HUMUS
AND THE FARMER

By

FRIEND SYKES

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IN THE KNOWLEDGE THAT THEIR

TRAINING AND GENERAL UPBRINGING

HAVE BEEN FOUNDED UPON A LOVE

AND REVERENCE FOR THE LAND, THIS

BOOK IS AFFECTIONATELY DEDICATED

TO MY THREE GOD-CHILDREN

MICHAEL, PAULINE AND RICHARD

FOREWORD

'Ill fares the land, to hast'ning ills a prey,
Where wealth accumulates, and men decay.'

GOLDSMITH

In these immortal lines of Goldsmith's, written about the year 1750, there is deep thinking and cryptic prescience. Is it coincidence that these ancient words should be so peculiarly applicable to the social, political and physical condition of the land in our own time? By what divine inspiration does a poet foretell the world's condition two hundred years to come? For had these fateful words, so pregnant of dismal and dangerous foreboding, been written by a Kipling or a Masefield in 1944, their pointed incidence could not have been more timely.

To-day, the soil from which we spring, the source of all our beginnings, calls aloud for urgent and earnest consideration by every thinking man and woman.

Most writers use their 'foreword' as a space in which to express apology for inflicting upon an unwilling world what they hope will be read. They announce their incapacity for literary expression. They emphasize their own unworthiness and inability to execute their self-imposed toil.

Mine is an easy task, for I have a simple message to deliver, and a number of elementary facts to set forth. When I have done that my duties will be discharged. My disappearance from literary work will be as complete as my advent has been sudden and dramatic to me. Divine inspiration and immortality as 'Men of Letters' belong to the poets and the saints—not to farmers.

Next to being immortalized as a man of letters or canonized as a saint, the greatest and noblest craft that can be the lot of man is the one of being a farmer—a tiller of the Good Earth.

F.S.

PREFACE

There are two disclaimers which I should like to make at the outset.

As I shall have occasion to mention and to commend a number of implements and machines, in certain cases giving the names of the makers, and as I have been concerned in the invention of some of them, I want to assure my readers that any implement or machine mentioned in this book will be named solely on account of its intrinsic merit and its fitness for some particular task of husbandry, and for no other reason. I have no desire that the sale of anything I have helped to design should be promoted by what I have written. Equally, I disclaim any desire to advertise the wheat we grow at Chute. Lest it might be thought that I am inviting inquiries for our own home-milled flour, or for our home-grown wheat, let me explain that the law, as it stands at present, prohibits our selling wheat except through Government organized channels. We are unable to mill our wheat either for wholesale or retail distribution and, similarly, we are unable to sell our wheat for milling by private people. I do not invite correspondence from people interested in wholemeal bread for their own consumption because I am unable to do anything in the matter whatsoever.

F. S.

Chantry, Chute,
Andover, England

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My especial thanks are due also to Sir Albert Howard for kindly reading my MS. and to Rupert Thompson for criticisms and similar help.

Finally thanks are due to my amanuensis Marjorie Ayling for the hard work she put into typing and retyping my MS., again and yet again, to comply with my own fastidious demands to give of my best in presenting this work.

F.S.

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PART I

CHAPTER I

WILL THERE BE A SECOND BLACK DEATH?

I began farming over thirty years ago with a basic interest in Friesian cattle and Berkshire pigs. By 1923 our herd of Friesian cattle in the show-yard and in milk production ranked with the best in the country. Most of our foundation stock were the winners of the famous 500-guinea Silcock Cup, and later we won the Makbar Gold Cup for the best herd of dairy cattle in the counties of Buckinghamshire, Berkshire and Oxfordshire. At the Royal Agricultural Society of England Show, at the Royal Counties, at the Bath and West of England, at the Great Yorkshire Show, at the Royal Lancashire Show, at the London Dairy Show our stock was usually well to the fore. Kingswood Ceres Daisy, for some time the European champion, who gave 6,600 gallons of milk with her first three calves, was in our herd. In Berkshire pigs we bred and exhibited the famous sow Richings Beauty 1st, who won the supreme championship at the Royal Show at Leicester in 1924. For years breeders from all over the world sought descendants from this animal. It was an interesting thing in those days to attend the pedigree Berkshire pig sales and to observe how punctilious were the auctioneers to refer to the fact that this or that pig were descendants from the Royal Champion, Richings Beauty 1st.

Encouraged by these and many other successes we embarked upon the breeding of thoroughbred horses and again fortune smiled on our efforts. We were lucky indeed to breed such horses as Statesman and Solicitor-General, both of them by Blandford ex Dáil, and His Reverence, by Duncan Gray ex Reverentia; but I must not allow myself to digress into the fascinating subject of horse-breeding.

The long run of achievement in livestock production and showing which my two brothers and I had enjoyed came to an end with dramatic suddenness. The Ministry of Agriculture had been made aware by medical and public opinion that all was not well with the nation's milk supply, and by way of grading up the dairy cattle the first Accredited Milk Scheme was established. As one of the leading breeders we were asked by the University of Reading to show the way to other stockmen by submitting our herd to the Tuberculin Test. We agreed. Judge of our surprise when 66 per cent re-acted—the premier herd of the three counties! What must have been the condition of all the other dairy cattle in that area?

This startling result gave us much food for thought, and it was some time before we could diagnose the cause. We pedigree breeders have a saying, '50 per cent of the pedigree goes in at the mouth'. Therefore, we concluded there must be something amiss with our system of feeding, and we eventually suspected that the cow, with her four stomachs, was not a concentrated food converter, but, in her natural surroundings, a consumer of 'roughage'. Were not the highly concentrated cakes, with their well-known stimulating abilities for the production of rivers of milk the cause of the decline in the health and stamina of our cattle? We thought it over. We consulted authorities famous for their eminence. We had produced fantastic milk records, had been accorded the highest awards in the show-rings; but was it at the expense of the health and constitution of the cows?

We then took a decision requiring both courage and action. We would completely reverse our milk production policy; we would feed the cows more normally, abandon high milk yields, and make the health and constitution of the cattle our primary object, and milk production secondary. We held a dispersal sale of our valuable Friesian cattle, which had taken so many years to breed and which had, in the eyes of the showman and record-breaker, achieved so much. We then went in for Channel Island cattle, and here good fortune again attended us in the show-yard, for we bought as a calf Christmas Delight of Maple Lodge, the bull which won the supreme championship at the Royal of England Show at Chelmsford.

But troubles seldom come singly:

'In troubles to be troubl'd
Is to have your troubles doubl'd.'

And at this same period our most valuable thoroughbred mare contracted the dreaded disease—contagious abortion. An eminent veterinarian advised her destruction. I declined the advice and determined a treatment of my own, which was to turn the mare out into a large paddock where no horse stock had been

grazed, where artificial manures had never been used, and where she was condemned to live for two years eating practically nothing but grass. At the end of this period she was examined by a competent vet and declared clean. She was mated and later proved in foal, and subsequently bred over the next seven years four valuable foals, she herself living to the ripe old age of twenty-one. Here was my first attempt to cure an allegedly incurable disease by giving the creature nothing but grass grown on land where artificial manures had never been applied, in other words, Nature's food from humus-filled land.

In the early nineteen-twenties I had the good fortune to meet the late Major Morris, of Aston Tirrold, Berkshire. He became the trainer of my thoroughbreds, and in succeeding years I was to see and learn much that was to shape my future agricultural policy and practice. Morris was a man of the highest character, education and farming knowledge. He was years ahead of his time as a grass-grower and knew how to establish the sward for a racehorse paddock such as none of his generation ever created. His experience was not available to all; but, being both a patron and a friend, I was privileged to learn much from him. Bone of the extreme density that is found in the cannon-bone of the deer is the object of every racehorse breeder. This can only be obtained by growing the right kinds of grasses, clovers and herbs on lands which are in good living health and balance, and which have a subsoil of either limestone or chalk. From Morris I learned those elementary lessons which stood me in good stead in later years. Morris farmed some 2,000 acres of Berkshire's light downland overlying the chalk, yet on that thin soil he grew the heaviest crops of grass and clovers I had ever seen. Our land at Richings Park—'Rich-ings' means 'rich meadows'—would grow good crops of potatoes, mangolds and the like, and market-garden crops, but never herbage in the quantity and quality that Morris used to grow. I determined to sell the estate at Richings Park and find a place high on the chalk hills where some of the practices of Morris could be tried out. In 1934, we left Richings and in 1936 bought Chantry, Chute, in the county of Wiltshire, the highest-lying farm on the eastern escarpment of Salisbury Plain. Four pounds per acre was all this land was worth; but Richings found ready buyers at £100 and over, per acre. I took a Yorkshire farmer to see my new property and he said, 'To think that you, who have achieved so much as a livestock man and a farmer, could be so unwise as to buy land like this. This is not farmland—it is just space-out-of-doors.' Encouraging comment!

After killing many thousands of rabbits we settled down to farming a real piece of England's neglected acres. The first implement I ordered was a subsoiler. The look of permanent surprise that covered the features of the agent receiving the order was worthy of *Punch*. 'Do you know, sir, in all our experience we have never supplied such a thing. What do you want an implement like that for in a God-forsaken country like this?' Yes, there was a lot of encouragement everywhere. But my knowledge of farming had told me two things—that you cannot farm without the plough, and that its full value can only be obtained if its operations are preceded by those of the subsoiler. To prove this, one of many such stories will suffice. The subsoiler broke down after only part of a field had been done—no time to repair it, so ploughing and reseeding with barley followed. The few acres that had been subsoiled grew a splendid crop, the rest of the field practically nothing. The next year the whole field was fallowed and subsoiled, and wheat was sown. The crop, yield thirteen to fourteen sacks to the acre, was one of the best in the county. This yield was fifty-six bushels to the acre. Subsoiling accounted for this improvement.

A new herd of Guernsey and Jersey cattle were got together and kept on the open-air system, with a movable milking bail, which was shifted every day and eventually travelled all over the farm. In this way the land was uniformly refertilized by dung and urine, and as each field has been sufficiently grazed and dunged, ploughing of the old turf took place, followed (during war-time) with three corn crops; after this it was cleaned and laid down to a four years' ley containing the following mixtures of grasses and legumes:

6 lb.	Perrenial Ryegrass	10 lb.	Common milled Sainfoin
6	Cocksfoot	4	Lucerne
3	Timothy	4	Melilotus alba
3	Italian Ryegrass	3	Hants broad loaf clover
1	Rough Stalked Meadow Grass	2	Alsike clover
2	Crested Dogstail	2	S.100 clover
2	Meadow Fescues	3	Kidney Vetch
—		4	Burnet
23	of grass seeds	2	Chicory
		—	
		24	

—a total of about 57 lb. of seed to the acre.

The details of farming technique which I have devised are important:

1. Subsoiling two feet deep.
2. Several ploughings.
3. Several harrowings.
4. Thorough land cleaning.
5. Two heavy roller rollings.

