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SOIL AND NUTRITION

The subject I have chosen for my address is one of such magnitude that I cannot hope to do more this evening than scratch the surface of it.

It is, however, of supreme importance to all, and to none more so than to the medical profession, for not only does each member of the profession owe to it his own life, but also he must know something of the nature of its products, so that he may be able to advise his patients in the matter of diet.

Twice within the last quarter of a century we have been, in these islands, on the verge of starvation, and only by the superhuman efforts of the farmer has this been averted. This is a state of affairs that can be prevented, and therefore should never be allowed to recur.

The very fact that we have been so hard put to it has stimulated many to seek again, in the cultivation of the soil, some of the joys that enriched the life of these islands, and laid the foundation of our present greatness.

When we speak of soil, I think that we ought to keep clearly in our minds two things – first, the soil as such, and secondly, the many additional constituents that go to make up what I might describe as real soil.

Some years ago I paid a visit to the North Cape and, despite the beautiful picture of the midnight sun, the utter desolation of that scene still lingers with me.

As I wander across some of our fertile fields here at home, it is hard to believe that, if one could go back far enough in time, one might see here just a similar picture of desolation as exists to-day on the North Cape.

This wonderful change has been brought about by the weathering of the rocks with the formation of soil, and its deposition here and there by the movement of ice, water, and wind.

But just as the rocks from which it springs are composed of different substances, so also the soil varies between sand at one extreme to clay at the other.

These two substances, sand and clay, are, as we all know, very dissimilar in their properties, but I should like to comment very briefly on some of these points.

First of all there seems to be something permanent about sand; the winds and the tides beat upon it, but, apart from moving it from one place to another, no other change takes place.

If a particle of sand could be kept under observation from one age to another, no change would appear to have taken place in its shape, and it is this power of the particle to maintain its consistency that makes the mass porous, and this allows of rapid drying.

Growth in sand is practically impossible, but how different it is with clay. This is a substance made up of minute particles, which can be packed so closely together that the air space between them is limited exceedingly. It is described as a “colloid” and therefore is “like glue.” So strong is this quality that only a very little is required to be used to give this characteristic to other soils. It is interesting to point

out that the sum of the pores is as great, and indeed may be greater, than an equal bulk of sand. The pores are, however, so fine that movement of water is difficult, and one may have the unusual experience of seeing a plant withering because it cannot extract the water from the very small pores. When water-logged soil, deeply impregnated with clay, dries in the summer-time, it shrinks, and thus the cracks in the soil, familiar to us all, are produced. Clay therefore tends to dry in lumps,, and this renders cultivation difficult and exacting, and demands knowledge and patience on the part of the farmer as to how best to deal with it.

I assume that at first this soil is incapable of supporting life, but later this quality is obtained by absorbing into it many forms of organic life. Thus we have our soil, but experience teaches us that something more than mere soil is essential to produce the maximum of food, and when we examine this something we find that it is sub-divided into certain factors, and that these, because they exert a limit on production, are known as limiting factors.

Six of these factors are recognised:–

1. Plant food.
2. Water.
3. Air.
4. Temperature.
5. Root room.
6. Freedom from harmful substances, e.g., pests.

None of these factors can replace another; all must be present; absence of any of them restricts growth.

Let us look at each of these in turn – and first, PLANT FOOD:–

In the "London Chronicle" dated Saturday, September the 2nd, 1786, there appeared the following:–

"A gentleman at Hendon who farms largely has just erected a mill, which is worked by the Brent brook, for grinding bones into a coarse powder for manuring land. According to experiments made in some parts of the county, the ground dressed with this kind of manure is rendered surprisingly prolific, and it is supposed that the energising quality will not be exhausted in less than twenty years."

Historically it might be of interest to follow up this experiment, but our time is too limited.

Chemistry as early as 1755 had commenced on the "Principles of Agriculture," but was itself not sufficiently advanced to accomplish much. Changes in this branch of science were already under way, and with the new methods Theodore de Saussure of Geneva was able to prove that plants derive their carbon and oxygen from the air, and their nitrogen and mineral matter from the soil.

This work was confirmed by a Frenchman, J. B. Baussingault, who, working from the farmer's angle, measuring and weighing the manures applied and the crops obtained, was able to show how far other sources, e.g., air, rain, and soil, had been drawn upon.

The next step in the advance was made by the German Liebig, who suggested that farmers could increase their crops by adding more of the necessary mineral matter to the soil in the form of definite salts.

Looking back from our present standpoint it seems a simple observation, but at the time it was fraught with great possibilities, and showed wonderful forethought.

The next event was staged in England – John Bennett Lawes commenced to make a number of experiments to test the manurial value of various substances. The chemists had provided him already with the information that bones contained calcium and phosphorus in the combination known as phosphate. Further, they had discovered three other phosphates of calcium – one of which was soluble in water, i.e., superphosphate of lime, and the other two insoluble. The soluble one could be prepared from the insoluble by the addition of sulphuric or hydrochloric acid. Geologists were keeping well in step, for they had discovered large deposits of mineral calcium phosphate, and Lawes recognised the importance of this mineral, and showed that by treating it with sulphuric acid the same soluble phosphate as bones could be produced.

