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MR. W. J. T. GOODMAN
(General Manager of the Tramway Trust).

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## THOMPSON COMMERCIAL SCHOLARSHIP.

The George Thompson co-operative scholarship in commerce at the Adelaide University, which was founded by the Adelaide Co-operative Society, Limited, Angus street, to perpetuate the memory of the late Mr. George Thompson, who was founder, general manager, and secretary of the society for 37 years, has been awarded to Mr. Eric A. Gibson, of John street, Goodwood Park. The scholarship is tenable for five years, and is for the benefit of members of the society, or their sons and daughters.

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# THE MAN ON THE LAND.

## CHEMISTRY OF FARM PRODUCTS.

### A PAPER FOR PRODUCERS.

By A. T. Jefferis, B.Sc. (State Agricultural Chemist).

Chemistry is a science abounding in technical terms and ugly names, intelligible to the chemist, but awkward to the layman. These will be avoided as far as possible. As, however, chemical processes are at the root of all husbandry, many substances are familiar by name. These may be examined, and the few simple experiments shown should make the farmer acquainted with most of the elements concerned in plant and animal nutrition, whereby terms occurring in papers and journals might convey more than a hazy idea of the substances and processes to which they refer. The term "chemistry" is applied to that science which embraces all that is known of the composition of any material in the universe, whether solid, liquid, or gaseous, and the changes which such matter is constantly undergoing. Hence the chemist is not necessarily concerned with pills and toothpastes, as so many suppose, pharmaceutical chemistry being on a small, if important, branch of a universal subject. Agricultural chemistry deals with all material living or dead concerned in the growth of crops and raising of stock, and is hence the foundation upon which all methods of soil improvement and feeding must be built. To be a successful farmer one must be conversant with the best methods of soil treatment. "Best," however, is here used in a relative sense only. Finality has never been, and never will be, reached. Agriculture in South Australia has attained a standard as high for the existing condition as perhaps anywhere in the world. Yet there is an infinity of progression still possible, and for a farmer to advance it is not sufficient for him to know the best proved method of procedure, but to fully understand the "why," and, from this knowledge, evolve the new "how."

Who keeps the pinions of his mind
 Feathered, unfettered, free
From webbed use and wont which bind
 With false authority;
And hungering for truth would throw
Its beak against the shell, and know
 The naked kernel, see
Where cause has embryonic root
Where plumule of effect may shoot.

### The Organism.

The living parts of plants and animals are composed of innumerable minute vessels or cells containing a jelly known as protoplasm. These are Nature's laboratories in which all the compounds of the body are made. Through protoplasm passes the food material absorbed as simple compounds and emerging as the diverse complex material going to build up the living body. Protoplasm is similar in plants and animals. Thus there is no essential difference between the cells of a gumtree and a genus, a Prime Minister, and a Pollywog, the living portion of each being this jelly and containing some 11 elements:—Carbon, hydrogen, oxygen, nitrogen, sulphur, chlorine, phosphorus, potassium, calcium, magnesium, iron. "Element" is the term given to primary substances such as iron and sulphur, which cannot chemically be split up into anything simpler. Elements are Nature's raw material from which she was built up the universe, just as stone, bricks, mortar, wood, and iron are used in building, yet many thousands of houses of different design may be made from these, so from the comparatively few elements in the world, fewer than one hundred, thousands upon thousands of different compounds are made, while protoplasm, and consequently all living matter, contains only a few of these elements. The distinction between plants and animals is mainly a question of nutrition. Plants feed upon simple compounds taken from the soil and air, animals upon more complex substances built up by the plants or other animals.