The subsoiling two feet deep aerates the subsoil and splits into fragments the underground colloidal pan, thus opening up an unlimited store of mineral plant food which the deep-rooting varieties will seek in a very short time. The ploughings and other cultivations aerate the five inches of topsoil and work down a fine tilth, which is indispensable to a good grass establishment. The deep-rooting plants, Sainfoin, Chicory, Burnet, Kidney Vetch, Cocksfoot and Melilotus Alba go deep down into the earth for several feet, bring up both minerals and moisture in abundance, and make the sward drought-resisting under the hottest sun, while all the leguminous plants draw copious supplies of nitrogen from the air and make this available in the soil for the grasses. This ley is left down four years: the first year it is grazed; the second, it is hay and grazing; the third, hay and grazing; the fourth year it is all grazed, after which it is ploughed under for roots and the sowing takes place on the upturned sod. The old turf and the wastes of the livestock are transformed into humus by natural agencies—in other words, sheet-composting takes place all over the farm. Enormous weights to the acre of crops of all kinds are grown; the next year a crop of wheat; then a clean and the sowing of oats; and the fourth year it is sown back to the grass and clover mixture as before. Neither farmyard muck, nor compost, nor artificials are applied. The organic refertilization is performed by the controlled intensive grazing of cattle, sheep and other stock, which stock, in the four years of the ley's duration, deposit at least twenty tons of dung and urine per acre, and this is harrowed in frequently to secure uniform distribution. This organic activation, coupled with the considerable root system of the ley when ploughed under at the end of its four years, provides the land with such a surplus of humus that one or two heavy crops of roots can be taken and two corn crops, and there is still enough surplus humus to re-establish the next rotation. The grass and clover seeding is varied and heavy, but my experience tells me that this is a wise proceeding, in so far as it smothers out in the first year most of the weeds and secures an amazing sward in the first year of establishment. I have this year cut seventy acres of land under such a sward, and it must have averaged from two to three tons to the acre of hay, and this on land 800 feet above sea level, and for which none of my friends would say a good word when it was bought. Good average meadow-land of the permanent grass type seldom gives more than 15 cwt. to one ton to the acre.

I have so far dealt with the first steps in the reclamation of a piece of worn-out land. Spectacular as are the results obtained, I am convinced they are only the beginning, and that it is possible to raise the fertility of Chantry still further, and to carry a much larger head of livestock. This can be achieved by converting the large volumes of unused straw and the other vegetable residues of the farm into muck and then into compost. Now that the mechanization of the compost heap has been achieved and the Rapier tractor-driven muck-shifting crane has been made available, it is possible to multiply the volume of farmyard manure by four or five and, at the same time, improve its quality. The motto is 'Muck, more muck, and much better muck'. Such a machine as I have now described is at long last on the market, and has been for one year in operation. Here now, all the wastes on the farm, both vegetable and animal, are returned to the soil in the shape of freshly prepared humus. In this way the full effects of the subsoiling, and of the deep-rooting ley, will be obtained, and results now undreamt of will be available for all to see.

When the whole of the farms of England are farmed with compost— and I am sufficiently sanguine to hope that one day they will be—there is not the slightest doubt that we can grow enough food here of every kind (excepting citrus fruits, tea, coffee and the like, which represent a small amount in the aggregate) to sustain a population of more than twice that in Britain to-day.

But our experience at Chantry was not nearly so cut and dried, or so straightforward and easy as the foregoing account might lead a reader to believe. We bought valuable cattle and put them on land which was couch-ridden and very infertile, and the ability of which to sustain life was so low in the early years that food of every kind had to be bought elsewhere to augment the supply of the poor herbage. Then heavy stocking and treading began to develop other troubles and, as always on dirty, foul, neglected land, disease of many kinds began to show in the cattle. Contagious abortion—the most devastating of all complaints, mastitis, Johne's disease, tuberculosis, all took their toll, and before we were through with them all we lost cattle to the pre-war value of over £2,000 (to-day's value—over £8,000). The veterinary service could help us but little. As is usual, the course followed had to be devised by the farmer.

We decided to plough up the whole 750 acres. We determined to rely upon home-grown food, especially avoiding all factory compound foods and concentrates. Above all to apply artificials nowhere. And after

seven years of heart-breaking toil, with the added difficulties of war-time conditions thrown in for luck, we have (touching wood) (1) almost completely rid the farm of disease; (2) built up a large herd of home-bred, attested dairy cattle, now tubercle free for over four years and of a soundness of constitution to all critical appearances such that no expert would believe that any scourge had ever visited the farm, and (3), as each succeeding generation of young stock is born, have unmistakable evidence of still greater stamina and endurance.

Now we didn't bargain for all this trouble with disease, and it was as unexpected as it was unwelcome. Our ability to deal with it, however, is something rather remarkable. How has this been done?

We have based our policy on the premises that the health of the soil, the plant and the animal are interdependent, that the refertilization of soil—the basis of life where we all begin—is biological rather than chemical, that this can be accomplished only by the agencies of animal dung and urine acting upon the decaying vegetation of the farm to form humus, and that chemical fertilizers (particularly those of nitrogenous content) must not be applied to the land, because while they may momentarily stimulate a crop, they do noticeable damage to the soil through the destruction of the earthworms and other micro-organisms. That these premises are believed to be sound is suggested by the evidence that twice in fifteen years we have had serious diseases of animals to deal with and, with humility, we have dealt with them.

Sir Albert Howard wishes me to write a great deal on the subject and to record the whole of my experiences and accumulation of details of evidence to support the system of farming which has now been laid down for the land at Chute, and which, after much travail, is now working smoothly—and nothing short of a book will suffice to give me the space I need to set out the facts and results in their proper sequence and forcefulness. Here, then, if this country in particular, and the world as a whole, are to avoid the major catastrophes that may be lying not very far ahead, I must set down the argument for the urgent and wider application of my system of farming. This task is by no means easy.

Therefore, I will ask myself, what are the major lessons that I have learned after thirty years of farming observation? They are:

(1) That the well-being of mankind is interdependent with that of the animal, the plant, and the living soil.

(2) That a fertile soil is one rich in humus.

(3) That whenever the humus content of the soil is depleted (as in the growing of a wheat crop), the humus must be replaced with more humus manufactured by the biological processes, e.g. by vegetable growth (as in grass) and by its decay, when ploughed, accelerated and activated by the earthworms and by the micro-organisms of animal dung and urine.

And if the world as a whole adopted these hypotheses, what would be the result? A healthy, robust, and practically disease-free human race; because man—who is healthy according to the food he eats—would live on a healthy diet of wholesome and disease-free milk and animal products, wholesome vegetables, and wholemeal bread, all grown on soil that was humus-sufficient and disease free.

And if the health of a nation is as simple as all that, why can we not adopt my system of farming to-morrow and in five years have a disease-free world? Because for over a hundred years the world has laboured under a sad and pitiful delusion—that the refertilization of land is a chemical and not a biological process, and because there have grown up in England and America most powerful interests who are determined that the world shall not be disillusioned.

Then, is there no hope for mankind? Yes, there is one hope—disease. It may teach us the mistakes we should avoid. Just as this war, with all its enormities, was unavoidable, so disease may prove to be equally unavoidable before mankind will learn its lesson.

The continued use of artificials is the first mistake, for it produces food of diminishingly efficient feeding value for both man and beast, and is, in my opinion, reducing vitality so low that resistance to the malign bacilli and bacteria of disease is becoming less and less. Notwithstanding the formation of the Ministry of Health with its myriads of enactments, its inoculations, its housing and its hygiene, with the spending of millions-sterling, disease is still defiant. The source of all disease is in the food we eat; and the food comes from the soil. Start there. Make a healthy living soil. Grow thereon a healthy plant. Produce a healthy animal and, in turn, a healthy man, and the Ministry of Health can be liquidated in a very short time.

The second mistake is the feeding of concentrated cakes and meals— yet more of these are being continuously used. They are unnatural foods and are fed to cattle and poultry to stimulate the production of unnatural quantities of meat, milk, eggs and poultry meat. I have cured disease in animals by cutting out the feeding of factory-made concentrates and substituting such food as oats, peas and beans, and grass, grown on the farm, on humus-sufficient fertile land.

Two difficulties present themselves:

(1) Farmers will not cease to use artificial fertilizers for their land, because they have been taught by clever propaganda over a long time that it is more profitable to use them for crop production than keeping and relying upon livestock; and they are averse from the wide use of humus because this involves labour which is unobtainable or costly. The whole of this difficulty, of course, will eventually disappear with the advent of the Muck Shifting Crane but it is bound to be some years yet before the whole country can have sufficient machinery of this type to make its influence really felt.

(2) Farmers will continue the use of factory concentrates for their cattle feeding, because, again, skilful propaganda has driven into their heads that they can produce neither milk nor meat without them. It does not begin to occur to one farmer in a thousand that the prevalence of contagious abortion, tuberculosis and the other ills of their livestock may be brought about by the use of artificials on the land, or the use of the concentrated cakes fed to their cows.

And so disease will come. Come? It is already here, everywhere in abundance. There are very few disease-free herds in the country. Foot-and-mouth is periodically rampant; tuberculosis is most dangerously prevalent; mastitis is as common as the dawn of day; Johne's disease and barrenness are rife everywhere; contagious abortion, the worst of all, is almost in every herd. It is estimated on reliable data that 80 per cent of dairy cattle passing through the markets are diseased in one form or another. The milking life of the average dairy cow has been reduced from ten years to two and a half years.

Are the Ministry of Agriculture worried? Yes, indeed they are. Remedies? Oh, yes, vaccines and veterinary panels. But why not start at the bottom in the soil itself? Hush! No one has ever thought of that. In officialdom you must never go to the root cause of disease—this is a most unprofessional approach.

And so before the nation can have disease-free food—food with good nutritional composition—we must first of all endure the terrible agony of a wide visitation of plague or disease which will make the BLACK DEATH appear like a summer shower in comparison. Disease will become uncontrollable in cattle ere long, and through meat and milk may transfer itself to men, women and children. We may lose millions of livestock and perhaps millions of our human population. And then— what then? For a time doctors will be overworked with inoculations, and more deaths will ensue, and after that someone will arise in the midst of a bewildered community and point to the warnings of Sir Albert Howard and Farmer Sykes, and inquire why their advice was not heeded; and since by that time most of the beneficiaries of the vested interests of both artificials and cattle cakes may have succumbed to the prevailing plague—well, perhaps a trial, anyway, will be made of my system of farming.

What a pity it is that such an experience appears to be the inevitable and only way to bring a world, which places vested interests before life itself, to any sense of true decency of conduct and sensible action. For only by downright disaster will man come to repent the error of his ways.

Is it not possible that great men like Mr. Churchill and General Smuts —and all are agreed these two are really great men—could be induced to investigate this important subject of Humus-Fertile land and its bearing on human and cattle disease?

The Union of South Africa is already becoming compost-minded, and great strides are being made in the faithful adoption of Nature's great law of return. In the United States the resources of the Rockefeller Trust are available for demonstrating on a large scale the great principle that a fertile soil means healthy crops, healthy livestock and last, but not least, healthy human beings. There is still time, but not too much time, to establish this great truth before the war ends, so that when peace comes agriculture can take its proper place in the world of to-morrow and the public system of the future can be based on a soil in good heart.

The real arsenal of democracy is a fertile soil; the fresh produce of which is the birthright of the nations.

Author's Note

'The Black Death (1348-9) was succeeded by four outbreaks of similar disease before the end of the century. It destroyed from one-third to one-half of the rural population. But the great pestilence was not an isolated incident but the last and worst of a series of plagues which swept over England for a hundred years or more as regularly as trade booms and slumps do now. Shortage of labour and rural unrest compelled a reform of farming. But it was many years before the land recovered. Throughout the closing years of the fifteenth century successive outbreaks of murrain killed numbers of cattle and sheep, swept off geese and poultry and even destroyed the bees. The Black Death was therefore preceded and followed by disease in the livestock.'

(English Farming, Past and Present, 3rd Edition, 1922. This chapter which was written at the repeated insistence of Sir Albeit Howard and Doctor Picton, O.B.E., of the Cheshire Medical Panel, was originally published in the *Veterinary Journal,* the *Medical Press and Circular,* and *The Compost News-Letter.* It was reprinted in a large number of newspapers and periodicals throughout the entire world. Its circulation must have reached many millions. As a brochure it was circulated in almost every country. It was also translated into other languages. All this was unorganized and voluntary. Everywhere throughout the world

to-day there is springing up from all quarters a 'biological consciousness', a sense that materialistic science may be misleading us, that old and new insidious diseases are on the increase and are not yielding to orthodox treatment. Suspicion is widespread that this may originate in the soil; that the biology of the soil, of which we know too little, may hold the key, not only for the eradication of the ills with which both man and beast are afflicted, but for the very preservation of life itself.