In addition, Lawes also demonstrated by experiment that sulphate of ammonia increased plant growth. He went even further and showed that it was the nitrogen element in the ammonia that was the active agent. He carried out field experiments with these two artificial fertilisers, and showed that the yield of wheat could be increased from twenty to thirty bushels per acre.

These advances made in 1842 were received, as one can well understand, with a good deal of scepticism and foreboding by the men of the time, and yet by 1855, and presumably by the use of fertilisers, the farming industry had entered on a period of prosperity hitherto unknown.

Liebig had emphasized in 1840 the importance of potassium salts as plant nutrients, and Lawes and his co-worker Gilbert had added potassium sulphate to their "mineral manure" without carrying out any experiment to prove or disprove its worth.

About the year 1861 the Stassfurt mines were opened, and some three years later these were visited

by one Agustus Voelcker, and he ordered a quantity of the crude potash salt and carried out experiments in England, but these were inconclusive. Later, with the improved cultivation of the potato, the advantages of this salt became apparent.

Of the next four limiting factors – water, air, temperature, and root-room – all might be described under the word cultivation.

In the lapse of time since Adam was expelled from the Garden of Eden, and was told – "In the sweat of thy face shalt thou eat bread," one might be justified in concluding that a definite plan could have been formulated, and that cultivation could have become an exact science, but this is not so, and the very first act of all cultivation is still a matter of controversy.

H. L. Gee makes one of his characters say:– Plough shallow, and you'll get a worthless crop. Plough deep, and you'll get a good harvest, most years."

I have watched ploughmen of the old school lay the furrow well over, for, as they say, it makes a good seed bed. But perhaps, in the very next field, another ploughman will be setting the furrows on their sides so as to give plenty of depth for good root formation.

The point is debatable, but for myself I agree with Gee's ploughman, and I do so for the following reason amongst others:– As the sole of the plough passes over the ground it tends to consolidate it and, when this is done repeatedly and to the same depth, a "sole or pan" is formed through which penetration, for either roots or water, is difficult, and the crop suffers. Therefore, by going as deep as possible there is ample room above the pan for root-room and water.

But ploughing is the first step in what should be a very extensive process. To obtain a good tilth is the object and aim of all good farmers, and all labour spent on this work is well spent and returns a good dividend.

Temperature plays an important part. A severe frost on the newly ploughed land is worth many discings, and will often turn a sticky clay into a friable crumb; and here let me turn aside for a moment, and remark that frost is of benefit also because it locks up the moisture, and so limits the loss of nitrogen in the form of nitrates. This is the origin of the old proverbs:–

"Under water, famine; under snow, bread."

and

"A snow year is a rich year."

But a knowledge of what the weather is going to do for the next twenty-four hours is of great importance, and will often save days of labour if interpreted correctly. Hence the importance of more correct weather forecasts in the future.

"Speak to the earth and it shall teach thee," said Job, and I have no doubt of the truth of this remark. Haphazard sowing of crops on ground ill prepared is worse than useless, and produces its own penalty.

Having discussed cultivation, I think it would not be out of place if I made a few remarks, at this point, on seed and sowing.

It may not be understood generally that for the small cost of a few pence the Ministry of Agriculture will supply you with a report on a specimen of the seed it is proposed to sow.

This report deals first with germination and, as a rule, the quality of seed, but it also deals with purity, and gives an idea of the number of weed seeds per bushel. I do not think that it is a good policy to dogmatize from a few facts, but it is my experience that seed is being used at present without being adequately cleaned. In other words, there are far too many weed seeds present, and of course these, when sown, naturally reproduce themselves, with the result that the land becomes more and more polluted by their presence. But there is another point of importance; the seed itself may be diseased and the resulting crop also infected. Much has been done to overcome this by the use of certain dressings. These dressings are composed, for the most part, of a mercurial preparation, and can be used as a dusting powder and applied to the seed immediately before sowing. I do not know if the addition of even a small quantity of mercury to the soil is likely, in the long run, to have a detrimental effect, nor do I know whether the diseased condition of the crop is likely to have any injurious effect on the human consumer, but these are points which for the present I should like to leave to those with more adequate knowledge.

Now, as regards sowing, the picture of the sower going forth to sow and treading lustily across the plough is almost a thing of the past. It may be seen occasionally however, but if so it is usually the farmer-owner, and he is almost certain to be an old man, for few of the present-day farm labourers are sufficiently skilled in this art.

There is, however, in the mechanical seeder a first-class substitute. This has two great attributes: first, the rate of sowing can be controlled to a nicety, and secondly, the seed is sown to an even depth, and is covered immediately. It is easy to obtain the rate of sowing by referring to a book, but on referring to the practical farmer a very considerable difference may be disclosed. On inquiring, it will be pointed out that by sowing rather more than is thought necessary, and thus by crowding the breird, a finer straw is

produced, which is more palatable and nutritious to cattle.