### Processes of Nutrition and Growth.

All plants consist essentially of the following compounds:—1. Water, containing the elements of hydrogen and oxygen. 2. Carbohydrates (sugar starches), fibre—hydrogen, oxygen, and carbon. 3. Fats and Oils—Hydrogen, oxygen, and carbon. 4. Proteins—Element nitrogen in addition. 5. Mineral Salts—The other essential elements. The protoplasm obtains the material to make these compounds from the soil. The air is mainly a mixture of two invisible gases, oxygen and nitrogen. Oxygen is utilized by animals in breathing, and to a smaller extent by plants. It is this gas which is instrumental in the burning of fuel and in the rusting of iron. Respiration or breathing is a process of slow burning, the body temperature of animals being due to this. Substances burn very violently in pure oxygen. Even iron will be consumed with great brilliancy, uniting with the oxygen to form rust. Nitrogen, on the other hand, is very inactive, and serves the purpose of diluting the oxygen. The nitrogen present in the air, although comprising four-fifths of the volume, is not used to any extent directly by plants or animals, although recent research in America indicates that the former may absorb and use a small portion. In addition to water vapour in the air, there is also present small quantities of a colourless gas, a compound of the elements oxygen and carbon (or charcoal) supplied largely by the outgoing breath of animals. It is this gas which is of prime importance to plants. Green plants have the power, under the influence of sunlight, of absorbing the carbon-dioxide, as this gas is called, using the carbon to build up their tissues, and expelling the oxygen. Since about one-half of a dry plant is carbon, it will be seen that the air is a great source of nutriment.

### Balance of Nature.

It is interesting to note how Nature keeps a balance. Animals would deplete the air of the oxygen necessary for their breath, were it not for that constantly supplied by vegetation. In return the animal supplies carbon-dioxide to the air essential to plant growth. From the soil plants absorb:—(1) Water. This liquid is composed of two gases—oxygen and hydrogen. Hydrogen is the lightest gas known, and is used for filling balloons. It is extremely inflammable, and explodes when mixed with air or oxygen, and ignited, forming steam, which condensea water. From 60 to 90 per cent. of a green plant consists of water. Thus, from air and water the plant obtains the three elements—carbon, oxygen, and nitrogen, which go to make up the sugar, starch, fibre, and oil mentioned above. The nitrogen for the proteins is obtained from the soil in the form of nitrates dissolved in the soil moisture. These nitrates are supplied by various means:—(a) Small quantities brought to the soil from the air by rain; (b) the breaking down of proteins contained in the dead vegetable and animal matter, for example, stubble and manure, by bacteria; (c) the conversion of atmospheric nitrogen into nitrates by certain bacteria in the soil. These appear to be very active in South Australia; (d) the absorption of nitrogen from the air by particular bacteria living in the nodules on the roots of peas, lucerne, and other legumes, and its conversion into nitrates. Hence the advantage of legumes in crop rotation; (e) the addition of nitrogenous fertilizers, such as sodium nitrate and ammonium sulphate.