CHAPTER II

WHY THE ENGLISH FARMER DOES NOT MAKE AND USE COMPOST

Those who have seen the effect of compost on gardens have found themselves puzzled and disappointed that it is not widely used in English farming.

There is no more important problem troubling the would-be intensive farmer in this country to-day than the problem of maintaining fertility. 'If this war goes on much longer,' he is asking himself, 'and I am compelled to continue this depleting-fertility-cropping, how am I to keep up the fertility of my farm, and when the war is over, how am I to avoid being left with a farm that is worn-out and utterly exhausted of every bit of its fertility? I am compelled "by order" to use stimulating artificial fertilizers which, while giving a crop for the moment, are leaving me with a soil that will be bankrupt of humus and useless.'

Every farmer of any education and experience knows that he cannot farm for ever without organic replacements, and yet he does not put them into the ground.

WHY?

Millions of tons of straw are lying in ricks all over the country and no attempt is being made, except in isolated instances, to tread this into muck in the good old-fashioned way.

WHY?

To answer these two questions one has to examine the background that has produced this set of conditions.

I think the trouble really began in 1846, when Sir Robert Peel passed the momentous Act, 'The Repeal of the Corn Laws'. This Act, although it actually took a long time to do it, proved the death-knell of British farming. There are no complete statistical data available with which to measure its effects upon British agriculture during the ensuing twenty years; but figures are obtainable for Ireland, and these show that areas under wheat, barley and oats declined by 570,000 acres between 1847 and 1854. The floodgates of *cheap food* had been opened, and when the development of transport in the new countries of the world, together with the invention of the self-binder, enabled the virgin prairies to be exploited fully, the British market stood open, ready to absorb a steadily increasing flow of imports. Then there followed a sensational reduction in freight rates. The cost of moving wheat by rail from Chicago to New York was 10s. 2d. per quarter, and from New York to Liverpool from 5s. 6d. to 1s. 7½d. in later years. The opening of the Great Lakes route more than halved the cost from Port Arthur on Lake Superior to Liverpool. With no refertilization to bother about, the New World soon made corn growing in all its branches anything but an attractive business proposition to the British farmer, who, with small fields, no mechanical power, and with re-manuring as an essential of good husbandry, was at a serious disadvantage. As one looks back over the periods of change of the last ninety-eight years, one is not surprised that farming at the outbreak of this war was devoid of technique, machinery and implements; but rather that there were any men of any kind— farmers or workers— to be found on the land at all.

The late Christopher Turner said of one of his best tenants:

'In the summer of 1938 one of my tenants (aged forty-two) said to me, "Something is wrong. I have worked for twelve years, I have lost my capital. I have now only an overdraft, and I have lived hard".'

This man was a good farmer.

With economic pressure like this the British farmer was steadily driven into effecting every possible economy; land was allowed to tumble down to grass; the labour bill was reduced by every means. Workers left the land, not because they did not like the work thereon, but because there was less and less work for them to do. Our towns became increasingly congested, our countryside derelict and depopulated. Taking the whole of the world's man-power, we find that three out of every four persons are employed in agriculture; but in Britain the proportion is one in agriculture to nineteen engaged in industry. Surely this is a shocking state of affairs and only goes to show how very fundamentally out of balance this old country has become by disarranging the ratio of those who are engaged in food production on the one hand and those who are employed in industry on the other. The most important of all farming operations in maintaining fertility is to return to the soil all, and more than all, that the farmer took from it. This involves the handling of an enormous tonnage of muck or compost. Until 1944 there was no alternative to manual labour to perform this function; and as a consequence the job is only partially done at best and all farmers have to reduce it to a minimum, to the great detriment of fertility, because there is *no labour available.* To-day, therefore, British

farming methods have to be based, not upon what the farmers know to be the best for their land but upon what work they can get carried out. We talk officially about our high degree of mechanization because we have about one-third of the tractors we require. Mechanization only begins with tractors and the mechanical handling of muck runs the tractor pretty close in importance. When this has been successfully accomplished—as it now is with the Rapier Muck Shifter—then and not until then will you see the fair lands of England begin to absorb the millions of tons of straw and organic manure which are waiting to be returned to it. I am informed on good authority that there are at this moment no less than 20,000,000 tons of muck and organic manures lying about the country waiting to be returned to the land. There is no mechanization immediately available to handle this enormous tonnage and there is certainly not the labour available. That is one of the problems that I have to deal with in this book.

CHAPTER III

SOME SCIENTIFIC RECORDS AT CHUTE, WILTS

The general substance of this book provides a resume of evidence from representative countries setting forth the conditions of the soils of the world as they are in the year 1945. With the rate at which modern life is carried on, are we not approaching the greatest of all the menaces that have ever faced civilization—the day when soil fertility in almost every country will be a thing of the past? Soil exhaustion is taking place, soil erosion is the order of the day, and unless we face this great problem mankind may be ultimately doomed.

In support of this I am now reciting a number of pieces of evidence from our own farm in Wiltshire.

A healthy soil, which, as I understand it, means a soil refertilized by natural organic manures and residues—will grow a healthy plant, which must have a considerable bearing on human health.

Several factors are operating against this method of fertilizing, and among them is the use of chemical fertilizers.

To remedy this state of affairs in England there is needed:

(1) The return to the soil of some officially estimated *twenty* million tons of straw, muck and other vegetable refuse now lying on our farms, by composting processes using animal residues for their activation.

(2) An enlightened system of education for our farmers; they are still unfamiliar with the virtues of new leys, in which deep-rooting leguminous plants, mixed with deep-rooting grasses, are substituted for the old disease-ridden permanent pastures, and upon which by means of controlled grazing new fertility can be accumulated through the action of excrement and urine of the animals resulting in bacterial activation and sheet composting.

(3) The universal use of the subsoiler (where the soil is deep enough to admit of its use).

A few incidents from my own experience will emphasize the value of the system I advocate.

Twelve of the best ears of wheat were taken during the recent harvest from a field which had been subsoiled and organically manured. Twelve ears were similarly taken from an adjoining farm where artificial manures and no organic manures were used. The varieties of wheat were the same. A chemist of repute in London gave the following certificate of the weights of the respective samples of grain:

COMPARATIVE WEIGHTS OF GRAIN 11TH AUGUST 1943

	SYKES	C.
	grams	grams
Weight of the whole of the contents of the packet	31.001	26.625
Weight of 50 grains, chosen at random	2.923	2.390

In other words the weight of the ears grown on land organically manured exceeded that of the ears grown with artificials by 21 per cent.

Last spring fifty of our milking herd were grazing a field which was fertilized 'naturally', and they were yielding 110 gallons per day. Later they were driven into the adjoining field, a new ley, but 'artificially' fertilized. In two days the milk dropped to seventy gallons per day. The two fields were alike in soil qualities and composition of the ley and differed only in their systems of refertilization. At one side of the artificially fertilized field the cows cropped the grass right down to the crown of the plants, while elsewhere no such close grazing was to be seen. The cowman drew my attention to this and asked me to explain the reason. Five years before a large pile of farmyard manure had been accumulated on that spot. As a result, the grass was sweeter and obviously more acceptable than the rest of the field.

In another field I observed the oats were growing with unusually long straw and were very thick on the ground. July rains came, and the crop at this point, about an acre, went down flat and was lost. Next year Little Joss wheat was grown and a similar occurrence was observed. A fallow followed, succeeded by swedes. Crossing this section of the field one morning with the foreman I observed that this patch was growing a very bad crop of swedes compared with the remainder of the field. I told the foreman what I had noticed with the preceding crops and asked him if he could account for this very bad patch of roots where, in the preceding crops, there had been an excess of growth.

He replied, 'When we took over this farm in 1937 we found a bag of nitro-chalk in the barn. This is where we spread it. The oats grew to straw. The wheat, too, grew all to straw. Both crops went down and we lost them. Now we have lost the land. You can see it is beggared.'

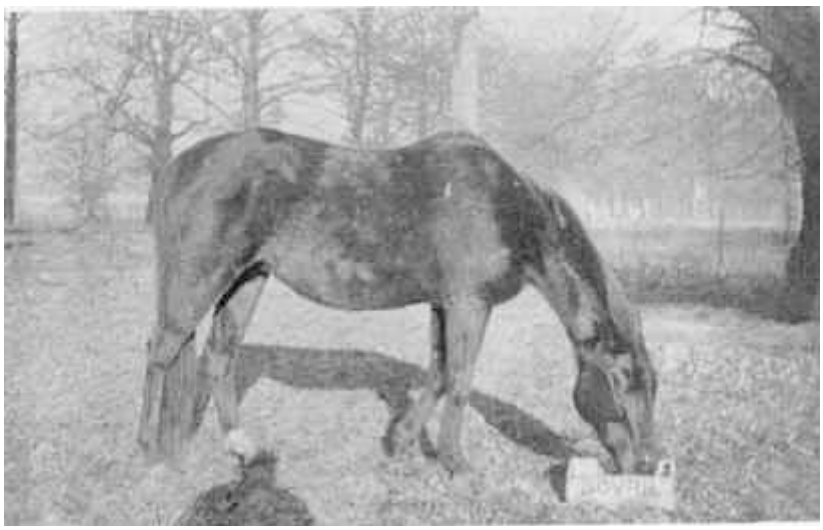
Another field of thirty acres I bought in 1937. It did not belong to the original estate, but its wedge-like shape fitted into the property. I bought it because of this, but I got it for next to nothing because for twenty years or more it had been lying derelict, just a home for rabbits, and utterly bare of vegetation, not even growing weeds. I knew I had bought some responsibility, and began by ploughing and cross-ploughing. Then I rolled it and sowed half a ton of basic slag per acre; then 20 lb. of Italian ryegrass and 4 lb. of rape per acre were sown. Nothing germinated. I have never seen land so dead that such initial treatment so completely failed. Realizing that it was thirty acres of utter desert, and therefore bereft of humus, I knew that nothing would ever be done with it until humus was put into it. So I put the milking herd in the field, and took the milking bail there, keeping the cows in that enclosure for some three months and carrying food from the rest of the farm to feed the cows. In addition, large quantities of straw were littered all over the field which, mixed with the dropped dung and urine, made 'sheet compost' preparatory to being ploughed under. This was costly, but years of untold neglect necessitated this drastic treatment. In other words, when land is really 'down and out' artificials will do nothing to restore it to life. Only 'life itself, which is humus, can come to the rescue then. Since that time this field has had two heavy dressings of compost, has produced various crops, and this year grew ten acres of oats and vetches, seven acres of potatoes, six acres of mangolds (estimated at fifty tons per acre) and a heavy crop of kale. At an altitude of 829 feet above sea level this thirty-acre field is to-day one of the most fertile in the county.

A further piece of evidence in regard to subsoiling and to general cultivation information is to be found in a field of thirty acres on the south side of this estate. This land was ploughed up in 1940 and sown to oats. The crops completely failed—the outgoing tenant said it was wireworm. It was nothing of the kind. It was obviously waterlogged land where such wet conditions prevailed that any seed which germinated was poisoned by acidity and very soon died. I subsoiled this field. After subsoiling some ten acres the subsoiler broke, and as it took a considerable time to get the spare part to repair the machine, we could not wait, and had to sow the land to barley because of the advancing season. It was sown with the variety Plumage Archer. The effect was interesting. We had about twelve sacks to the acre on the ten acres that were sub-soiled, and on the twenty acres that were not subsoiled we had a complete failure of crop as the previous tenant had had with his oats. The following year we first of all subsoiled the whole of the field with the new machine, then we summer-tilled, and in the autumn sowed Vilmorin 27 wheat. The resulting crop was thirteen sacks to the acre. This very large and healthy crop was entirely due to the cultivation and subsoiling. No fertilizers of any kind were applied to the crop, and a great improvement in the land condition was brought about by cultivation and the subsoiler.