I regard this as a very debatable point, and from my own experience I believe that by sowing as lightly as justifiable, a straw is produced quite as good from a feeding point of view, although it may be a little coarser; but what is of far greater importance – the yield of grain is better.

We now come to the last of our limiting factors, viz., pests. What a wealth of expression there is in that work. How exceedingly annoying to see the result of your labours turned to naught by some insignificant looking animal, but even worse still by something invisible to the human eye, and for whose presence we have to accept the word of the bacteriologist.

To enter into a diatribe against any or all of these evils would serve no useful purpose, but it is important to note that there is a school of thought advancing the teaching that if crops are nourished properly in what they describe as nature's way then all insecticides and sprays become unnecessary.

Having dealt briefly with these preliminary steps, I propose to discuss some of them in more detail.

It might be supposed that with nitrogen playing such an important part in the production of the plant protein, the addition of nitrogen to the soil in the form, say, of sulphate of ammonia would increase this very important food, but in practice this is not found to be so. When nitrogen is added to the soil, the response is different according to the amount added. First, with small amounts little, if any, change takes place. Second, with larger amounts, changes in the leaf become apparent; the size increases, and the colour becomes a darker green. The increase, however, in the size of the leaf is not accompanied by increased efficiency, and this is capable of proof.

Finally, with still larger amounts a baneful effect may be produced; this is caused by an alteration in the amounts of the protein and carbohydrates present, with the result that a plant is produced which is more susceptible to diseased conditions due to fungi and other pests.

I think it is this latter effect that has brought this artificial fertiliser into a certain amount of disrepute with some farmers. If you discuss this point with them, they will say that such plants as turnips and mangolds winter badly and decay more easily, and from what I have said it may be obvious that such is the case.

Many farmers, will condemn whole-heartedly the application of sulphate of ammonia to potatoes for the same reason, and they claim that much of the flavour is lost, and the potato has the same well-known "soapy" appearance.

Tests have been carried out on this point by competent cooks, and marks assigned, and the result shows that nitrogenous manuring has reduced the quality. Against this, however, it can be shown that for every hundredweight of sulphate of ammonia used there are certain definite increases,

e.g., Wheat 2.5 cwt.
Barley 3 cwt.
Potatoes 20 cwt., etc

Reducing these figures to terms of food value, we find that

2 ½ cwt. of wheat per acre = 27 lb. protein and 212 lb. starch equivalent.
3 cwt. of barley per acre = 23 lb. protein and 258 lb. starch equivalent.
20 cwt. of potatoes per acre = 13 lb. protein and 403 lb. starch equivalent.

As so many other factors modify the action of nitrogen, these figures must only be regarded as approximate. The composition of the grain is also effected, but varies according to the different grain. In wheat, high protein content determines baking quality, but the physical qualities of the protein are equally important.

Much work has been done on the composition of barley as affected by varying amounts of artificial manure such as sulphate of ammonia, and so far as malting barley is concerned, it has been shown that a low nitrogen content is desirable.

These two facts alone demonstrate that considerable thought is necessary when it is proposed to use a nitrogenous fertiliser. But there are other points, and amongst these I would place weather conditions first. As I have pointed out already, a severe winter is good, because it locks up the moisture and so prevents loss of nitrogen. Heavy rain throughout the autumn and winter months removes an appreciable amount of nitrogen and thus, theoretically at least, the farmer has to weigh up mentally the amount of nitrogen lost before adding more. As the amount varies with the nature of the soil, an additional difficulty arises.

If the amount of nitrogen lost by drainage were known, it might be supposed that to replace this an equal amount would only be required. But this is not so, as the amount of sulphate of ammonia necessary is greatly in excess of that which has been washed out.

One inch of rain above the normal during the winter months requires about 40 lb. of sulphate of ammonia per acre to replace what has been lost. If

too much sulphate has been used, harmful effects may be produced, and of these I would mention:–

1. Acidity.
2. Lodging of corn.
3. Bad keeping qualities of roots.
4. Increased susceptibility to invasion by fungi, pests, etc.

Now a few words about phosphorus. I have dealt already with the history of phosphorus as a plant food, but there are many points of considerable importance, a few of which I should like to mention.

Dealing with it first in the simplest possible way – the addition of phosphorus in the form of phosphates to the soil:–

1. Improves root formation.
2. Promotes tillering.
3. Hastens maturity.

These are three very important practical points, any one of which in my estimation is sufficient to warrant the use of phosphates. But these points constitute only a beginning.

In Northern Ireland we have been credited with a marked phosphate deficiency in our soils. Therefore, if phosphates hasten maturity, the absence of phosphate would tend to cause delay. If we add to this the vagaries of our weather, which may be the cause of an early or late harvest, it will be obvious that anything tending to stabilise the time will be of benefit.

Phosphate starvation is not detected easily, in fact the first indication may be a complete failure of the crop. The cause is not quite clear, but there seem some grounds for stating that, where farmyard manure is given, starvation does not exist. Phosphate is different from nitrogen in that it does not leach out, and therefore no matter how wet the season it remains in the ground.