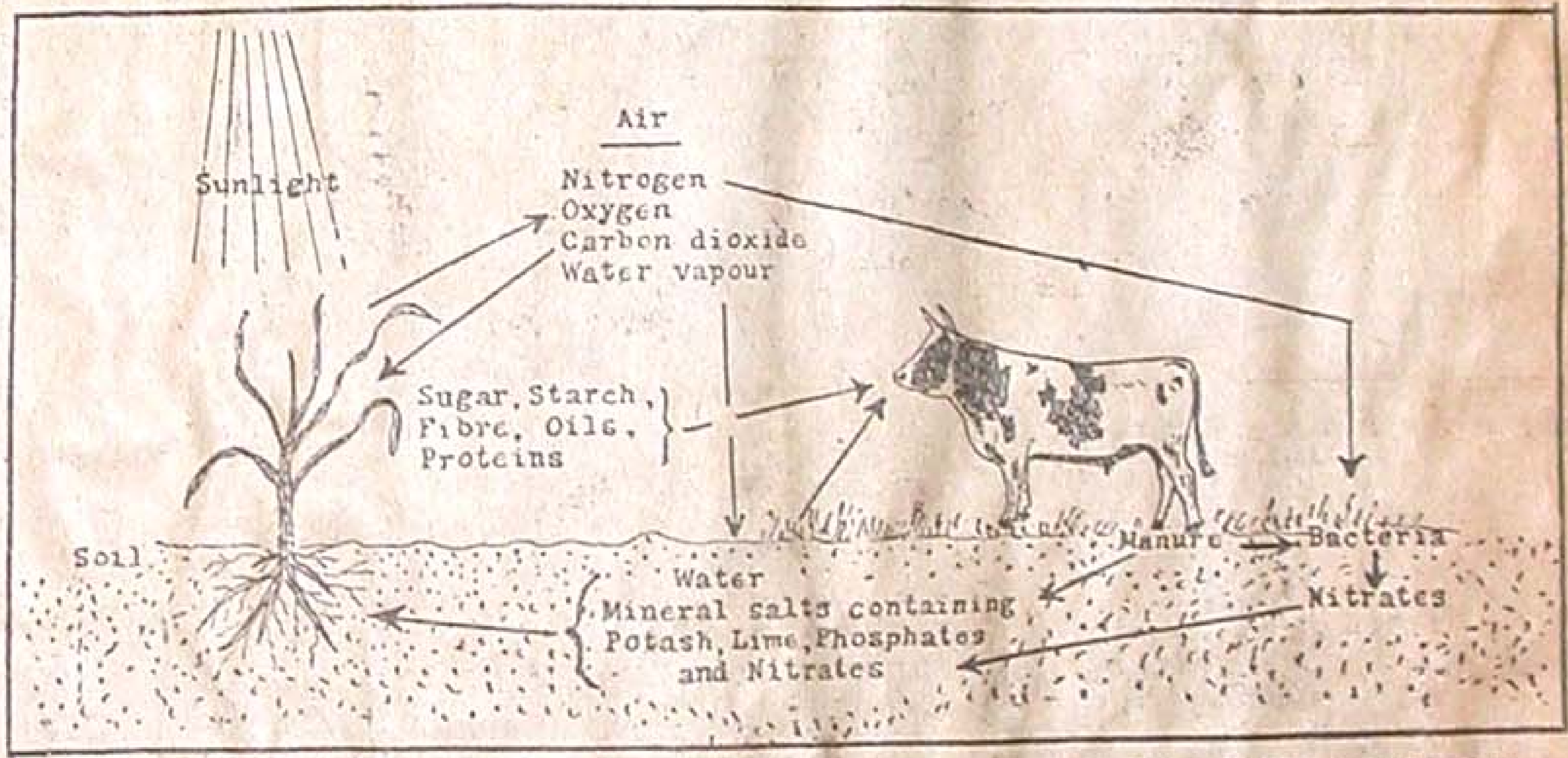
### Nitrogenous Fertilizers.

The use of nitrogenous fertilizers is very general throughout the world. In South Australia we manage for the most part to get along without them. The nitric bacteria appear to be particularly active in our climate, and keep pace with the depletion made by the removal of crop and stock. Whether in the future we may have to use nitrogenous manures will depend upon two factors. In the first place more intense cultivation, if found possible under our dry conditions, will remove more nitrogen annually, and consequently the soil supply may need augmenting. Secondly, it will depend upon what class of nitrogenous bacteria are especially active. If it be those fixing nitrogen from the air, they may keep the supply adequate. If, on the other hand, it be these microbes working on the organic matter in the soil, the supply of this must gradually decrease, since every non-leguminous crop, although returning a certain amount of material as stubble, or as droppings, necessarily removes more than it puts back. Finally, from the soil a plant obtains its necessary nutriment. Of the seven essential elements left, four are usually present in sufficient amounts in every soil for plant requirements. Sulphur in the form of sulphates, iron as the oxide imparting the red or yellow colour to the soil, magnesium as the carbonate, chloride or sulphate, calcium as the carbonate (limestone) or the sulphate (gypsum), and chlorine as chlorides of the above elements. Sulphur and iron you are familiar with. Magnesium is the bright metal which burns brilliantly in air, and is used for flash lights. Chlorine is a heavy greenish gas, with a suffocating odour, and poisonous when inhaled. Chlorine was the first poisonous gas used by Germany. It is contained in common salt.

### Potassium and Phosphorus.

There are two elements remaining—potassium and phosphorus. The former is a soft metal, which quickly tarnishes in air, and if thrown on water combines with it so violently that the gas hydrogen, liberated from the water, catches fire, and burns with a purple flame. Potassium, therefore, has to be kept in kerosine, upon which it has no action. The compound formed by the oxygen of the air and potassium is known as potash. This is present in most soils, in combination with other elements. South Australian soils mostly contain a plentiful supply of this, although some of our soils may benefit by a dressing of sulphate of potash or kainit. Phosphorus, on the other hand, is present in very meagre quantities throughout the State, hence the general use of super and other phosphatic manures. The element phosphorus is a yellow waxy solid, which glows in the dark, fumes in air, and will catch fire spontaneously. Phosphorus is extremely poisonous, hence it is used for rabbits. The baits are generally made by working pollard into a paste, with a solution made by dissolving yellow phosphorus in the liquid carbon-bisulphide. The latter evaporates, leaving the phosphorus disseminated through the pollard. A piece of blotting paper, if soaked in this solution, and waved in the air, will catch fire. Too strong a solution of phosphorus, therefore, should not be used in making baits, and care should be taken in laying them or fires may result. Having examined all the elements which the plant requires for its growth, it should be realized that the soil must be supplied with any of these which may be deficient. All must be present in sufficient quantities for the crop requirement. Just as a chain is as strong only as its weakest link, so an insufficiency of any one essential element will reduce the crop, and that particular element must in some way be increased.

