSEX.

This is a black breed of somewhat similar type to the last named, but with better heads, their faces not being so much dishd. It is not, however, much bred in Canada.



POULTRY.



PRINCIPAL PARTS OF A FOWL.

- | | |
|-------------------------|---|
| 1. Comb. | 18. Wing-bow. |
| 2. Face. | 14. Wing-coverts, forming wing-bar. |
| 3. Wattles. | 15. Secondaries, wing-bay. |
| 4. Ear-lobes. | 16. Primaries or flight-feathers, wing-butts. |
| 5. Hackle. | 17. Point of Breast Bone. |
| 6. Breast. | 18. Thighs. |
| 7. Back. | 19. Hocks. |
| 8. Saddle. | 20. Shanks or Legs. |
| 9. Saddle-feathers. | 21. Spur. |
| 10. Sickles. | 22. Toes or Claws. |
| 11. Tail-coverts. | |
| 12. Main Tail-feathers. | |

As in the case of the various other classes of live stock, breeding is here of great importance, and

farmers and others who keep poultry for profit, should use only males of the pure breeds—selecting such varieties as will best suit their circumstances or tastes.

I. AMERICAN VARIETIES.

Probably the best general purpose breed of fowls, and certainly the most popular with the farmers, is :



PLYMOUTH ROCK.
*the Property of H.A. Chadwick,
St James. Man.*

(1) *The Barred Plymouth Rocks.*

The chicks are hardy and are easily raised ; the young birds grow rapidly ; the cockerels or young males can be made to gain a pound a month up to five or six months, and they make good table fowls. The pullets, or young hens, lay pretty early, and are good winter layers of fair-sized eggs.

The "American Standard of Perfection," by which all birds are now judged, under the score-card system, at all poultry shows of any importance, calls for the following weights in Plymouth Rocks:—Cock, $9\frac{1}{2}$ lbs.; hen, $7\frac{1}{2}$ lbs. Besides the barred there are White and Buff Plymouth Rocks.

(2) *Wyandottes.*

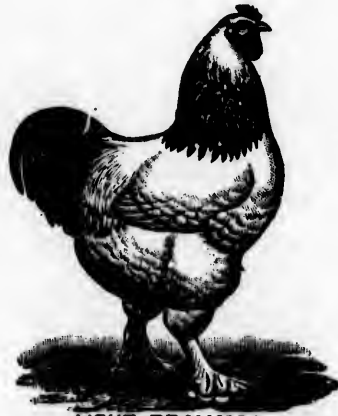
These are also an American breed. They are of several sub-varieties, White, Silver, Golden, Buff, or Black. They are good hardy fowls, of fair size, the standard for hens being $6\frac{1}{2}$ lbs., and for cocks $8\frac{1}{2}$ lbs. They make particularly good table birds, and are good layers of fair-sized eggs. The pullets begin to lay early.

II. ASIATICS.

Of Asiatic fowls there are several well-known varieties.

(1) *Light and Dark Brahmas.*

The former are the more popular. It is the heaviest breed of fowls, the standard weight being 12 lbs. for cocks, and $9\frac{1}{2}$ lbs. for hens. They are very quiet birds, stand confinement well, and thrive in small quarters if kept from becoming too fat. The young birds are not ready for the table at as early an age as those of some other breeds, but are good and plump when ready. The hens are good winter layers, and lay large eggs.



LIGHT BRAHMAS
The Property of C. M. Richardson
Winnipeg Man.

(2) *The Langshans.*

Of these there are Black and White varieties, the former being much the more numerous. These are large handsome birds, though not within two pounds of being as heavy as the Light Brahmas. They make excellent table birds, growing rapidly, and have a white flesh. The hens are fairly good layers of very large, rich brown eggs.

(3) *Cochins.*

This is another heavy breed, almost equalling the Brahmas, to which they are very similar. They are fair layers, of large dark-brown eggs. Of the Cochin there are four sub-varieties, viz.: The Buff, Partridge, White, and Black.

III. MEDITERRANEANS.

The greatest egg-producing hens are found among the Mediterraneans. These include the Leghorns, Minorcas, Spanish, and Andalusians.



WHITE LEGHORN.
*The Property of W. H. Garside
Brandon, Main.*

(1) *Leghorns.*

These have many sub-varieties, of which the white are the most common, followed by the browns. The Leghorns are a small, lively breed, requiring and taking much exercise, are great flyers, very hardy as chicks and easily reared, mature early, and lay well at all seasons large white eggs. They are non-sitters.