Plants respond differently – potatoes taking pride of place, then come swedes and turnips. One of the most marked effects is the production of wild white clover.

I have noticed that where sulphate of ammonia has been used on grass land to produce an early bite, there is almost a complete disappearance of clover, but if phosphate has been used, abundance of clover is produced.

It used to be thought that phosphates, like ammonia, by uniting with the lime tended to produce acid soil, but this is incorrect.

It might be asked, Does the addition of phosphate increase the phosphorus in the plant? But unfortunately the answer is not quite definite; the composition of hay, and therefore the feeding value, is known to be improved; but apparently, if the soil has been well cared for, the addition of phosphate has little, if any, effect in the composition of cereals or roots; but where there is known to be a deficiency, as in much of our grazing land, the additional phosphate increases the phosphorus in the grass to the distinct benefit of man and beast.

As much of our phosphate comes from North Africa, and that for Australia and New Zealand from Nauru, sources have been denied us by the War, and an opportunity may have been afforded to our scientists for a future study of the effect of the absence of this important plant food.

Just a word about potassium, the third of the plant nutrients. In a certain sense it is the direct counterpart of nitrogen, as it increases the efficiency of the leaf, but not its size. In addition, it performs some function called translocation, i.e., it favours the removal of carbohydrate from the leaf to its place of storage.

As time goes, potassium might be described as a modern fertiliser, for although it has been in use for at least one hundred years, it was not until about fifty years ago that it became so popular. This could be accounted for by the fact that a change has taken place in farming rotation, and that mangolds, swedes, and potatoes are in greater demand. A yield of five to six tons of potatoes about eighty years ago was considered quite good enough, and there was sufficient farmyard manure to produce this quantity; but with the decrease in available farmyard manure, and the increased demand for potatoes, potash came into its own. Its chief use is in association with nitrogen, e.g., used with a barley crop and in combination with nitrogen, it produces a barley low in nitrogen content so favoured by the distillers, but in addition it tends to reduce the susceptibility of wheat, flax, mangolds, etc., to infection by pests or fungi. It also tends to prolong vegetation, which in certain crops may be desirable, but generally speaking I regard this as an unfavourable point. It does not seem to have any appreciable action on the composition of, for example, potatoes, although tests have been carried out by competent chefs, and first place has been given to those that have had a dressing of potash.

The feeding value of hay is reduced, and if the potash is withheld over a number of years the quality of hay is also reduced, and there is a tendency to weed formation.

LIME.

I must say something now about lime. In the first place, from my point of view, I consider the term lime

to be unfortunate; it suggests to me something in the soil, and in the soil only; something, that is to say, that has nothing to do with plant life, but rather is concerned with the p.H. of the soil, and certain other vague and ill-defined functions, which attain to different degrees of importance according to the views of the various authors writing on the subject. But calcium – that is a different word altogether: it calls up to my mind a sticky, unworkable clay made nice and friable and easily worked; it suggests a nice clean soil, free from those acid-loving weeds, and it reveals a beautifully tapered root to all my cabbage plants, instead of that twisted, knarled, and distorted monstrosity known as club-root. It encourages activity by the worms, and thus prevents that mat-like formation that is so detrimental to our grass lands. Bacteria seem to thrive, and altogether there is a sense of certainty that all is well.

To speak of the available lime or of the lime in excess does not sound quite the same as available calcium or calcium in excess. You see, the word brings home to us the very close connection between what we are applying to the soil and something of extreme importance in our own composition.

I have written at some appreciable length on these four major elements, but there are others, and although for the present they might be described as minor, yet who can say but that one day some, or indeed each of them, might occupy a very prominent position amongst the plant foods.

Dr. Katherine Warington as recently as 1923 showed, and showed for the first time, the importance of a minute quantity of boron. Copper, cobalt, manganese, and zinc all play an important part; indeed it would seem that as yet we have touched only the fringe of the possibilities of these elements. So far as is known at present, copper and zinc exert their influences by their curative properties, but boron, manganese, and iron are essential to the proper growth of plants, and their absence reveals itself by certain diseases. Amongst these may be mentioned heart-rot in sugar-beet and swedes. This, which before Dr. Warington's work was regarded as incurable, now yields to a small quantity of borax. Potatoes also may suffer from this deficiency, and so also may carrots.

Manganese deficiency seems to be known on the Continent and in United States of America, but so far it seems more of a name here than an actual disease, although marsh-spot in peas has been credited to it. Apparently it plays an important part in the oxidation processes of plants, and from this it seems probable that a similar process of oxidation may take place in animals.

May I pause here to remark upon the prevalence, at present, of staphylococcal infections, such as boils, styes, and furuncles, involving all classes of society, and all ages from a few months old up to "old age," and to state that in my practical experience deep injections of collosol manganese are almost a certain cure. When this fact of the curative value of manganese is considered alongside the fact that we are all at present, theoretically at least, partaking of the same diet, then it would seem that some of us are unable to make use of the manganese available, or, per contra, fail to obtain an adequate amount.