Another field of some twenty-five acres was taken over in 1940. The previous history of this field was obtained from one of the past tenants and this is what he said.

'Every time I have put cattle into that field I have always had a visitation of mastitis. If I were you I would not, under any circumstances, put stock in that field.'

1. Richard, Michael, and Pauline to whom this book is dedicated



2. Dáil during her rest: winter

3. Dáil in foal: summer

DÁIL
by Land League *ex* Discourse (Paraffin family)
Dam of six winners and Grand-dam of Lady Chantry colt (1945)

To that extent I took his advice, and while I was making up my mind as to what treatment I should give it, I had the field analysed, and eventually received a report that it was deficient of lime, phosphate and potash, and probably deficient in nitrogen.

I also received a prescription for artificial fertilizers which it was alleged would put these matters right. I accepted and respected the report of the chemical condition of the field, but I did not act upon the advice of applying fertilizers. On the contrary, this is the treatment that was adopted on those twenty-five acres:

The land was ploughed and pressed. One sack to the acre of Victory oats were sown. We reaped a crop which threshed out at over twenty-two sacks per acre. A very heavy crop.

The field was immediately ploughed again and Vilmorin 27 wheat was sown. The next year a crop of over thirteen sacks to the acre of wheat was harvested. Another bumper crop.

At the end of that time the field was ploughed twice and left for the winter. The following year it was ploughed and cultivated several times. It was subsoiled. Towards the end of that summer it was analysed again, and the analytical report stated that it was not short either of lime or of potash, but was deficient in phosphate.

The analyst's report reads, 'Attention is drawn to rather low availability of phosphoric acid (P_2O_5). These low figures are the strong recommendation for the use of phosphatic fertilizers in liberal quantities for cropping purposes.'

Notwithstanding this almost peremptory advice to apply phosphates, I again ignored the chemists' findings and remedial advice and followed my own line of conduct.

In the autumn of 1943 the field was sown to Vilmorin 27. Three bushels to the acre seeding, which yielded a heavier crop than before.

The field is now heavily under-sown with Hampshire late flowering Broad-red clover and perennial ryegrass, and gives promise of giving a bumper crop of clover for seed for the year 1945. Here is a first-class piece of evidence of how valuable soil analyses can be, and how valuable too the advice which is based upon a purely chemical outlook.

First this field by chemical analysis was declared to be deficient in the four main essential elements, without which—according to the 'law of the minimum'—no crops can be grown. After producing two bumper crops —which according to chemical theory simply could not be grown, then summer tilling and subsoiling,I grow the third and greatest of all. (Average United States and Canadian production 18 bushels. Average production for a certain southern county in England during 1942 was under thirty bushels.) Yet no fertilizers of any kind—either artificials or muck—had been added to this land in the meantime.

How is one to account for this most interesting phenomenon?

This is my explanation.

I do not quarrel with either analytical report. I think they were correct —i.e. so far as chemical analysis can be correct. I myself conducted about twenty-four tests for lime deficiency and in every case a deficiency was recorded.

Of what value, then, is soil analysis?

Professor Paterson has written of the value of soil analysis: 'An ordinary chemical analysis can only show that the materials are present, and it does not indicate the rate at which these will become available for the use of crops. On this account it cannot be used as a guide to the manurial requirements of the land. It can only indicate probabilities. If one soil, for example, contains twice as much potash as another, there is a chance that the first soil will each year yield about twice as much potash as the second as a result of weathering. There is, however, no certainty. Analysis, indeed, is more useful in indicating the deficiencies than the sufficiencies of a soil.'

After being misled again and again in previous years, and finally by this recent experience, I have come to the conclusion that if a farmer uses his own observation and notes the kind of grasses and plants that occupy a pasture, this is a truer indicator of the soil's condition than any analytical report that was ever compiled—that is, of course, if the farmer himself knows how to read the signs provided by the vegetation in his pasture. And if he does not he had much better call in the aid of the County Botanist, rather than the analyst, or so-called 'chemical soil expert'. The educational background of these latter is all wrong. Their advice is misleading and wrongly founded.

In this field there were some two dozen samples taken and I therefore think that both the early analyses and the later one were fairly indicative, but the deductions made by the chemical advisers who presumed to advise me as to how to put this field right were as erroneous as anything could possibly be. The condition of the soil was purely one that needed cultivation to put it right. What actually happened in my view was this.

This field had been down in pasture longer than any man living in this locality can remember. During those intervening years it had been grazed time and again by countless numbers of stock and had been consolidated by animal feet to an appalling extent. The condition of the soil therefore was entirely anaerobic and was full of anaerobic organisms, such as wireworm, leather-jacket and the like. There was some evidence of wireworm in the second crop, that is the crop of wheat; but in the course of the subsequent cultivation and the following fallow when the soil was oxidized by the heavy cultivation, the wireworm were eradicated. Wireworm cannot live in the presence of oxygen.

There is no element in Nature more important to the farmer than oxygen. When land lacks this necessary element, the farm is on the down grade. The great underlying secret of cultivation—the penetration of oxygen into the ground and the consequent eradication of anaerobic bacteria, which are invariably there in untold numbers and are the destroyers of our crops. It was this heavy and deep cultivation, coupled with the action of the roots of the plants of the newly grown crops, that effected the enormous chemical and bacterial change in this field, while all this movement of soil accelerated the decay of the old sod and thus provided a humus reserve. This increased the fertility beyond measure and as each succeeding year went by, our crops increased. The condition of that field to-day is truly amazing. There are some hundred Galloway and Guernsey cattle grazing the vegetation at this present moment. They carry a bloom which makes a picture for

any farmer to see. Their condition shows me, as a practical man, that the land has now got into a thoroughly healthy condition. I am looking forward to the harvesting of a bumper crop of Hampshire late-flowering red clover seed next year, after which it will be immediately ploughed again and sown with another crop of wheat.

This was one of the fields that my Scottish friends made a point of seeing and they described it as one of the finest fields of wheat they had ever seen. Mr. Geoffrey Faber, the bursar of All Souls College at Oxford, who visited the farm, also remarked about the amazing sight that that wheat crop showed when he visited the farm in June 1944. This particular piece of evidence goes to show the practical farmer the value of subsoiling and the enormous store of minerals that lie under the ground if only we will make the mechanical effort to get at them. Mineral fertilizers, in quantities lie hidden in the earth, and are to be got by man if he has only the wit and the technique to do it. This can be done by mechanical, botanical and organic means. Mechanically by sub-soiling two feet deep, botanically by using deep-rooting plants like American sweet clover, Sainfoin, Lucerne, Burnet, Cocksfoot, chicory. These go down into the lower strata. They are nature's own subsoilers. They go down ten, and sometimes even twenty feet into the ground. The minerals are there in abundance. There is no need to buy artificials in a bag. Let the farmer farm correctly, using modern implements and those plants that are provided by Nature to establish and maintain fertility. It must be remembered, too, that Nature does not call for a great demand of phosphate or potash to grow a crop. The earthworm population will increase in untold numbers. They act as the unpaid labour force on the farm, and tunnel and fertilize to still greater depths than anything that man can do. The earthworm will bring to the surface ten to fifteen tons of casts per acre with a high nitrogen, phosphate and potash content. The chapter which I devote to the earthworm will further describe the usefulness of this wonderful burrowing animal and the services he renders to man. In fact, it may with truth be said that without the earthworm man cannot survive.

Professor John W. Paterson says: 'Fungus diseases, like rust in cereals and the notorious potato disease, find an easier prey in crops heavily manured with nitrogenous fertilizers. Manures are selected primarily with the object of securing maximum yields per acre, but it is well to keep in mind their secondary effects, particularly in regard to quality of produce and its susceptibility to disease.'

Speaking of the effects of compost, he continues: 'When plant and animal substances decay, the ultimate products are just those which are required by the green plant. Bacteria thus play an *essential* part in the *cycle of Nature,* and by their activity the effete matters of one generation are brought into general circulation for the use of the next.'

R. H. Elliot, one of the greatest farmers of all time, says:

(1) The cheapest food for stock is grass.

(2) The cheapest manure for soil is a turf composed largely of deep-rooting plants.

(3) The cheapest, deepest, best tillers, drainers and warmers of the soil are the roots of plants.

(All, of course, grazed by the animal, the residues of which activate and re-create bacterial life.)

Sir John Lawes, one of the greatest chemists of his generation, who founded and endowed Rothamsted, said:

'It is the physical condition of the soil, its permeability to roots, its power of absorbing and radiating heat, its power of absorbing and retaining moisture, that is of more importance than its, strictly speaking, chemical composition.'

So spake the father of the artificial manure industry. He knew that artificials were not real food for the plant, but at best an artificial aid, and should be used with the utmost discrimination, *always keeping in mind that it is the humus condition of the soil that is of paramount importance.*

Sir Albert Howard says: 'A fertile soil is one rich in humus.'

As a farmer, I say that one million tons of artificials applied to the land will not add one ounce of humus, and therefore will not add to the soil's real fertility.

From scientist and farmer alike evidence is accumulating that the present reckless use of artificials is depleting the reserves of humus in our land, is producing crops of a diminishing food value, which in turn is failing to build bodily resistance in both man and animal, the effect of which may have consequences of such a far-reaching character that this problem becomes second in importance only to the winning of the war itself by the United Nations. What are we going to do about it?

'Ill fares the land, to hast'ning ills a prey,
Where wealth accumulates, and men decay.'

CHAPTER IV

HEDGEROW FERTILITY; COMPARISONS BETWEEN COMPOST AND ARTIFICIALS; FOWL PARALYSIS

At my various lectures I have often been asked a question on these lines:

'I have recently put down the first of my new leys since I began my war-time cropping. I put my cattle in to graze them, and I have been mystified with the habits of the animals. My new leys look beautiful but the animals will have none of them—they all go into the hedgerow and travel round the field eating every blade of grass right into the middle of the hedge, including the weeds. Can the speaker explain this phenomenon?'

This is an experience which almost every farmer throughout the country is beginning to undergo and its scientific significance is so important that I propose to deal with it at length.

In addition to being a farmer I have been a land-valuer for over thirty years. To be a good land-valuer one needs to have more knowledge than the farmer possesses because, while the farmer may have the experience of his own farm, a land-valuer's needs to be so extensive as to be applicable to every farm in the district, every agricultural property in the county, and almost every county in Britain. I may here say that there are not very many land-valuers who are quite qualified up to this standard, but there are a few, and it has been my privilege to survey and value land in nearly every county from Aberdeen to Cornwall.

The most important qualification that such a land-valuer needs is the keenest possible observation. He must be competent to note changes of herbage, of crops, of growth, of colour, of affliction to disease and of a whole host of other details with which a long experience makes him familiar.

I have frequently gone into a district where I have never been before and in the course of one or two days I have made a survey of extensive agricultural property and become so generally intimate with its characteristics as to be able to talk about the condition of any farm on the estate with the resident agent who really knew his job. Frequently, these agents have asked, with words of inquiry and approval, how I had a faculty for taking in such a mass of technical detail in spite of only a fleeting acquaintance with the land which I had surveyed. I never gave away the whole of the secrets of my calling and, for the first time, I am now writing down for all the world to see, one characteristic which has guided me infallibly in making an estimate of the condition of the farms and of enabling me to calculate their worth.