(2) *Minorcas.*

These, another great laying breed, are excellent winter layers of very large white eggs. The Minorcas are very much like Leghorns, but are larger and more suitable for market. Of this breed there are black and white varieties. The former is best known in Manitoba, and is deservedly becoming a very popular breed

OTHER BREEDS.

There are many other breeds of fowls, such as the Houdans, Hamburgs, Red Caps, and the many varieties of Games, most of which are good layers, the first mentioned being layers of very large white eggs. The Dorkings are an English breed, and are subdivided into white, silver grey, and colored. They are of great merit as general purpose fowls, being good layers, and as a table fowl are unexcelled. Of Bantams there are many varieties; they are kept more for their beauty, than for any points of utility which they possess.

TURKEYS.

There are six recognized varieties of Turkeys, viz., Bronze, Narragansett, Buff, Slate, White, and Black. Of these the Bronze is deservedly the most popular. This breed is very closely related to the wild turkey of America, from which it derives its beautiful bronze plumage as well as its hardiness. The Bronzes are the largest of all turkeys, male birds



BRONZE TURKEY.
*The Property of M. Maw.
Winnipeg Man.*

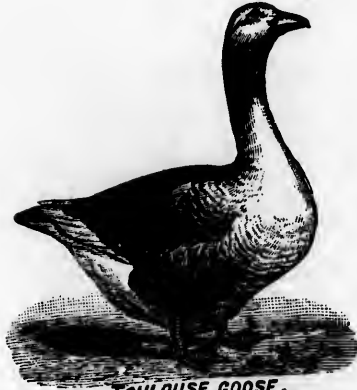
of the variety often weighing as much as 40 pounds. Turkeys are kept for table purposes. They are considered somewhat difficult to rear, the young birds being very delicate. When properly understood, however, and managed under suitable conditions, turkeys are profitable fowls, there always being a good demand for them when they are fresh, plump, and well dressed.



PEKIN DUCK.
*The Property of C. S. Matheson,
Portage La Prairie, Man.*

DUCKS.

Probably the best duck for the farmer is the Pekin. Though not the heaviest breed, the Pekins are the best layers and dress well for the table. They are a very handsome, pure white breed; standard weight of duck being 7 lbs. and of the drake 8 lbs.



TOULOUSE GOOSE.
The Property of Chas Midwinter.
Winnipeg.

GEESE.

The Toulouse and Embden are well known and valuable varieties, the former probably the best for general purposes. They attain a great weight, 20 pounds being the standard for both adult goose and gander. The wild grey goose is easily domesticated, makes a hardy, vigorous breed and is a good table bird. The feathers of the goose are the most valuable of those of all domestic fowls, and always command a good price for the manufacture of pillows, etc.

BEES.

The abundant growth of flowers upon the prairies might well suggest the wider introduction of bee-culture to our farmers. About a dozen experimenters have for several years been to a greater or less extent engaged in this important branch of farming, known as Apiculture. Their verdict is that it may be made profitable if care and shrewdness are shown in following it. One Manitoba farmer, during the present year, sold about two thousand pounds of honey at fifteen cents a pound. The bees used in Manitoba are those of the Italian variety, and they are imported from Ontario.

During winter the bee-hives are placed in dry cellars. Some observers state that cellars with walls of plank are better than those of stone, as the greatest danger to the bees is that of mildew. As soon as the maple blossoms begin to start in April or May the bees should be brought forth to sunlight again, and for some time in the spring they need to be fed with a syrup manufactured from sugar. Great care must, however, be taken to protect the bees during the frosty nights of spring. The flowers chiefly availed of by the bees in honey-making are white clover.

It is to be hoped that this delightful and profitable department of the farmer's work will be more extensively engaged in, as we have a good market at our very door for all the honey that can be produced for many years to come.

MIXED FARMING.