It is a remarkable thing how that so many great discoveries have been made simply by the ability of someone to observe accurately. I need not quote examples in proof of this statement, but it is not without interest to relate that "fruit and nut trees in parts of the United States suffer from various physiological diseases." Ferrous sulphate was tried as a remedy, but only certain samples were found to be beneficial – and these, on closer examination, were discovered to be in galvanised iron containers. Zinc sulphate was therefore tried, and it was found to cure the disease.

No discussion of plant nutrients would be complete without considering farmyard manure. One does not go far through the country before hearing adverse criticisms upon the use of artificial fertilisers, but, judging from my experience, one would be surprised to hear anything unfavourable about farmyard manure. Nor can this be put down to prejudice, for I have listened to discussions on this point, and the opinions expressed always seemed to me to be well founded. It forms the basis of all good farming, and the only complaint I can make about it is its scarcity.

Straw manure is best, although peat manure is not to be despised. It contains all three elements, but it requires a minimum of ten tons per acre to effect an adequate manuring.

So far as nitrogen is concerned, it is the urine that counts, and this introduces quite a nice point in efficient management in view of dairy regulations.

The food supply of the animal plays an important part, and one great advantage of the imported cotton cake was its beneficial effect on the manure. When removed from the sheds, every effort should be made to protect the manure from the weather, but I am afraid this is never done in Northern Ireland, and the black liquid seen running away from manure heaps must represent a very severe loss per annum.

Bacteria play an important part, and to aid this

action frequent turnings are necessary. Nitrification takes place, and humus is formed, and it is this latter product that places farmyard manure on a plane by itself.

One could imagine that Shakespeare had this in his mind when he wrote:–

"...The earth's a thief
That feeds and breeds by a composture stolen
From general excrement."

The method of application varies, some preferring to broadcast the manure and then plough it in; and when labour is scarce this is the method adopted; but if the ploughing does not take place immediately, and the manure is left to weather, it may be a very extravagant method, e.g., a delay of three weeks reduced the yield of sugar beet by 14 cwt. per acre as compared with farmyard manure ploughed straight in. The better method of application is to put it in the drills at time of planting, and then it is covered immediately. It tends to retain the moisture in the soil, and in dry seasons or on sandy soils this is a very important point.

It is claimed by some to produce a warmer soil, not by its chemical action, but because it produces a darker soil and absorption of the sun's rays increase. The increase of even so little as one degree by this means might have a very beneficial effect at seed-time.

I have pointed out already the scarcity of this product, and judging from my observations many fields at present under cultivation are being treated inadequately, and for this default a penalty in due time will have to be exacted.

Time does not permit me to speak of compost or town refuse, except to say that these have been tried, and tried with benefit, but so much importance has been and is being attached to the question of farmyard manure that a very brief description of McCarrison's work is not out of place.

A field whose past history was known perfectly was divided into three equal parts. One was dressed with farmyard manure, the second with chemical manure, and the third was left without any. A crop was grown, and the result on the separate portions examined. The farmyard manure portion produced, first, the best crop; secondly, the best growth in animals feeding on it; and thirdly, the best crop when grown again, but McCarrison's own summary of his work is well worth repeating.

1. The manurial treatment of the soil was shown to have influenced the nutritive value of millet and wheat grown upon it.

2. The soil manured with 'natural' or farmyard manure yielded a millet or wheat of higher nutritive value than the same soil when manured with a complete mineral or so-called 'artificial' manure. Soil that has not been manured at all for many years, but which has been continuously under crops, yielded a millet of very low nutritive value which was actually harmful to adult pigeons; on the other hand, the same soil yielded a wheat of relatively high nutritive value. It seems that different grains may be affected in different ways by want of manure.

3. The difference in nutritive value of grains grown on soil treated with cattle manure as compared with grains grown on soil treated with chemical manure amounted in millet to about 15 per cent., and in wheat to between 10 and 17 per cent.

4. This difference appears to be due, in considerable part, to differences in the vitamin-content of the grain; wheat grown on soil treated with cattle manure contained more vitamin A than wheat grown on soil treated with complete chemical manure; millet grown on soil treated with cattle manure contained more vitamin B than millet-grown on soil treated with complete chemical manure.

5. The inferiority of 'chemical manure wheat' as compared with 'cattle manure wheat' was evidenced in 41.6 per cent, of young rats. The remaining 58.4 per cent, did as well on the basal diet containing 'chemical manure wheat' as some animals on the basal diet containing 'cattle manure wheat.' Individual idiosyncrasy to the deficiencies of the 'chemical manure wheat' was a notable feature.

6. One gramme of 'cattle manure wheat' when added to the basal diet used in these experiments as the sole additional source of vitamins A and B, gave better growth in rats than when these vitamins were provided by cod-liver oil and marmite; one gramme of 'chemical manure wheat' gave as good growth.

7. Whole wheat was shown to be a rich source of growth-promoting factors.

VITAMINS.