## NATURE'S CIRCLE.




The diagram explains how a plant in nourished, its subsequent conversion into food, and ultimate return to the soil from which is sprang.

### Food Value.

It is not within the scope of this introduction to go fully into the question of foods and balanced rations. A few words, however, on the principle ingredients of a fodder, may not be out of place. As has been noted the three classes of elaborated compounds in a plant are carbohydrates, fats, and proteins. Although all of these are concerned in the nutrition and energy of an animal, each tends towards a particular function:—Carbohydrates—heat, energy, then fat; fats and oils—fat, then heat, and energy; and proteins—flesh, then heat, and energy. The appended table will show the composition of certain fodders, but it must be borne in mind that the digestibility, palatability, and the presence or absence of much fibre, have a very important bearing upon the actual value as a food, which therefore can only be assigned when all points have been determined. Seasonal variation in the composition of fodders is also very marked. This season's hay contains much less protein matter than last season's crop. Again, in general, it may be claimed that oaten and wheaten hay grown in our comparatively dry climate, are considerably richer than those of wetter countries. Here in Australia it is the proteins with which we are mainly concerned in estimating the value of a concentrated food. Our stock in the main find plenty of the other materials in the paddock, and to balance the rations in the stall a food with high protein contents is required.

Various Fodders Analysed.

| | Water. | Fibre. | Carbohydrates. Starch, & Sugar, &c. | Fats and Oils. | Protein. |
|---|---|---|---|---|---|
| Wheat grain | 11.1 | 3.2 | 67.4 | 2.2 | 14.8 |
| Barley grain | 10.1 | 2.3 | 69.6 | 2.1 | 12.6 |
| Oat grain | 11.0 | 9.5 | 59.7 | 5.0 | 11.5 |
| Maize grain | 12.0 | 2.0 | 65.8 | 5.5 | 13.1 |
| Pea grain | 10.5 | 14.4 | 51.0 | 1.3 | [illegible] |
| Linseed grain | 9.2 | 7.1 | 22.1 | 33.7 | [illegible] |
| Wheat bran | 11.7 | 8.2 | 57.1 | 3.6 | 14.1 |
| Wheat pollard | 11.7 | 4.9 | 60.9 | 4.5 | 15.2 |
| Lucerne hay | 8.6 | 16.3 | 24.3 | 3.1 | [illegible] |
| Oaten hay | 11.2 | 20.8 | 36.6 | 2.1 | [illegible] |
| Oaten Straw | 9.2 | 37.0 | 42.4 | 2.2 | [illegible] |
| Wheaten straw | 9.6 | 38.1 | 45.4 | 1.3 | [illegible] |
| Lucerne | 76.2 | 4.5 | 9.1 | 0.3 | [illegible] |
| Sorghum ensilage | 76.4 | 6.7 | 12.2 | 0.4 | [illegible] |
| Saltbush | 79.2 | 6.0 | 8.3 | 0.5 | [illegible] |
| Potatoes | 78.9 | 0.8 | 17.3 | 0.1 | [illegible] |
| Turnips | 90.5 | 1.2 | 6.2 | [illegible] | [illegible] |
| Copra cake | 9.5 | 26.8 | 37.6 | [illegible] | [illegible] |
| Molasses | 25.0 | — | 66.0 | — | [illegible] |
| Milk | 87.2 | — | 5.0 | [illegible] | [illegible] |
| Skim milk | 90.6 | — | 5.3 | [illegible] | [illegible] |
| Linseed meal | 10.0 | 8.4 | 36.7 | [illegible] | [illegible] |