Experience has shown us in Manitoba that it is folly to depend entirely upon the growth of wheat for our livelihood. Some farmers, making haste to be rich, undertake to sow two or three hundred acres of wheat, and entirely neglect the growing of farm animals, even going so far as not to keep cows enough to give them milk and butter for the house. This we think very foolish. A farm is not a farm without horses, cattle, pigs, and poultry. The wheat farmers we have spoken of, that is those who grow nothing but wheat, are at the mercy of the elements. A dry spring, an early frost, a wet harvest, hail and fire, may bring all their calculations to naught and leave them heavily in debt. It is a better plan to sow less wheat, to add a good quantity of oats, and grow horses to use and sell, to have a fair herd of cattle to feed on the nutritious prairie grasses, and to have pigs and poultry to eat up the shrunken or injured grain. The farmer, who grows grain only, puts, as the proverb says, "all his eggs into one basket." If that basket fall all is lost, and he is ruined or severely crippled in his affairs. If his grain fail, the farmer who follows mixed farming has his hay and his farm animals to fall back upon, and can thus make a surer living. The farmer who farms, according to this diversified plan, will

also find it profitable to grow root and fodder crops such as we have described. In this way farming will be a safer occupation, and will be much more interesting and profitable. Boys and girls brought up on the farm become fond of the animals grown about them. This is an education in itself of very great value.

(a) *Product of the Flocks and Herds.*

The advantage of raising flocks and herds is that the farmer gets the advantage of the natural increase. While the farmer sleeps his flocks and herds are growing. In Manitoba there is such a superabundance of plant growth upon the prairies that food for the animals in summer costs nothing. It is true, winter is rather long, but the farmer's other work is done, and with the hay cut and cured in summer he has plenty of food for his farm animals. Let the farmer who is a beginner start with two horses, two cows, a couple of pigs, and half a dozen poultry upon his farm, that is with about \$300 or \$400 worth of stock, and in five years he will have, after using an animal now and then for the house, a large stock of farm animals. We would like each scholar to calculate how many farm animals may be produced in five years with the farm stocked with the animals we have mentioned. The sale of beef, mutton, pork, and poultry will be a great means of profit, and these always bring ready money to the farmer.

(b) *Milk.*

We have seen that special breeds of cows are most profitable for producing milk. With well-chosen cows, which have plenty of succulent food, easy access to salt, pure water, and good warm stables in winter, the dealer in milk will be very successful. To those living near large cities or towns the selling of milk to the citizens is found to be very profitable. To a farmer who makes this a specialty the care of the milk, its being cooled and aerated in order that it may be kept sweet and wholesome, and in some cases its being bottled for customers, as required by some modern plans, are points worthy of great attention. The business of the milkman has become very important, now that manufactures and trade are building up our cities and towns so rapidly.

(c) *Dairies.*

The making of butter is a source of great profit in Manitoba, as it is in other provinces of the Dominion. Time was when the butter was sold by farmers to country storekeepers, and packed up in kegs after the butter had been lying in the dusty store, good, bad, and indifferent, all together. The result of this was to make the poor, rancid, or dirty butter poison the whole keg. Such butter, sent abroad, brought Canadian butter into disrepute. But now, by greater intelligence and greater care, butter-making is becoming a fine art. The

milking is to be done in clean stables, into thoroughly clean vessels, by persons with clean hands, and the milk should be immediately strained and aerated to remove any foreign particles and to expel any foul odours. The milk is set away to allow the cream to gather. This should be done in a clean place, with the cans surrounded by cold water—ice cold if possible. Deep cans are better than shallow pans, but the centrifugal cream separator is the best method for getting the cream from the milk. For the deep can system it is a necessary thing to have a thermometer, and the water about the cans of setting milk should mark about 40°F., or cooler if possible. The milk in the cans should be at 90°F. when the cans are placed in the cold water. When the cream has risen from the milk it should be skimmed off before the milk becomes sour. When removed from the milk the cream is kept in a cool place, and made into butter in warm weather every three days. A little sour cream is added to the sweet cream before it is churned. The cream should be tested with the thermometer, and prepared for churning by allowing it to run to 70°, twelve hours being given before it is churned into butter. It needs to be stirred several times during the day preceding the churning. The cream is generally churned at 57° to 60° temperature in summer, and at from 62° to 65° in winter. When, after being churned, the

particles of butter are formed, some cold water with a temperature of from 50° to 55° is added. One quart of water for every ten quarts of cream will be sufficient. The churning is then continued till the particles of butter are about the size of a good shot. At this stage the buttermilk is drawn off and its place supplied by water at the same temperature as before. This may be repeated after further churning, and then the butter is left in the churn to drain, when it is ready to be taken out and salted. The butter after being salted—with from three-quarters of an ounce to an ounce to every pound of butter—is slightly worked over, when it is set apart in a cool place to be again worked until the color becomes uniform and the texture firm after four or five hours of cooling, to allow the salt to dissolve. When butter is not made into rolls to be sold at once it is packed in clean packages, lined with parchment paper, and the whole covered with a wet paste of salt. The condition in which butter is packed has much to do with its profitable sale.