About the year 1912 a very important discovery swam into the ken of the scientists; a discovery which has had far-reaching effects on the health of the nation. Hopkins, working at Cambridge, demonstrated that milk contained a substance of great importance to growth – to this he gave the name of "Accessory Food Factor," a name that, in my judgment, should have been maintained, because it drew attention to the fact that this substance was a food – an agricultural product – something that could be grown on the farm as opposed to a drug, or something made in a factory. But the scientist, again in my opinion

leaving the substance for the shadow, proceeded to determine the chemical formula, and succeeded before long in producing a synthetic preparation said to be as beneficial as nature's product.

I regard this as a misfortune, for I contend that the natural source of every vitamin discovered should have been declared, and that by propaganda the benefits derived from the consumption of this accessory food factor should have been brought home to people instead of, as it is, clothing the natural product in a strange guise, and prescribing it in the form of a drug instead of what it really is – a food.

One has perforce these days to prescribe capsules or tablets containing this or that vitamin, but can one be confident that by doing so one is doing the best for one's patient. You will notice that I use quite naturally the word patient, but surely if greater stress had been laid on the natural source of these foods, a person could only have become a patient by neglect or starvation.

The natural source of these vitamins is of extreme importance, particularly as we know that different varieties of the same species contain different amounts, and that different parts of the same species may be better supplied than others. Thus I read that – the vitamin C value of Bramley Seedlings may be ten times that of Cox's Orange Pippins, or again in tomatoes, the vitamin A value of the skin may be about twenty times that of the flesh, and a thousand times that of the juice.

But the farmer has little, if any, control over these substances; the scientist has gone away ahead of him; and there is little he can do about it except in the case of milk.

When one looks at cows grazing in a field, a pretty picture may be formed in the mind of the observer, but like many other things in this world there is more in it than meets the eye.

If we look at the grass with the mental eye of the trained scientist, the grass becomes the storehouse of the substance known as ergosteral, and if we carry the flights of our imagination a little further and imagine that it is summer and that a bright sun is shining out of a clear sky, we have all the ingredients necessary for the manufacturing of vitamin D.

I have stipulated two conditions, a bright sun and a summer's day, because it would appear that by this combination the necessary ultra-violet rays which react with the ergosterol and manufacture vitamin D are alone produced. This is, however, not a complete process, as not all the ergosterol is changed, so our cow gets some vitamin D and also some of the unchanged ergosterol. But the same ultra-violet rays are playing on the cow's skin and act in the same way as they do on the grass, and convert more of the ergosterol into vitamin D. Now, the cow very obligingly secretes this vitamin in her milk, and thus presents us poor humans with a very important source of this vitamin.

I have stressed this story somewhat in order to emphasize the importance of sunlight, and by contrast the deficiency that is produced by withholding the cow from its influence. Now, as it is the general custom in this country to close the cow in its stall from November till May, it will be seen that our source of 'D' becomes markedly reduced, and when one adds to this the fact that hay, on which the cow depends for its maintenance ration, is a poor source of vitamin D, then the possibility of getting vitamin D in milk (or in butter) in this country in winter is reduced to almost vanishing point.

So far I have been dealing with the nutrition of plants, and now I should like to take the next step and deal with the effect of this on animals and man.

First of all the cow. From a nutritional aspect it is necessary to consider this animal from two points of. view.

(a) Milk. (b) Beef.

Now it is obvious that a selection made for one of these qualities may not be suitable for the other, and, therefore, in breeding these points have to be considered.

To assist in this decision it is very important to have milk records, and these should be kept. A cow that gives a poor yield may be guessed at by the farmer, but it is much better to be able to produce figures. If this is done, feeding becomes much more economical, and all poor yielders can be culled.

In the summer, good grass supplies all the necessary ingredients for the maintenance of the cow and the production of milk. For six months of the year these ingredients must be supplied in the form of concentrates, and as these for the most part are imported, considerable difficulties arose at the commencement of the War, and milk was in consequence greatly reduced.

Foods rich in proteins are essential, and amongst home-grown varieties field beans are considered best, but other crops, e.g., kale, also may be used, although the protein supply in it is small.

There is a simple rule, recognised by all, that states – Hay may be used for the maintenance of the cow and the first gallon of milk, but afterwards 3 ½ lb. of concentrates must be fed for each gallon of milk, and this is known as the production ration. As the

production ration is expensive, the importance of knowing the exact yield becomes more apparent.

As regards the quality of milk, some cows are recognised as producing a high butter-fat, whilst others are the reverse, but all efforts should go towards producing a butter-fat of at least 3.5 per cent, together with a clean and safe milk.

The object of all this work on the farm and in the cow-shed is to supply plenty of milk for human consumption, so now let us return to this aspect of the work and examine the recent report by Sir John Orr.