I am now referring to the growth of the hedgerow crops of every kind —grasses, weeds, thistles, nettles, blackthorn, brambles and timber. These were a better indication to my eye than the most elaborate calibrations that any scientist ever placed on a laboratory instrument. From the luxuriance of growth which I saw in the hedgerow, always in striking contrast to the growth of crops of any kind in the middle of the adjoining fields, I used to estimate the difference in fertility between what the land might have been as exemplified in the hedgerow and what it had become in the hands of the husbandman, who presumes to call himself a farmer.

In the hedgerow, Nature, the supreme farmer, produced a crop year after year of a variety of botanical species all with a luxuriance of production which shamed every farmer that I have ever met. Here in the driest season you found the hedgerow growth in blossom and in Nature's profusion, and the land thereunder with a capacity for absorbing moisture which defied the most venomous drought, while the adjoining cultivated ground in a hot time would be parched, the crop wilted and dying, and the farmer complaining of so low a rainfall that he could not run his farm at a profit. In the hedgerow, Nature can make a grand display but the farming in the centre of the field is miserable and threatened with extinction.

Here Nature is showing how the farmer should learn to farm. She grows a crop of self-sown seeds—no need here to seek renewal from seeds grown on some distant farm—and every year, without artificial manures, she grows a perfect crop of produce. If this crop is not grazed by the cattle it falls down dead in the autumn and replenishes the earth's requirements in humus and new fertility. As I have said elsewhere, the effete matters of one generation provide the food for the next. Nineteen-twentieths of the crop which is grown in the hedgerow comes from the atmosphere, so that when this crop decays, twenty times as much bulky material is returned to the soil as came from it. In the hedgerow, too, if examination is made and the soil is dug, you will find a copious supply of earthworms who are living happily and functioning perfectly. How then can man copy Nature's ways? By following out the instructions that are contained in this book and

getting back to Nature in every way, returning to the soil all, and more than all, that came from it, always remembering that a proportion of this must be through the animal dung and urine.

We then come to the quality of the produce grown in the hedgerow, and the explanation in answer to the question at the beginning of this chapter is this: that the cattle are better judges of the quality of produce than any chemist in a laboratory, and that when we wish to test the value of our farming we should test the crops that we grow by feeding them to our livestock. They will give us a true reading of the real success or failures in our farming, and when they decline to eat the new leys which the farmer has grown with the aid of artificial fertilizers in the centre of the field, and prefer the old grasses and weeds and rubbish which they find in the hedgerows, they choose the latter because they are more palatable, more nutritious, and grown with Nature's own system of refertilization: while the farmer stands back mystified at the phenomenon that the hedgerow can grow a crop which is preferred by the cattle and his expensive ley stands out there unconsumed, there is the reason for this mysterious happening. Properly read, correctly understood, it is utterly simple, and the farmer should take this lesson to heart and cease to use artificial fertilizers.

I have said elsewhere in this book that if the farmer will conduct experiments on his own in the same field with the same composition of ley, where one-half is composted and the other half is artificially re-fertilized, he will again see this same phenomenon and find that his cattle will prefer the grasses and clovers grown by compost.

Another important feature which I would ask every farmer to examine is the ability of the hedgerow to absorb the rains. He will find that notwithstanding torrential downpours there will seldom be a 'run-off' of water from the hedgerow land, while a few yards inside the field he will have the mortification of observing, especially if the land is on a slope, that his valuable surface soil is being washed away in 'erosion' due to the fact that the surface soil of his fields is insufficiently supplied with humus. The humus content of the hedgerow land absorbs almost untold quantities of water, retains it there during the hottest of weather, and provides the plant with vitalizing solutions all through its growing season. Hence, the luxuriance, the evergreen greenery, and the continuous production where Nature has her own way.

If the farmer will do still one more experiment on his own which will cost him nothing, let him take a walk on the wettest day of the season over his own farm. He will find that the soil of his arable land will accumulate round his footwear to such an extent that he can scarcely get along. In this condition, let him step into the floor of the forest where the rain, through the dripping of the trees, almost feels to be worse than it is in the open field, and he will find that his boots clean themselves as he walks through the forest, for the absorbent character of the forest floor is such that it can take all the rain that Nature provides and practically never give walking conditions which cause the slightest inconvenience to the man on foot walking underneath the trees. This is another object lesson telling the farmer that if he would farm well, he must farm as Nature intended that he should. He should copy her handiwork in the hedgerow and in the forest and see that his surface soil, at all times, is heavily charged with humus.

4. STATESMAN
(bred by Friend Sykes.) By Blandford *ex* Dáil

5. HIS REVERENCE
(bred by Friend Sykes.) By Duncan Gray *ex* Reverentia

6. His Reverence winning the City and Suburban Handicap at Epsom, from Guinea Gap, and Rippon Tor, after making all the running

COMPARISONS BETWEEN ARTIFICIAL FERTILIZING AND COMPOST

When I had the pleasure of entertaining Mr. John Mackie, of Laurencekirk, at Chantry, he put this question to me:

'As you know, I am a large potato grower. I do not claim to be a chemist, I do not claim to understand organic manuring, I am a practical farmer possessed of an open mind, always anxious to seek information. At the present time I am growing potatoes extensively and I apply muck and heavy dressings of artificial fertilizers. As a result of my technique it is usual for me to harvest fifteen tons to the acre of potatoes. Now I

do believe that if I cease to use artificial fertilizers and change over to your system of farming, I think that I should not grow the same weight of potatoes that I am now growing. What is your opinion?'

I replied that I was of opinion that if he applied compost in place of farmyard manure which he was then using, and if he applied a sufficiently large tonnage of that material he would grow as great a crop, and much better quality crop, than he was growing with the combined use of farmyard muck and artificials.

I propose now to seek outside evidence in support of the statement that I made to Mr. Mackie, and I am now going to quote from Robert Elliot's experience and also from experience at a demonstration farm in Northumberland:

'In my paper read at Cambridge, I said *(vide* Appendix IX) that the chemist must become more of a farmer, and the farmer more of a chemist, before either can work effectively in arresting the downward course of our British soils. And is it not obvious that if, when the blind lead the blind, the result is liable to be unsatisfactory, the leading of the semi-blind by the semi-blind is certain to end in much more serious disaster? In the former case both are proverbially liable to be abruptly aroused to the inadvisability of their proceedings, and that, too, before they have gone very far; but when a chemist who is agriculturally semi-blind leads a farmer who is chemically semi-blind, still more unsatisfactory results are, as we shall see, certain to ensue, for they are sure to be the means of doing much harm by the propagation of that most dangerous form of knowledge known by the name of half-truths. In order to prove this it is only necessary to look into the seventh annual report on experiments with crops and stock at the Northumberland County Demonstration, Cockle Park Farm, Morpeth. It is there evidently assumed that the British farmer has done all he can for himself by fully employing the natural resources within his reach, and that all that remains is for the chemist to step in and assist the farmer either to increase his crops or improve the condition of his animals by the aid of commercial fertilizers. But the chemist (though adding the name agricultural would lead people to suppose that he is an agriculturist as well as a chemist) really knows nothing of agriculture, and indeed it is obvious that he does not, for otherwise he would first of all inquire whether the farmer does make a full use of all the natural resources at his disposal before advising that various kinds of chemical manures should be used. But the chemist makes no such inquiries. He takes British soil in hand as he finds it exhausted more or less by long courses of limings and artificial manures, and tells the farmer that all he has to do is to replace what he has taken out of the soil, and that if he wants more produce from it he must at once apply an increased supply of the chemical ingredients that have been carried off the land. By this process the chemist manures the plant and not the soil, while the farmer puts down as little as he thinks will serve to grow the plant, which he could not otherwise effectually do, and the plant, grown through this aid, searches through the soil to absorb the remains of its natural fertility. Thus the decline of our soils proceeds till the humus of the soil becomes so thoroughly exhausted that the diseases of plants increase, and they are more and more at the mercy of the vicissitudes of unfavourable seasons. Then as the fertility of the soil declines, and natural sources of plant food diminish and are not replaced, or only in most inadequate degrees by natural agencies, the artificial manure bill must be increased, and it has been so increased that farmers now complain that it amounts to another rent. But such manures, even if they could be had for nothing, would not enable the plants of the farmer to contend successfully with climatic shortcomings which so frequently occur in these islands—excessive drought, or excessive wet, or excessive cold. If the season is perfect the artificial manure will act fairly well. If it is too dry there may be too little water present to convey the plant food into the plant, and if very wet much of the manure may be washed away, and other parts of it, if not used at once, are liable to enter into insoluble compounds in the soil; while if the season is cold the artificial manure cannot raise the temperature of the soil as humus does. It is evident then that what the farmer requires is at once a chemical and a physical agent provided at the lowest cost, which will act with the greatest certainty, no matter what the season may be, and which will continuously increase the humus of the soil, and add to its depth. This he can provide, as I have abundantly shown, by growing a turf of deeply rooted, and powerfully rooted plants. The chemist with his artificial manures can only provide, of course, a costly chemical agent which must always be, as I have shown, at the mercy of the season, and not only cannot permanently ameliorate the fertility of the soil, even in the most favourable seasons, but, unless supported by dung or turf, must deplete the soil. To the agriculturist who has what Locke terms "Large, sound, roundabout sense", the preceding statements are, of course, mere truisms; but as there are many of my readers who, to use Locke's words again, "have not a full view of all that relates to the question, and may be of moment to decide it", it is advisable to refer them to the statements I have made as regards the crops grown without manure, and also to allude to some facts with reference to the experiments made at Cockle Park County Demonstration Farm. These, as we have seen, are made on the assumption that the British farmer has done, and continues to do, all he can for himself, and that it only remains for the chemist to show him how, by the application of artificial manures, he may derive increased crops from exhausted soil. If the

assumption is correct then the results of the experiments are valuable to the farmer, but the assumption, as I have abundantly shown at Clifton-on-Bowmont, is not correct, and the experiments are really only of value to show the farmer how, with the present low price for agricultural produce, he may lose his money if, after having adopted my system and manured his land with turf, he chooses to add artificial manures. The experiments made at Cockle Park, in order to stimulate the seed hay crop with various manures from a cost of 13s. to 36s. per acre, show results which, as compared with my results from turf-manured land, are distinctly inferior, so that the farmer working on my system would have lost the value of the artificial manures had he used them. When I pass to the potato experiments at the College, as shown in its seventh annual report, the results are still more striking. As shown in my paper delivered at Cambridge, August 1904, 1 last year produced, without any manure other than turf, 13 tons 14 cwt. of potatoes per acre. With the aid of 12 tons dung and 6½ cwt. artificials, costing 101s. 1d., the College produced 13 tons 7½ cwt., and the College estimates that this manurial application brought in a profit due to manure of £23 11s. 2d. But how was this profit estimated? By comparing the yield with that of the no-manure section, which only produced 2 tons 16 cwt. But if this section had been coated with a deeply rooted turf there is no reason to suppose, as mine is a poor land farm, that it would not have produced as much as the manured section, costing 101s. 1d. per acre, and it must be remembered that, when growing the turf, no expense other than that of the seed would have been incurred, while the hay and grazing obtained when growing the turf would, at a small cost, have yielded a handsome profit [1]—the average cost of the seed divided over the years when the turf was being formed coming to about 10s. a year—varying in occasional years with the goodness or badness of the grass seed crop, and the demand for seeds. From what I have shown it seems clear that the Board of Agriculture is really spending the national funds in teaching agriculturists how to farm at a loss.