(d) *Creameries.*

It is now being found a very profitable mode of dealing with the milk in many closely-settled country districts to have a creamery or factory established to which the cream may be taken to be made into butter. The advantage of this is that experts are employed who have

every facility for cooling and heating the cream, and who carry on the process according to strict rule. These creameries are being established in different parts of Manitoba, and their butter is so excellent that it is in great demand. The supply of cream is obtained from different farmers, and the gathering is done by the factory. The cream is tested and the value assigned to it with great care. Machines, called separators, are now used for removing the cream from the milk.

The following table shows the advantage of using the separator as compared with the old methods of collecting cream from shallow pans or from deep cans :

FROM JAN. TO DEC.	SEPARATOR.	SHALLOW PAN.	DEEP PAN.
Whole milk—per cent. of fat.....	3.67	3.67	3.67
Skim milk " " "08	.48	.52
Buttermilk " " "18	.22	.24
Unrecover'd fat " " "	2.29	11.63	12.05
Lbs. butter per 100 lbs. of fat.....	113.52	105.57	104.77
Lbs. milk per lb. of butter	24.06	25.89	26.11
Proportion.....	108.52	100.85	100.00

In some scattered districts in the far west the milk is treated by a separator on the farm, and the cream removed and carried to the factory, the milk being left behind for feeding calves and pigs.

(e) *Cheese-making.*

Cheese-making is not easily carried on with success by the individual farmer. It requires a large quantity of milk at one time, and this can only be obtained by the the co-operation of a large number of farmers living near to each other. For this purpose cheese factories are now being established in many places. Just, as in the case of creameries, the superior facilities for making the cheese and fitting it for the market, are giving Canadian factories a high reputation all over the world. It depends much on the character of farming in a locality whether cheese or butter-making will be found the more profitable or convenient.



FARM BUILDINGS.

While the new settler has little choice in the kind of farm buildings he is required to erect, having to take log, sod, or whatever the neighborhood in which he is and his circumstances supply, yet as soon as practicable he should aim at having a good house and good stables and other farm buildings. The choice of site is a very important thing after his farm is chosen. The first step to ascertain, when the pleasantest and best drained spot is chosen, is whether water of a good quality can be obtained. Quite often in Manitoba the site of the house and farm buildings is to be determined by this. To the farmer whose resources are small a simple cheap house is all that can be afforded. Happy is he if in a few years it can be replaced by a better. Certainly a cheaper and smaller house, free of debt, is better than a large house with a mortgage upon it. Formerly in Manitoba lumber was so expensive that log or sod farm buildings were chiefly erected. But experience shows that these last but a short time; they require frequent repairs and are not the cheapest in the end. The requirements of a good building for horses or cattle may be stated as follows:

1. Warmth.

In a cold building a large proportion of the food used by stock is required to keep up the animal heat. In horned cattle this is about 100°F.

Therefore it will pay the farmer, in as much as the material has only to be supplied once in a good number of years, to get good material and have the building well put up. In a warm stable provision can also be made for the safe keeping of roots, which are so desirable for the winter food of cattle.

2. *Light.*

It has been clearly shown that the health of an animal is greatly benefited by the free admission of sunlight and fresh air. For instance the germ of tuberculosis, which is becoming so dangerous to cattle, is found able to stand severe frost, but finds direct sunlight fatal.

3. *Ventilation.*

As all animals give off much carbon dioxide, some provision must be made for the escape of the gas, else the blood will be poisoned and ill health follow.

4. *Convenience.*

The proper feeding and care of cattle requires much labor. Anything that will save time and work is desirable, and this should be considered in erecting farm buildings.

The Bank or Basement Barn.

This is so called because it is partially built into a bank or hill side, and because the horses or cattle are kept in the basement. The first ten feet from the foundation floor is built of stone, which can be obtained in almost all parts of

Manitoba, while the upper story, made of lumber, is used for storing food for the animals. This is the best style of barn for Manitoba, unless the farm may be so level that there is no knoll or hill upon it. The shelter of the bank is a great protection for the animals in winter. By having the ceiling of the basement ten feet high and with plenty of windows in the front there is abundance of light, while with properly built air shafts, good ventilation may be secured. In the upper story the hay, straw, and other material of food is kept, and it can be prepared and given down to the cattle and horses with a mere trifling amount of labor. Although the first cost of such a building is somewhat great, yet it is so permanent and saves such great repairs that it is cheaper in the end than a mere temporary building. Where the farmer's purse will not permit its being completed, the stone foundation may be built and covered over with poles or beams on which hay may be spread. In this way warmth, cleanliness, and advantage are all secured. Stables and other farm buildings should be placed near each other for convenience, and not too near the house. As already stated, good water and drainage are first essentials.