This observer has divided the population into six groups by income. The first and sixth containing ten per cent. of the population, and the others twenty per cent. each. The graph shown in his book, "Food, Health, and Income," dealing with the consumption of milk, is most interesting. It shows that 3.1 pints per head per week are consumed, but that the graph is well into the fourth group before this amount is reached. In other words, groups 1, 2, and 3 consume far too little milk in the liquid form, and even when the condensed milk, which is used in large amounts by these three lower groups, is added, the consumption is still below the required standard for health.

This failure to make adequate use of the milk available has accounted for much ill-health. Experiments on rats have been devised and have been carried out to prove this point, and whilst it must be admitted that such experiments are not a true guide, yet when they are contrasted with the known facts of closely allied tests on school children, and are found to be very similar, there is definite ground for stating that a greater consumption of milk would improve the health of the nation.

As milk supplies calcium and phosphorus in the most assimilable form, no one need be surprised when the graphs already referred to show that the adequate calcium requirement is reached only by those in group 6.

It is now many years since I pointed out that such conditions as neurosis and catarrh were associated with a high degree of translucency of the facial bones, to which my house-surgeon of that time, Dr. Bob Smith, gave the very descriptive title of "Tissue-Paper Face." But these defects are, I am sure, within the experience of you all, and it scarcely requires me to add that more attention to this point is of vital importance, and to quote that "the extent of calcium deficiency in this country is very widespread, and if the larger numbers of children in the lower group be taken into account, the degree of deficiency in these groups is even worse than here portrayed."

I come now to the question of beef, and here let me start off by remarking that this is a product of the farm and not, as so many seem to think, of the shop. No greater problem faces the farmer at present than that of grazing. When I say that many people were recently quite content to pay as much as ten pounds an acre for food grazing land in and around Belfast, it shows the importance they attached to it. I have pointed out already how that in the past the grazing lands of Northern Ireland were notoriously deficient in phosphates, so that it becomes a matter of considerable urgency to see that, as a result of the War, this state of affairs is not allowed to recur.

As calcium plays such an important part in the growth of these animals, it must be always present, and so, constant care and attention is required to see that this and all other essential minerals are present, and what is of almost equal importance – a good water supply.

The day is therefore past when a few head of cattle were bought in the spring and put out to graze with, no doubt, a fervent prayer that before the winter set in they would sell at a profit. Every farmer to-day is alive to the importance of this end of the industry, and therefore tries to get as big a turnover as possible in the shortest time.

Let me explain, for the benefit of those who do not understand, that all beef cattle offered for sale are graded, i.e., they are examined by an expert whose decision is final, and they are given a grade in accordance with their condition, and the price paid varies directly with their grade obtained. It is therefore to the farmer's own interest to produce his cattle in the best condition possible, and to the interest of the State in that more food is supplied to the public per head of cattle. If we turn now to the consumption of beef as shown in Sir John Orr's groups and graphs, we find that when the average is shown as 38.2 ounces per head per week, the graph is well into group 4 before the average is obtained. Whether this deficiency in the consumption of beef is to be regarded as a defect or not, is open apparently to debate, e.g., in 1917-18 the Danes, by reason of blockade and therefore shortage of feeding stuffs, were forced to destroy large numbers of their herds, and they themselves were compelled to live on dairy products; coarse whole-meal bread and potatoes. This diet differed from their pre-war diet in that the animal protein was replaced largely by protein from dairy products. "This change in diet was associated with a drop of 17 per cent. in the mortality of the whole country down to 10.4 per thousand, the lowest

ever known in any country."

Apart from this, the cost of meat always seems to me to be out of proportion to the amount of energy obtained, and it is worth recording that the total expenditure on beef reached the colossal figure of 294.5 (million pounds) in the year 1934.

Beef can be regarded therefore as an expensive item, but if even the small average of 38.2 ounces per head per week be regarded as a minimum post-war allowance, then there must be a considerable increase in consumption in the three lower groups, and this would reflect in favour of the producer, i.e., the farmer.

Now that the greatest experiment of all time in nutrition is approaching its termination, it is justifiable to take stock of the situation as it is revealed to each of us.

Whatever our own private feelings may be as regards rationing, each of us must admit that much useful, and possibly revealing, data will have been collected, and will form the basis of future ideas on this subject of nutrition.

So much is hidden from us at present that no one is in a position to criticise. One fact does seem to be obvious however, the beef ration of approximately twelve ounces per head per week has been sufficient to maintain health. When this is compared with the average – as shown in Sir John Orr's groups and graphs – of 38.2 ounces per head per week, it would seem that this average was, if anything, unnecessarily high, and therefore those in groups 1, 2, and 3 were not so badly done for as otherwise it might appear, and that our vital statistics, on the analogy of the Danes in 1917-18, might be expected to show a very excellent result per thousand.

A glance back over the figures for the past hundred years is interesting, because it reveals that – and here I quote:– "The rise in the standard of living of the last hundred years has been accompanied by a decrease in percentage of the income spent on food." Strange to say, sugar is the one article that seems to have shown a marked increase in consumption, and it has increased five times. I am interested in this because most, if not all, of this sugar would have come from abroad, and it would be a nice calculation to try and determine what the result would have been in additional health if even fifty per cent of the cost of this sugar had been spent on extra green vegetables.