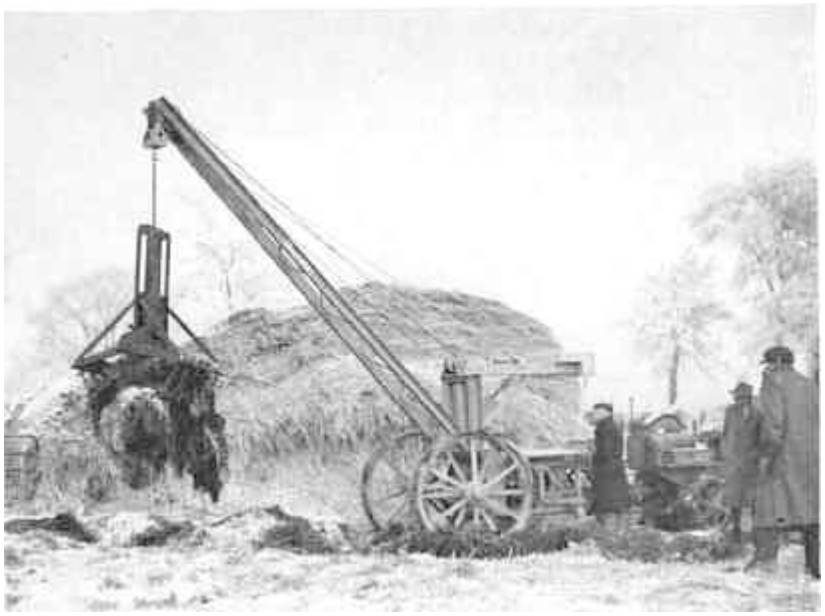
'These conclusions are confirmed by an experiment I made in 1901 in the Big Haugh field *(vide* Appendix III), by which I lost about the rent of the land by adding dung and kainit to my ploughed-in turf. The manured section gave 15 tons of potatoes an acre, at an estimated cost for manure of £2 10s.; the turf-manured section gave 14 tons 6 cwt., estimating the potatoes at £2 per ton, the result was that we lost £1 2s., or about the rent of the land, from having used manures in addition to turf. This year (1904), which I am told is an inferior potato year as compared with last year, the potatoes, grown on Hayhope Shank Field East, show a decline to 12 tons 18 cwt. 4 lb. on the manured section, and 12 tons 7 cwt. 1 lb. where the turf alone was relied on. It is interesting to note that these results had been obtained under much more unfavourable circumstances, as, from certain requirements on the farm, the rotation system in the case of this field was altered to oats out of grass, turnips, barley, and turnips, part of the field this year being allotted to potatoes so that they were preceded by a cereal crop, then a turnip crop, and then by another cereal crop. As neither of the two cereal crops had any manure, and the turnips some artificials only, the crop of potatoes, may be considered to be the most satisfactory evidence of the great value of turf as manure, and especially of its lasting effects. It will be interesting to observe how, on the potato section of Hayhope Shank field, the grass will compare with that on the section in turnips. As yet, no difference can be perceived in the Big Haugh field between the grass after potatoes and the grass after turnips. But it must be remembered that the Big Haugh potatoes were taken out of grass, while those of Hayhope Shank were the fourth crop of the series, which no doubt accounts partially for the shortness of the crop. A fifth crop, a cereal one, will be taken next year, when the grass seeds will be sown along with it, and this crop will be taken without manure so that the system will be put to a very severe test.[2] The soil of the field is what it known as very light land.'

[1] As it might be supposed that a good turf could not be grown at Cockle Park, as it is a poor clay soil, I would refer the reader to Appendix III, giving results of experiments on the Abbotsley poor clay soil with one of my mixtures, which has there produced a fine turf in four years.

[2] No difference could be perceived in the grass taken after potatoes, and the fifth crop (oats) was a satisfactory one, so that the lasting effect from land manured with turf has been proved beyond doubt.

7. Rapier Muck Shifter, Mark II: Self-propelled model

8. Rapier Muck Shifter, Mark I tractor-driven model, loading an American spreader



9. Rapier Muck Shifter, Mark I, tractor-driven model

10. Rapier Muck Shifter, Mark II, working on a Suffolk farm

It will be seen, therefore, from the figures provided by the late Robert Elliot that there is not much difference between a field which is highly fertilized with artificials in combination with farmyard muck and one which is refertilized by sheet composting made out of the four years' ley, which has been grazed according to the system set out in this book. It will also be seen that after four or five years' arable that the lasting effect from land manured with turf has been proved beyond doubt. This knowledge, provided by Elliot, which is in complete accord with my own experience, tells me that if the farmer will but go in for a system of alternate husbandry of four years' mixed ley which I provide, and four years' arable, he will suffer no diminution of output in tonnage of the crops, but that he will gain all the time in permanent fertility and produce crops of food for both man and beast which are far more life sustaining, and therefore, more disease resisting.

FOWL PARALYSIS

In the early days of 1945, I was invited to give a lecture in a certain northern county. This lecture was delivered under the auspices of the National Farmers Union and the War Agricultural Executive Committee. At all my lectures I am received with a great display of genuine hospitality—this was no exception to that rule, and the next day I was invited to visit some of the leading farms in the county.

Among these was a very large, well-conducted poultry farm. This man, for the most part, specialized in poultry—he was a large egg producer—and the only other class of stock which I saw were a few bullocks which were being very well done.

This young man—I do not think he was much more than thirty years of age—would appear to have been very well financed, and I must here record that his holding showed better management and a degree of efficiency than I had seen anywhere for a long time. I thoroughly enjoyed my survey of his property and took pleasure in having described to me the details of his poultry organization which was outstandingly efficient.

Towards the end, when we were returning to the car, he asked me if I could make any criticisms, to which I replied that I would like to know if he had any disease on the farm. He seemed quite surprised at this question and said so, and inquired why I should ask it. I said it was because I knew he applied artificial fertilizers to his ground and that I should be really surprised that any poultry farm could keep clear of disease if they applied artificial fertilizers.

'Are you of opinion, then,' he inquired, 'that fertilizers were the cause of any of the fowl diseases?'

To which I replied I thought they probably were and had he, for instance any trouble with fowl paralysis, to which he quite honestly replied:

'Yes, I have, and I am considerably worried about it.'

'Have you any remedial measures?' I asked.

He told me that he had for some time been mixing potassium iodide with their mash and that he thought that the disease had been less in consequence. But he was quite frank about it, and said that the disease had not disappeared and he was still dissatisfied with the state of affairs. I therefore suggested that he should take 2,000 of his 4,000 this-year chickens and fold 2,000 on land which had received no dressings of artificials for some three years, or even longer, and that he should fold 2,000 birds on land which he would dress this year with phosphates and potash, that in the latter case he should continue to feed his potassium iodide while in the former he should feed the same food with these chemicals excluded. I ventured to suggest that I thought he would find that he would have a greater freedom from fowl paralysis where artificial fertilizers had not been applied—even if it did not clear it altogether as I thought it might—while he would also be able to compare his results with the other 2,000 birds treated and kept as he now keeps them.

This young man was one of the most intelligent farmers I have met for a long time, and he offered the opinion that there was probably something in what I said and that this may be the key to the cure of fowl paralysis. He asked if I could offer any theory for my remedial measures and I told him that I was of opinion that the superphosphate in particular, which was applied to the surface grass land, was scratched up by the fowls in their folds and was consumed by them, and this mineral, artificially provided, was probably a most unsuitable ingredient for poultry to consume. I told him that I knew a certain amount of research had been conducted by a friend of mine who had taken no other step beyond excluding superphosphate from the land, and that the fowl paralysis in succeeding flocks had disappeared. The experiment is now being done by this young man and in later editions of this book I hope I may be able to make further reference to it.

It must be remembered, too, that superphosphate is mono-calcic phosphate, which is soluble in moisture. It may be that when this mineral finds its way into the wet crop and gizzard of the fowl that through trituration and moisture the phosphate becomes solutionized, passes into the blood-stream, and thus causes slow poisoning finally resulting in fowl paralysis. If tricalcic phosphate were spread on the land instead of mono-calcic phosphate, this would not happen because the tricalcic phosphate is insoluble in moisture or water. Tricalcic phosphate, however, has to be transformed into mono-calcic phosphate by the application of sulphuric acid, and in consequence there would be little refertilization result in applying the tricalcic phosphate.

It is only fair to record that I believe there may have been one other possible contributory cause of disease on this farm. He was working with a large number of well-designed closefolds. From a money-making point of view, many poultry people believe in these folds. Two friends of mine who have carried out more research work on poultry than anyone I know, both condemn this system. They tell me that the close covering of the ground with the fowls' dung, etc., to the point of saturation is deleterious sooner or later to the health of the fowl.

Carrying on his research Sir Robert McCarrison in Madras found that grain produced with farmyard manure contained more vitamins than that grown with minerals. A confirmation of this finding, in the case of vitamin B, is recorded in the experiment carried out by Rowlands and Wilkinson of the Knightsbridge Laboratories.

The only tests a farmer can make on his own, however, are with animals, and several instances are recorded in these pages. One of the most arresting concerns hares.

Some sixty-five acres of wheat were sown in the autumn of 1944. There was good germination, and a strong plant, but throughout the entire winter—which was exceptionally severe during January 1945— the hares from an adjoining estate showed a preference for my wheat, as against other peoples' crops, and especially as against another crop of wheat grown with artificials by a neighbouring farmer, over which field the hares had to travel in order to reach mine. This adjoining field of wheat was left quite untouched, but every plant in the whole of my sixty-five acres was systematically eaten. Following the drills right through the field the hares kept the wheat plants cropped down to the ground. Whenever I advanced towards them they bolted across my neighbour's wheat, leaving it untouched.

The only explanation that I can offer is that my wheat, being grown with humus and without artificials, was distinctly more palatable to the hares than my neighbour's: this incident provides the best advertisement for the use of artificials in neighbourhoods where rabbits and hares abound. My general experience both with my own animals and with ground vermin corroborates the experiments mentioned above in showing that crops grown by artificials are neither so life-sustaining nor so palatable as those grown with humus.

Some 300 hares were shot by my neighbour and his twenty-nine guns in a two-day hare-drive in February; it is a curious law, surely, by which a farmer may have to provide his neighbour with this quantity of 'sport' and have no claim to compensation. It is curious, too—in this year of 1945 when famine is threatened in almost every country—that the authorities administering our agricultural policy should do nothing effective to secure the destruction of hares and rabbits when the human population is crying out for food. If we allow some ten sacks to the acre and allow one sack of wheat for an average family per annum, no less than 650 families went short of breadstuffs in providing these hares with their diet.

CHAPTER V

MAKING A NEW PASTURE

What wonderful crops can be grown on the upturned sod of an old pasture! Those who have had this experience appreciate its latent fertility. Fertility has been accumulated over years of grazing and manuring, and when it is ploughed all this store of wealth is liberated and cashed in by the lucky farmer. I had one experience among very many which will be interesting for the reader to note. A field of some twenty-five acres was down, I suppose for over sixty years, perhaps longer. This field was credited with being full of disease. I was advised not to put stock into it unless I wanted them to be infected. I ploughed it, and on the upturned sod I sowed one sack to the acre of Victory oats and had the satisfaction of harvesting over twenty-two sacks to the acre. The next year I sowed Vilmorin 27 wheat, and again I had a bumper crop and harvested some thirteen sacks to the acre. Then the whole field had to be summer-tilled. It was subjected to several ploughings, cultivations and to subsoiling. At the end of that summer-tilling, three bushels to the acre of Vilmorin 27 wheat was sown and this time a phenomenal crop of wheat to the acre was grown— and this on a field some eight hundred feet above sea level. For land like this, and an altitude like this, perhaps it may be something approaching a record. Thus it will be seen that to break a pasture makes a man.

Now we must consider the other side of the picture altogether. To me a pasture is something on which bullocks will grow and fatten for some years to come. A place where I can graze dairy cattle in the hope that they will milk adequately without any kind of concentrated feeding. It is an important and scientific undertaking, therefore, to study how to lay down such a pasture, and how many operations and how much time will be necessary before results will show themselves.