Sheep House and Piggery.

Sheep do not require a warm building, but it should be such as to exclude snow and rain,

and be free from drafts. It should also be convenient to a good yard. The building for pigs should be warm. It needs to be built, in Manitoba, of a double coating of boards with tar paper between. It should be dry and clean. Drainage is very important for a pig-gery.

Cellars and Storehouses.

Especially for butter and cheese making it is a necessity that there should be a good cellar under the house, or, what is perhaps better, an outside building, partly under ground, for milk, meat, and other cold storage purposes. This milk-house should be carefully finished, be well ventilated, and be kept scrupulously clean. It should be regularly whitewashed and pains taken to make it sweet and wholesome. A plentiful supply of pure water, and ice, if possible, is needed near by. Time spent in keeping the milk-house in the best order is money saved. For potatoes, roots, and the perishable food of farm animals, when the basement barn can not be had, good outside cellars are needed. These should be built with care, be well ventilated, and of course warm enough to keep the interior always above the freezing point in winter.

Implement Sheds.

The large quantity of implements, such as plows, harrows, cultivators, mower, and binder, requiring to be used on a Manitoba farm, makes

it very necessary that sheds should be built, in which they may be sheltered. The strong winds, the rain and sunshine will soon rust and destroy machinery standing in the open air. It causes one great pain to see the wastefulness of many Manitoba farmers in allowing valuable implements to weather and decay in the open air. The farmer's wagons, carriage, and all articles used for farm and garden should be safely stored away in dry buildings prepared for the purpose. These need not be expensive, but ought at least to keep out snow and rain. Habits of order and thrift are thus cultivated by having "a place for everything and everything in its own place."



FENCES.

In Manitoba much difference of opinion prevails in various localities as to fences. In some of the largest and best municipalities herd laws have been passed by which farm animals are not allowed to run at large, and when not confined in the corral—the name given to the strongly enclosed field near the farmer's barns—must be watched over by a herd boy. In some districts several farmers combine and engage a herder for the summer months who takes charge of their cattle in common. Where this law prevails fences are not needed, and a large amount is in this way saved to the farmer. In many parts of the country, however, fences are required, and the following purposes are served by them :

1. They confine farm stock in pasture fields.
2. They prevent the destruction of crops by cattle.
3. Fields may be separated so that a rotation of crops may be carried out.
4. Fences protect trees, shrubs, vegetables, and flowers.

That a fence may meet the requirements in Manitoba it must be :

1. Inexpensive.
2. Strong, and high enough to resist all stock.
3. Neat in appearance, and without unsightly corners to collect weeds and rubbish.
4. Durable.

Kinds of Fences.

It is stated that the original fence of America, in the old colony days in Virginia, was the zigzag rail fence. This is largely used even now in the eastern provinces of the Dominion. It is however unsightly, is a shelter for weeds, and requires a considerable clump of forest to supply material for its repairs. The board fence is expensive, displeasing to the eye, and not durable.

The Wire Fence.

Of the other varieties of fence sometimes suggested, the post and wire fence, if properly built, is found the best for Manitoba. There is a good deal of complaint that barbed-wire fences injure farm animals. It is the experience of the best farmers that they have not known injury to be done if the wire fence is kept in good repair. Where the corner posts give way through being poorly braced, and the wire becomes loose or breaks away from the fence, it may become entangled about the legs of animals and injure them badly; but where the fence is in good condition it is almost impossible to drive horses or cattle against it. What is evidently needed is a law not to forbid wire fences, but to punish farmers who allow these fences to fall out of repair.

Posts.

The posts of a wire fence should be of cedar, tamarac or oak, and these are now brought

in from the eastern part of Manitoba. The posts should be sound to the heart. To prevent decay the bark should be removed, and the lower three feet charred in fire, or better still, dipped in hot tar. In size the posts are from four to eight inches in diameter at the small end, and for the sake of neatness moderately straight. Eight feet long is a good length, as this will allow them to be put three feet in the ground, and have sufficient above ground for fastening the wire.