One could continue this line of argument and show that, with the exception of potatoes, bread, and flour, the consumption of other farm products, and especially green vegetables, is much too low, and conclude that as long as it remains so the health of the nation cannot be what it ought to be.

As the Minister of Agriculture has recently said:– "I see no reason why we should not be able to absorb … the greater total of food supplies, both home and imported, by raising the level of nutrition of the people."

Commenting on his words, "The Farmers Weekly" adds:– "Backed by the Ministers speech and the outlook that speech represents, we feel that we are at last tackling the future with a proper recognition of values. Food for the people means work for the people, health for the people, and it is not too much to hope that it will also mean peace for the people."

In a letter to "The Field," the secretary of the Economic League wrote as follows:– "At the present time, when the fifth war harvest is being carried in, it seems desirable to stress yet once again the great part that has been played by British agriculture in winning the war on the home front, and its future vital importance in relation to industry and the whole national economy.

"Britain to-day is not only getter better balanced food, but more of home- produced commodities, including milk, potatoes, and vegetables. Great credit for this is due to British farming. Pre-war, the amount of potatoes consumed by the civilian population annually in the United Kingdom was 177 lb. per head. The figure for 1943 was 256 lb. British farmers are producing not only enough potatoes and vegetables for our own population, but also enough to feed the vast American forces over here.

"The pre-war consumption of milk was 38 lb. per head; in 1943 it was 49 lb. Where civilians had 99 lb. of vegetables per head per annum before the war, last year they had 133 lb. Cereal consumption had risen from 211 lb. pre-war to 247 lb. in 1943. As may be expected, there was, due to rationing, a fall in the consumption of poultry, fish, meat, and imported foods.

"It cannot be emphasized too often that the prosperity of agriculture and urban industry are interdependent. The prosperity of any great nation, if it is to be sound and lasting, must include prosperity for agriculture. This will apply in Britain to an even greater degree after the war than it ever did before."

So far I have been speaking of food and health, but it must be quite obvious that a person who was receiving food adequate for health would be under-nourished if his work is taken into account.

I have referred already to the cow's ration as consisting of two portions: (a) maintenance, (b) production, and this division is quite justifiably applicable to man. The point is of some little interest

because in the ordinary everyday life few, if any, arrange their diet according to their work.

Many of us on entering a restaurant for a meal are guided in our choice of food by our inclination or desire. Others, however, less fortunate in this world's goods, are compelled to make their choice a monetary consideration, and often select their food to suit their purse, instead of making a scientific approach, and selecting their food according to its value in calories.

In order to make this possible, the value in calories of the food would have to be shown on the menu, and in point of fact I believe that this is done in Toronto; and although from the point of view of appetite this might be most uninteresting, it is just as practical and as economic as using a high-grade coal to drive an express engine instead of one inferior in quality and cheaper in price.

I do not wish to nauseate you with an overdose of facts and figures, but I should like to point out that there are two problems; one of agriculture and the other of nutrition. Ages ago these two were joined in wedlock, but in more recent years they have been drifting apart until, in the years between the two great wars, they might have been described as "separated." I am, however, one who believes that in this case divorce is impossible. Indeed, on the contrary, I am all in favour of a closer union. All who have followed me so far must admit that there is a scientific side to agriculture that requires an education and an ability of a high standard. Further, there is a dignity about this most ancient of professions that requires no pen to describe, but which is always present and visible to those who have the adequate knowledge and understanding.

"Far back in the ages,
The plough with wreaths was crowned;
The hands of kings and sages
Entwined the chaplet round."

I know of no more glorious venture of faith than that of the man who, despite many set-backs, goes forth as spring revisits the earth and once more demonstrates his abiding trust that what he doeth then shall bring forth fruit abundantly.

I regard it as a call to one's manhood; a call that no one need be ashamed to answer, and yet there is a drift from the land into the towns which already has reached alarming proportions, and reminds one of Goldsmith's famous lines –

"But a bold peasantry, their country's pride,
When once destroyed, can never be supplied."

This year, as indeed every year, but this year especially, the farmer is fighting a strenuous battle; with inadequate and often unsuitable labour he is being asked to gather in one of the largest harvests on record, and this, not in order to make himself rich, but in order to supply additional food, so that all may have enough.

Too often in the past the cry has gone up for cheap food, and the farmer has been exploited to meet this demand. This is not the way to produce a contented peasantry nor, on the other hand, a healthy nation, but this is a point of political importance, and so I must leave it.

Let me hark back for a moment – I said above that nutrition was also a problem, but it is a problem that in one sense is governed by heredity and environment. By nutrition a plant may be forced to produce up to its maximum, but beyond that it is impossible to go, and any additional plant food is uneconomical.

The same is true of man. Heredity sets its stamp on each family, and therefore any attempt to reach a common standard is bound to fail, but it should be assured to every one that the standard as set has been reached. If this ideal be attained, the circle will be complete; the health of the nation will be improved, and farming will prosper.