The lack of knowledge amongst farmers generally about grass growing and clover production is considerable. When they need a grass and clover mixture they would appear to possess little experience which will enable them to compile it for themselves. Their usual plan is to go to their seed merchant with whom they regularly deal, and ask him for a mixture of clover and grass seed. He immediately asks whether it is for one year or for two years, or for three years or for longer; and then the farmer is further at a loss-—he is not sure sometimes whether he wants it for a short term or a long term. After some discussion, however, the seedsman gives him a prescription—perhaps the seedsman knows the land; but I should say, more often than not he knows nothing at all about the particular soil for which he is providing. My method of providing a seed prescription is as follows:

I go over the old pasture and I take careful record of the different grasses, clovers, and various species of herbage that are growing there, and then I build up as nearly as I can a new prescription from those species. By so doing I know that I am introducing new seeds of varieties that will thrive and develop on that particular field. I know, furthermore, that by getting a thriving plant I shall eventually establish a sward which will feed my stock in the desired way. This is the way I always build up my seeds mixture.

Sir George Stapledon has made a great reputation, and quite worthily so, in recent years, by the study he has made of grasses and clovers. He has written many interesting books on this subject, and 1 think that he is the first to recognize that the authority from whom he learned most of his early lessons, was Robert Elliot, the author of that famous book, *The Clifton Park System of Farming.* The modern edition of that book, which was written originally about the year 1890, has a foreword written by Stapledon. I am glad to be able to note the fact that Sir George admits how much he owes to that great pioneer of grass and clover farming. No one in our generation, or in the generations immediately preceding us, have done so much research work of such a valuable character as did Elliot, at Clifton Park, on the Scottish border.

The next item that I have to remember is to regard any ley that I may put down as a crop of a very temporary character. Although many grasses are known as perennial, they are not in fact really so; and the longer they remain down, the weaker they become. Possessed of this knowledge I see to it that I make no pasture of a greater duration than four years. As I have indicated in other parts of my book, I run a four years' ley, with a four years' arable (see Chapter I).

Having settled the seed mixture, the next important matter for the farmer to decide is the time of year when he will grow it. The following is my technique of land preparation which is, perhaps, most important of all.

After the third year of arable, in the four-year arable rotation, I give the land a ploughing in the autumn following the previous year's cereal crop. This first ploughing is left to be attacked by frost throughout the coming winter, and as soon as possible, in the early months of the year, perhaps about mid-February, if the

weather is favourable, this ploughing is cross-ploughed. In a fortnight or three weeks' time, again governed by the weather, this is again cross-ploughed, and then perhaps it is cross-ploughed a further time. Altogether 1 should not be content with less than three or four ploughings. Then it would be cultivated with the Ransomes Equitine Cultivator. This process of ploughing and cultivation would go on between the middle of February and the end of June. On July 1st—and may I emphasize the importance of noting these dates because timeliness is the essence of this contract—on July 1st I should sow, after a cultivation, twenty pounds of mustard to the acre. Harrow this in and roll it. In about four weeks' time that crop of mustard will be from four inches to six inches high. On July 31st—not later if you please—I should plough this under. Again harrow and roll. On the upturned ploughing I should then drill three bushels to the acre of giant Essex rye. The next day sow my grass and clover seeds mixture. That would be harrowed and rolled at once. In six weeks' time there would be a growth of rye probably four to eight inches in height; and the clovers and grasses would be growing quite well. The depth of the growth would obviously be governed by the rainfall and warmth of the season and the inevitable contributions that climate always makes to growth. Usually the growth is considerable and it is generally so heavy that one of two courses has now to be pursued. One, that this should be grazed as quickly as possible and, if the weather is fine, by bullocks and sheep. The crop is grazed fairly severely, but not too hard, and to do this put on the greatest number of animals that are available. In about a month or six weeks' time again repeat this grazing process, when it will be found that on a thirty-acre field sometimes as many as eighty or a hundred bullocks can be carried for periods, on and off, right up to Christmas; again, this is governed very much by the weather. If the weather in the autumn is wet, the bullocks should be kept off the land, and the sheep should be grazed in preference. If sheep are not available then one or possibly two crops of ensilage should be made; because the growth of the rye is such, that something must be done to get this crop cut; otherwise it will fall over and will smother the oncoming grasses and clover, which is undesirable in the year 1944, for that crop of grass and clover seeds alone will cost the farmer something like 100s. per acre. Obviously these valuable seeds must be cared for. This is the treatment right up to Christmas. After that the land is again harrowed when weather permits, to spread the manure. Then it should be left until about the end of March. Again, the growth will vary, but usually it is considerable. Somewhere in the very early days of April this crop is again ready to be grazed. Heavy grazing should again be the order of the day. After this third grazing, rest it again for a few weeks; but again take the precaution of spreading the manure with a chain harrow; also, the act of rolling the land with a flat roller is important. After about a month or six weeks, again according to the growth of the crop, repeat the grazing process by as heavy a head of stock as is available. Taken by and large, this will bring the farmer somewhere about to the tenth or eleventh month after the date of the original sowing. He will then find, looking back, that he has taken off that land already four very heavy grazing crops of food, which has sustained bullocks, milking cattle, or sheep, or a mixture of all of them, for nearly a year. He will also find that he is possessed of one of the finest swards of grasses and clovers that he has ever seen.

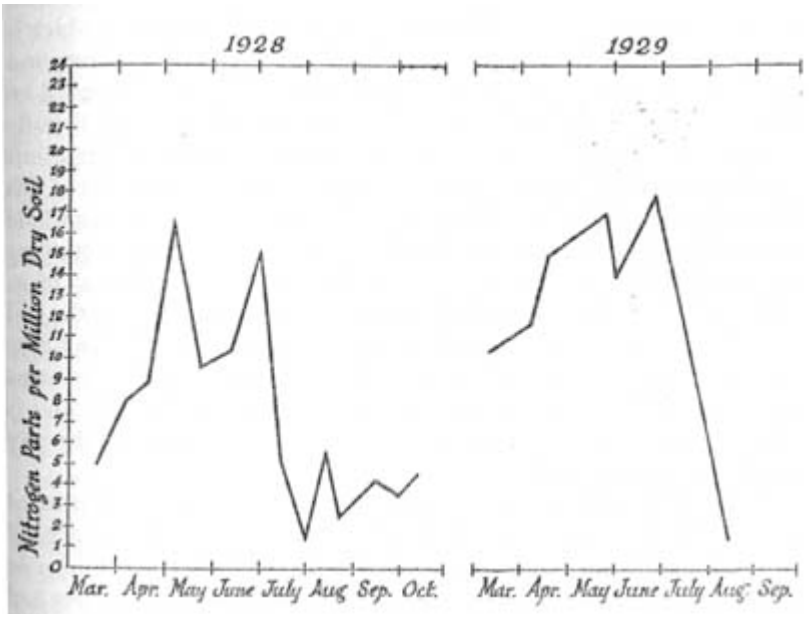
I propose to explain exactly what happens here, but before doing so, I would like to refer to some of the other methods that farmers try, which I have tried, of establishing swards at various seasons of the year. All of these methods, whatever their merit, frequently lead to failure and disappointment. There is what is called the direct system of reseeding; that is to say, early in April or the last few days of March, mixtures of grass and clovers are sown direct to the soil, and if good rain comes perhaps you get a nice establishment in six or eight weeks, which you can graze lightly, preferably with sheep: but in my part of the country this is almost invariably a deadly gamble; because we are accustomed to spring drought nearly every spring, and I have never had the satisfaction in this part of Wiltshire of having a good 'take' with seeds at this time of the year.

Then there is the next school of thought which believes in sowing about half the usual crop of cereals, say two bushels of oats to the acre, or half the usual barley sowing, and under-sowing this with the seeds mixture. Then in the middle of the season the crop of oats or barley, or the combination of the two cereals is cut, and after that the oncoming clover and grass seed are lightly grazed. But this, again, is a speculation and a gamble on the hills of this part of Salisbury Plain, where our rainfall is sadly too little (sometimes under twenty inches) and where we are asking the Almighty to give rain when, in His mysterious dispensation, He decides not to do so. Therefore, I have abandoned this kind of experiment along with others because of its many uncertainties.

Then there is the further scheme, which others and myself have tried, of sowing grass seed and clover without another crop towards the end of July. Generally speaking, as far as this part of the country is concerned, this has given me better results than the spring sowing, but none have given me any results comparable to the one which I have described in the early part of this chapter; and it may now well be asked, 'Why is it that there is such a certainty of a good "take", and can you scientifically explain why you have

inaugurated such a system, which has never been heard of in any other part of the country?' This is my explanation.

On the opposite page, I refer you to a graph which I have drawn, and which has been checked by the kindness of Sir Albert Howard. This is a graph referring to the 'fixation of nitrogen'. Nitrogen fixation is a mysterious subject about which most farmers know little or nothing. It is not a too difficult subject to understand, and in the words of explanation which I am now providing, together with the graph, I believe my explanation will prove easy of understanding. First of all it is necessary to know the physical fact that there are two nitrogen cycles in the course of spring and autumn. The first cycle begins to show itself about the first or second week in March and, as the soil warms with the oncoming spring sun, nitrogen increases. As the nitrogen rises from day to day the bacterial population, the fungi, the earthworms and the soil microorganisms multiply in untold numbers. When we reach the first week in April,



NITRATE ACCUMULATION, 1928-9

the soil population is rising very rapidly as reference to the graph will show. It continues further to develop until the third week of May— it varies a little, of course, in different localities—and towards the end, or about the end of May, organic-nitrogen-fixation has increased to its maximum. From that time we notice that the lines of the graph steadily decline until they come down considerably in about the middle of July. Now, as a result of this great increase in nitrogen availability, the soil population of nitro-protein-consuming-organisms, fungi and earthworms, is really tremendous. As the nitrogen falls in volume there is a soil population which is probably much too great for the soil to carry and, at this season, there is insufficient food to sustain that population. In a hungry condition they begin to attack one another, and do a great deal of deadly damage in consequence. Now, this is the time that we choose to sow our mustard, and we begin by sowing it on July 1st. As a result of the nitrogen which is already in the soil, we get a very quick growth during that month of this particular crop. As soon as that crop is turned in, precisely on August 1 st, the soil population, in a desperate state of hunger, consume that luscious and high protein containing food, now newly turned in, and they eat it with avidity. They convert those proteins into further nitrogen supplies, phosphate supplies and supplies of potash, and all from an organic source.

This is made immediately available to the oncoming rye crop, which is sown on August 1st, and the oncoming grass and clover crop which is sown on August 2nd. The result is that the rye and those clover and grasses grow with a magic which is greater than if you had supplied an enormous tonnage of artificial nitrogen and phosphates. They literally almost jump out of the ground, and they continue to grow in luxurious profusion during the whole of the twelve months. The one point of this discussion, which I want to emphasize, is the *timeliness* of the whole operation. I have heard many people say: Oh, I have tried the growing of mustard, but it never seemed that I got much usefulness out of it. The real value of ploughing in a green crop is to plough it into the soil at a time when the soil population can make most use of it; and thus convert that green crop into food for the nitrogen-forming organisms and other living soil-conditioners of the

greatest possible value. This is the season of the year when this can best be done, and that is the way I establish my new leys.

Some of my friends have already named this the 'Sykes system of establishing a ley'. However that may be, and for what it may prove itself to be worth, I am glad to hand it forward to coming generations of farmers, and the benefit of such experiments and practices as I have had the privilege to carry out. That, then, is my method of putting down a ley and provided the *timeliness* of the operation is strictly observed, it ought never to fail.