Construction.

Posts are generally placed sixteen feet apart, but if a top rail is to be used eight feet is the proper distance. The holes, three feet deep, can be dug easily with a post auger. In the Red River valley it is the custom to use smaller posts and drive them, but this plan cannot be followed in all parts of the province.

Bracing.

Before the wire is stretched all the corner posts and gate posts must be well braced. If the fence is a long one, a few additional braced posts are needed at regular intervals as well. If bracing is not well done the strain of the wire will draw the posts to one side and loosen the fence. The ground end of a brace needs to be set against a stone or post.

Wire.

Fence wire is made of two strands of galvanized wire, the barb being now generally fastened

to both of them. The wire is sold in spools of about one hundred pounds each. Some skill is needed to unroll the wire. This is perhaps best done by hanging the spool in the space usually occupied by the tail-board of the wagon, and then, as the wagon is drawn slowly forward by the horses, the wire can be unwound without difficulty. In stringing the wire, it is made tight by stretchers provided for that purpose.

Rails.

A rail placed at or near the top of the posts adds greatly to the strength and appearance of the fence. This rail serves best when it is made of a scantling, two inches by four, planed on all sides. It can be nailed on the top of the posts, but has a better appearance if placed five inches lower. To complete the fence two furrows should be plowed on each side, throwing the soil under the lower wire.

The School Fence.

As has been already stated, there can be no improvement of the school grounds, trees cannot be successfully planted, school gardens grown, or even tidiness secured, until a fence encloses the grounds. This should be attended to by trustees as soon as the school is built, and it is expected that the regulations of the Education Department will require this. The

double smooth wire fence may perhaps be found better for this purpose. We hope soon to see the day when every Manitoba school house will have a fence around it, and every school ground be a picture of neatness.



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TREES AND SHRUBS.

In Series I. of the course in Agriculture, much is said of Arbor Day and its importance to Manitoba. The matter of tree-planting is so essential to our province that we wish to give additional information regarding it. The obstacles in the way of successful tree-growing in Manitoba are the long, cold winter, and the hot winds and light rainfall of summer, now and then occurring. The first of these can only be met by planting hardy varieties of shrubs and trees, and the evil effects of drought can be greatly lessened by proper cultivation.

Hardy Varieties.

For a long time it was thought that because a tree was hardy in Manitoba, therefore trees of the same variety, grown from eastern seeds or plants, would also prove hardy. In practice this is not found to be the case. The white elm, for instance, grows wild in our province, and seedlings from it are quite hardy, but small trees raised from Ontario seed are decidedly tender. It will evidently take several generations to sufficiently harden many imported varieties. The fact of a tree living through one winter does not warrant us in supposing it will succeed generally. It may flourish for a year or two, and then, in an exceptionally cold or dry season, perish, leaving

an ugly blank in our plantation or grounds. After numerous disappointments we have learnt to depend mainly on native forest trees. There are, however, a few trees from Ontario, and several from Russia, which have thriven in Manitoba.

Surface Cultivation.

Though it has before been stated, yet it must be again and again repeated, that the secret of tree growing in Manitoba is constant surface cultivation of the soil. By this means the weeds are killed and the moisture conserved. With a constant hoeing or cultivating of the surface we can almost be independent of rain-fall. Once, however, let the ground become baked, allow the water to evaporate, and the trees will perish. Of course as soon as the trees become sufficiently large their shade keeps the moisture in the ground, and cultivation is not needed.

Trees Propagation.

Trees and shrubs are usually propagated from seed, or by cuttings, layers, or grafts. Seeds are so varied in form and quality that various methods are to be followed in propagating them. For example, the ash-leaved maple has a small, dry-looking seed, with a wing attached to it. In the wild state a large proportion of these seeds hang on the trees until midwinter, without injury to their germinating power. This shows us clearly that they may be stored

away in a dry place all winter, and be sown in spring to sprout successfully. In contrast to this look at the thorn apple. It has large seeds, with a thick coating of flesh surrounding them. In a state of nature these apples or haws fall to the ground in autumn, are buried in leaves where the pulp decays, the seeds are liberated, germinate, and the young plant grows up under the protection of the mother plant. To succeed with the thorn tree, or any tree of like fruit, we must imitate nature as closely as possible, by removing the pulp, and at once burying the seed, for it is found that if the pulp is allowed to dry, not one per cent. of the seed will germinate. In the case of seeds that will sprout within a year it is found to be the better plan to sow them as soon as fully ripe, in the seed bed, taking care to remove any pulp that may surround the seed in the fruit.

Seed Beds.

The seeds of trees and shrubs are generally sown in specially prepared seed beds, either in narrow rows or thickly broadcast. This avoids the labor of keeping a large plot of ground loose and free from weeds. After one or two years the seedlings are transplanted to the nursery, which is simply a more extensive seed bed. In the nursery the young trees are planted in rows three or four feet apart, and two or three feet from each other in the row.

They remain growing in the nursery till needed for transportation to their permanent location.

Cuttings.

Nearly all the soft-wooded trees, such as poplars and willows, are propagated from cuttings. These are about eight inches long. They are cut in the autumn, bound up in small bundles, and either buried in the soil outside, or in boxes of sand under cover. By springtime the ends of the cuttings are dry and hard and ready for planting. Only one bud is left exposed to the air. As soon as well rooted these cuttings are removed to the nursery. Cuttings are made from either ripe or green wood, new wood or old, as well as from roots. Experience shows the variety of treatment which is required.

Layering.

This consists of bending a branch or some other part of the plant down to the ground and covering it with soil. Thus fastened it takes root while still a part of the original plant. When finally established by its own roots it is separated from the mother plant, and may then be removed to the nursery. The Snowball, which is a species of *Viburnum*, and the Gooseberry, are often propagated by this means.

Grafting.

This is seldom used for forest trees, but is largely employed with fruit trees, as well as with

ornamental trees and shrubs. It is usually effected by cutting off a small branch of the tree, splitting the fresh end with a sharp instrument, and inserting a small cutting of another variety of plant called a scion. The scion grows into the supporting plant and produces fruit after the nature of the scion.

Adaptations of Trees.

Trees are utilized for hedges, wind-breaks, ornamental planting, avenues, and forestry proper. Some varieties are suitable for one of these purposes, others for another. Upwards of one hundred varieties of trees and shrubs are found hardy, and are now growing on the Experimental Farm, Brandon. We can mention only a few of the more important as adapted for the several purposes named.

Ornamental Hedges.

The Caragana, or Siberian Locust, which belongs to the Pea family, is the most promising plant for this purpose. It is a small tree and covered with flowers in summer. It may be propagated from the seed.

Hedges and Wind-breaks.

The Russian Poplar and Sharp-leaved Willow are the most successful hedge plants yet tried in Manitoba. They are propagated from cuttings, and are planted in two rows, three feet apart, the plants breaking joints with one another.

Ornamental Planting.

For this end trees must have a graceful appearance, and be set at such distances from each other as to allow vigorous growth. Such trees should be free from catkins, produce no suckers, and have no gummy ooze to attract insects. It is difficult however to obtain trees which will grow well in Manitoba, free from all these objections. On the whole our best ornamental trees are Russian Poplar, Native White Spruce, Siberian Poplar, Laurel-leaved Willow, Elm, Ash-leaved Maple, and Caragana.

Avenues.

A good avenue tree is exceedingly hard to obtain. The white elm is by far the best avenue tree in Ontario, and judging by our limited experience, it is full of promise for Manitoba. It is hardy, sufficiently tough to stand heavy winds, very graceful in appearance, and free from insect enemies. Our native ash-leaved maple is generally used for that purpose, and does fairly well if properly cared for. If neglected, it is soon infested with insects, splits with rapid changes of the weather, and soon dies.

Forestry.

By this is meant the growing of blocks of forest trees, as largely done in France and England in the old world, and in Nebraska and other parts of the United States. These extensive plantings serve for shelter, and also for producing

large quantities of timber. In growing clumps of trees we should imitate nature. In a natural forest there is a variety of trees. Evergreens, deciduous trees, and fruiting shrubs are found side by side. The result of this is that the trees, shrubs and brushes protect each other. The fruit-bearing plants supply the birds with a part of their food, and attract the feathery host to destroy the insects which do injury to the trees. To attract birds our berry-bearing shrubs, such as Buffalo berry, High Bush Cranberry, Saskatoon, and the like, should be interspersed throughout the plantation. For the more exposed places vigorous growers like the Cottonwood, Ash-leafed Maple, Russian Poplar, and Willow are very useful; while the more tender trees, such as Birch, Ash, Pine, and Spruce will thrive under their shelter. If the production of firewood or other timber is desired, the following trees should be largely cultivated: Pine, Spruce, Tamarac, Birch, Ash, Poplar, Oak, and Elm. These supply a considerable part of our fuel.

Shrubs.

Many persons are of opinion that there are few flowering shrubs hardy enough to endure the Manitoba climate. This is a mistake. At the Experimental Farm, Brandon, not less than fifty varieties, some flowering and others bearing ornamental foliage or fruit, have been proved hardy. Of these the flowering shrubs

include many varieties of Lilac, Flowering currant, Tartarian honeysuckle, Snowball, Broom, Caragana, Japan rose, and eight varieties of Spiræa. The other varieties are grown for their fruit or foliage.

We look forward to the day when Manitoba prairies will be covered with trees, and when with shelter thus afforded all the flowers and fruits of the Northern Temperate Zone will grow abundantly.



REGULATIONS FOR MANITOBA SCHOOLS

AS TO

TEACHING OF ELEMENTARY SCIENCE.

The Department of Education of Manitoba calls the attention of teachers to the following important points :

Agriculture in the Public Schools.

(1) "Our Canadian Prairies" (Series I. of the authorized Course of Agriculture for Forms VI. and VII. in the Public Schools.) Accompanied by 40 colored plates of Manitoba flowers to be placed in each school.

In schools which are carried on during the winter months and have vacation in summer, it is recommended that the book should be taken up in two parts as follows :

The month of April may be spent in reading pages 1-18, and 98-139, and in preparing some of the selections for Arbor Day, which comes in May. A sharp lookout should be kept for the early anemone, the dwarf buttercup and other early flowers, and systematic work ought to proceed according to the directions of the text book, until the end of June.

After vacation the months of September and October may be used in the study of the later flowers and enable the class to finish the work begun in May.

(2) "Prairie Agriculture" (Series II. of the authorized Course of Agriculture for Form VII. and VIII. in the Public Schools).

On the opening of the schools in September the experiments in the germination and growth of seeds, pages 15-20, may be begun. In the middle of October, when the time

of the teacher will be more at his disposal on the close of the botany season, the chemical experiments, pages 5-14, should be undertaken. Taken twice a week they will last till the Christmas holidays, and they should be regularly and faithfully performed. The teacher ought to work over every experiment in private before bringing it into the class. Two pupils, a boy and a girl, may be detailed as assistants in each experiment, and all in the class should be thus taken in turn. The assistants should be required to do all the arranging and as much of the experiment as possible, under the direction of the teacher. The remainder of the "Prairie Agriculture" may be taken up in January and finished in June.

Normal Schools.

Practical teaching on the Botanical and Chemical portions of the Course of Agriculture, Series I. and II., will be regularly given in all Normal Schools, Provincial and Local.

Science for Teachers.

NOTE.—School Boards are called on to note the fact that a certain amount of apparatus is absolutely necessary for the preparation of candidates who go up to the teachers' examinations. Candidates prepared without the use of apparatus in Agriculture, Botany, Chemistry and Physics are almost certain to fail on presenting themselves at the Teachers' Examinations.

1. Botany (3rd and 2nd Classes).

Every Intermediate and Collegiate School will be expected to have a Herbarium, and Inspectors are instructed to specially report on this, and on the practical work done in Botany, the Botanical Note Book being taken as the evidence of this. Evidence as to the practical study of the germination and growth of plants will be required.

2. *Chemistry.*

Regular notes of each experiment performed and kept by the teacher are expected to be laid before the Inspector.

Practical work is required of each candidate along the line of the experiments laid down. Arrangements will be made for a practical examination in the Chemistry named at the Teachers' Examinations.

3. *Agriculture.*

Practical work on the Botany and Chemistry of the Agriculture Course, Series I. and II. will be required at the Teachers' Examinations.

4. *Physics.*

The necessary apparatus for conducting the experiments in Gage's Physics, chapters 1 to 5, must be provided by Intermediate and Collegiate Schools as a condition for such schools receiving the special grant. Arrangements have been made for obtaining these at the lowest rates in Winnipeg.

Candidates at the Teachers' Examinations will be required to pass a practical examination in any of the experiments on the list following, as well as in the book work of chapters 1 to 5, viz.:

The experiments 1-110 in Gage, omitting 3, 4, 5, 14, 15, 83, 40, 42, 51, 59, 60, 61, 66, 68, 73, 74, 75, 76, 77, 78, 79, 98, 102, 103, 109.