One hears such a lot in these days of farming innovations about 'the early bite'. One instinctively conjures up in one's mind all sorts of delicious tasty morsels which might be calculated to tickle the fastidious palate of the most epicurean cow that ever walked into a luscious spring pasture. We can allow the imagination to run riot with thoughts like these since we too can just dimly recall the day when to sit down to a well-prepared dinner composed of a variety of the best products of the good earth was an incident to live for. One never knows, but even cows may have equally well-developed gastronomic fancies and predilections. Certainly I have witnessed cows in the early spring go into a new pasture with an eagerness which far outweighed the looks of happy anticipation that the most ardent epicure has ever displayed in approaching a gourmet's meal at the Savoy.

How can one provide this delicious treat for our animals who have lived through the rigours of winter, with all the inevitable rationing restrictions thrown in? The artificial manure manufacturer has written sheaves of propaganda on this subject. Needless to say, after expatiating on the technique, the mixture of grasses and clovers to sow, he advises one to apply a top dressing of sulphate of ammonia, and sometimes he includes the provision of either superphosphate or basic slag as well.

I don't believe in dope like that for the good of the land, or the crop, or the animal eating the crop. My methods, I think, apart from being better, are more in accord with Nature, and the old adage 'never get far from Nature's practice when you go farming, my boy, and you will never go far wrong', has much to be said for it.

Therefore, my advice is this. Every year, see to it that you put down a fresh crop of grasses and clovers according to the 'rye cover crop' outlined in this chapter. You will find your rye growing in the month of March and early April with a wealth and luxuriance such as none of your established leys will show, even if those have been top dressed with sulphate of ammonia. You will be able to graze this rye probably in the third or fourth week in March, or early April, and the crop will carry a very heavy head of stock. Be sure to graze with the largest head you can muster, and graze on the 'on and off' principle. This rye will carry your stock on until your grazing leys are ready for spring grazing, when the rye can be rested and grazed again when it has grown up tall enough. Rye is our 'earliest of all' spring growing 'graminae', and I am surprised that no farmer in my wide experience has ever sown it, even if for no other reason than it provides this invaluable 'early bite' that we all so badly need in spring, and provides this, moreover, without the addition of any top dressing by artificials.

Another interesting feature of this rye crop technique is the ease with which the farmer can deal with the serious problem of charlock infestation.

I cannot think that any farm in England has had worse farmers in years long ago than this piece of land which the Almighty has handed on to me.

Soon after I bought this property I had occasion to visit my solicitor in London, and he asked me to go into a private room to read over the deeds of this estate, and this I did, covering the history of most of a hundred years. I found that during the last sixty or seventy years there had been something like a dozen farmers in occupation of this land and nearly all of them had either gone broke or left the place in financial difficulties. There may have been one exception.

This will give the reader some idea of the very poor condition of the land and of its general neglect. One of the farms is now named 'New Zealand farm' but in the old maps this is called 'Van Diemens farm', and a better name could not be given to this out of the world spot.

I think, too, that in the days of old charlock must have been one of the principal crops in this part of the world, and the farmers determined that they should grow prize crops of this particular botanical species. In any event, I have never seen soil so infested with this infernal weed as much of my land is, and how to grow a spring crop and not suffer its being suffocated with charlock becomes one of the most serious problems in farm planning.

In testing out this rye system of laying down a new ley, I have accidentally discovered a method by which I can deal with my charlock troubles.

Sowing on August 1st the strike of charlock is as instantaneous as the growing of the rye itself, and I succeeded in producing a mixed crop of rye and charlock which I am quite sure must be without equal

anywhere in England. This does not worry me in the least, however, at this particular season of the year, because I know how to deal with it and although it may be news to some farmers cattle eat charlock quite readily especially if it is mixed with rye; in fact I think it may seriously be claimed that the rye crop itself is improved in palatability by the addition of the charlock. Be that as it may, the cattle eat the whole crop in the first eating and I have no further trouble from charlock during the next four years. This is an interesting and useful piece of technique for farmers everywhere to note, for the problem of dealing with charlock-infested land is a serious one and it restricts one's spring sowing so much that it nearly makes the farm impossible to manage.

Sir Albert Howard, commenting on this chapter, says:

'The graph is the graph of nitrate accumulation which follows nitrification.

'The spring peak is higher than the late summer peak. The mustard uses the nitrate in the spring peak, the rye what is left, the grasses use the late summer peak now assisted by the organic matter of the mustard.'

CHAPTER VI

RENOVATING AN OLD PASTURE

At this point, with the last chapter in mind, some readers might want to interrupt me, protesting that there are some pastures which, because of their close proximity to the homesteading, and their general accommodation value, the farmer is more or less compelled to keep indefinitely in permanent pasture. It is not possible to put them into the ordinary scheme of the farm's rotation. What should be done to renovate such pastures and make them as high yielding as possible?

Let us take an imaginary but typical case such as I have more than once had to advise on—a water-meadow, with a ditch at the bottom of it which has been blocked up for a lifetime. The drainage provided many years ago is now ceasing to act. The hedges are overgrown in places, and exceptionally high in others; and brambles are everywhere luxuriant, both in height and width. Part of the meadow is boggy, and full of reeds and bulrushes. Here and there the hedgerows are riddled with rabbit burrows, and the rabbits have been energetic enough to destroy a great deal of such grass as they found still growing. There is a certain amount of couch here and there, and also of matted grass with Yorkshire fog buttercups and weeds: the land everywhere shows obvious signs of neglect.

The first job would be to tackle the rabbits, and I would give them a real good doing. I would trap them, ferret them and, if necessary, poison them. There is no method of killing rabbits of which I disapprove, so long as cruelty is reduced to an absolute minimum.

After the rabbits had been dealt with, and I was satisfied that they had gone, I would then start work on the ditch, seeing that the drains were unblocked, and that the earth dug out in effecting the repairs was put into a tidy heap to be made use of later in making compost. Any ant heaps in the field should be cut off, carefully collected and added to the soil that had been accumulated out of the ditch. I should then broadcast a dressing over the field of two or three tons of chalk, or ground lime to the acre. The lime would have the tendency to rot down a good deal of the bent and mat; it would eliminate some of the weeds; it would cause some of the sourness to disappear; and it would make the cultivation that would have to be done in the following spring easier. Next to claim attention would be the hedges, the clearing away and the destruction of the brambles and other undergrowth.

The larger branches from the hedges would be burnt, while the smaller stuff would go into the compost heap.

The field could then be left for the winter; but later on, when frost and rain had done their part, I should begin to know whether the drains were working as effectively as I had hoped they might.

If they were not, I should take steps to subsoil that field, but generally, where there is pipe drainage and where the original pipe laying was done well, a field becomes drained in the course of a few weeks' rain and the drains begin to operate again quite freely.

If they do so, it may prove to be unnecessary to do the subsoiling, although, if a subsoiler is available, I should urge it being done in two or three places between each pipe-line. In this way the bottom colloidal pan would be broken up; also, more water would be released down to lower strata and would sweeten the soil enormously.

This treatment obviously improves the fertility of the land, and the general growth of the new herbage which we are trying to encourage. In the spring, I should take a Wilder Pitchpole Harrow, or a Ransomes Equitine Cultivator with turf cutting blades, and harrow the field very thoroughly, first one way and then the other. When I had finished that harrowing you would think the field was in an awful mess. By this time the compost heap that I had accumulated, with the addition of some farmyard dung, would be in such a state of decomposition, and perfect humus content, that it could be spread evenly over the dilapidated and broken up field. After this treatment had been completed I think anyone who has not carried out such drastic renovation would be amazed at the improvement that would be produced.

About July I should try to cover the field with from five to ten hundredweight to the acre of compost, made in the manner described in this book. Next, having harrowed the field, I should sow about a 20-lb. mixture of the grasses described in Chapter I and then these would be harrowed and rolled. I should choose the last week in July for the sowing of this seed.

In about six weeks' time, there would be the biggest surprise for the farmer to see. Those who have never tried this system of grassland renovation cannot believe the growth there would be. I should have so revivified this old pasture that the farmer would be grateful to the day he read this, and carried out the technique I have described. He will have a more or less permanent pasture, and, as time goes on, maintaining

the drainage in good order, he will carry greatly increased mixed stock grazing, so that each class of stock keeps the land in health and balance, and it does not get individually poisoned by an excess of grazing by any particular species of livestock. I have seen good pastures created out of old fields that were a picture to look at. Such treatment as I have described is absolutely dependable but must be done thoroughly.

CHAPTER VII

LAND RECLAMATION

In the month of July 1944, I was invited to visit the estate of the Viscount Arbuthnott of Arbuthnott House, Fordoun, in the county of Kincardine, on the north-east coast of Scotland. Lord Arbuthnott took me over the whole of his estate, and particularly asked me for an opinion about land reclamation, which he had been compelled to carry out by the orders of the County War Agricultural Executive Committee.

This work had obviously been done incorrectly. He did not claim to be knowledgeable on the subject, and he asked me for my opinion whether the instructions issued by the War Committee were wise or otherwise. I said these were incorrect in almost every detail and I afterwards, at his request, wrote him a professional report which is reproduced in this chapter.

I should mention that this was high land, somewhere about 1,000 or 1,100 feet contour, high moorland, which had been derelict for, I should imagine, most of a hundred years, or possibly even longer than that. More unfruitful land to bring into cultivation it would almost be impossible to find; and certainly the War Committee had something of a nerve to determine that this land should be brought back.

The technique which they demanded and prescribed however was, in my opinion, utterly wrong: I submit my report to my readers as being of considerable importance, because, as time proceeds and it becomes necessary for every acre of land in this country to be returned to fertility, many thousands of acres of similar material may have to come under the plough and be brought back into usefulness. In that event the technique which I have set out is one that ought to be followed.

'Chantry, Chute,
'Andover, 2nd August 1944.

"The Rt. Hon. the Viscount of Arbuthnott,
'Fordoun, Kincardineshire.

'Dear Lord Arbuthnott,

'THE UNDRAINED LAND ON THE HIGHLANDS OF YOUR ESTATE.

'I have examined this ground, and consider the technique employed faulty.

'In my opinion, to put matters right, the people who did the ploughing With the Prairie Buster, should be called upon at their own expense, using the same implement, to plough back the land carefully so as to restore the soil to its original position and condition. The subsoil—now on the top—will thus be returned below; while the topsoil—now below—will be returned to the surface, where it should always remain. If there is any fertility—real or latent—in this marginal soil it is in the top four inches.

'The subsoil may be rich in minerals and trace elements, but it is not fertile, and deep ploughing in the early days is mischievous.

'The only method of reclaiming this poor land, both for immediate usefulness as well as for permanent farming, is to pursue approximately the following course of husbandry.

'1. Subsoil two feet deep—where the land will admit of it—every four feet, with a Ransomes C.I.C. Subsoiler, pulled by a Tracklayer Tractor.

'2. Cross-plough this operation with a semi-digger-type plough four inches deep.

'3. Disc this ploughing with a Heavy-duty No. 3 Baron Ransome Disc, or equal heavy disc of other make, and make a really good seed bed. This may need several diskings.

'4. Apply one ton of ground lime to the acre.

'5. Apply five to seven hundredweight of high content slag to the acre.

'6. Then sow per statute acre:

2 lb. of Aberystwyth S.100 White Clover
3 lb. of Rape
15 lb. of Italian Ryegrass

and roll thoroughly.

'7. Graze intensively with sheep when crop is four to six inches high, on the "on and off" principle.

'8. Continue to graze with sheep and cattle for two years.

'9. Then plough four inches deep and sow oats.

'10. Undersow with 5 lb. of Hants Late Flowering Red Clover, or equal, and 18 lb. of Perenial Ryegrass to the acre.

' 11. In its season make hay, plough immediately and sow wheat, about September 15th, using Vilmorin 27 or barley.

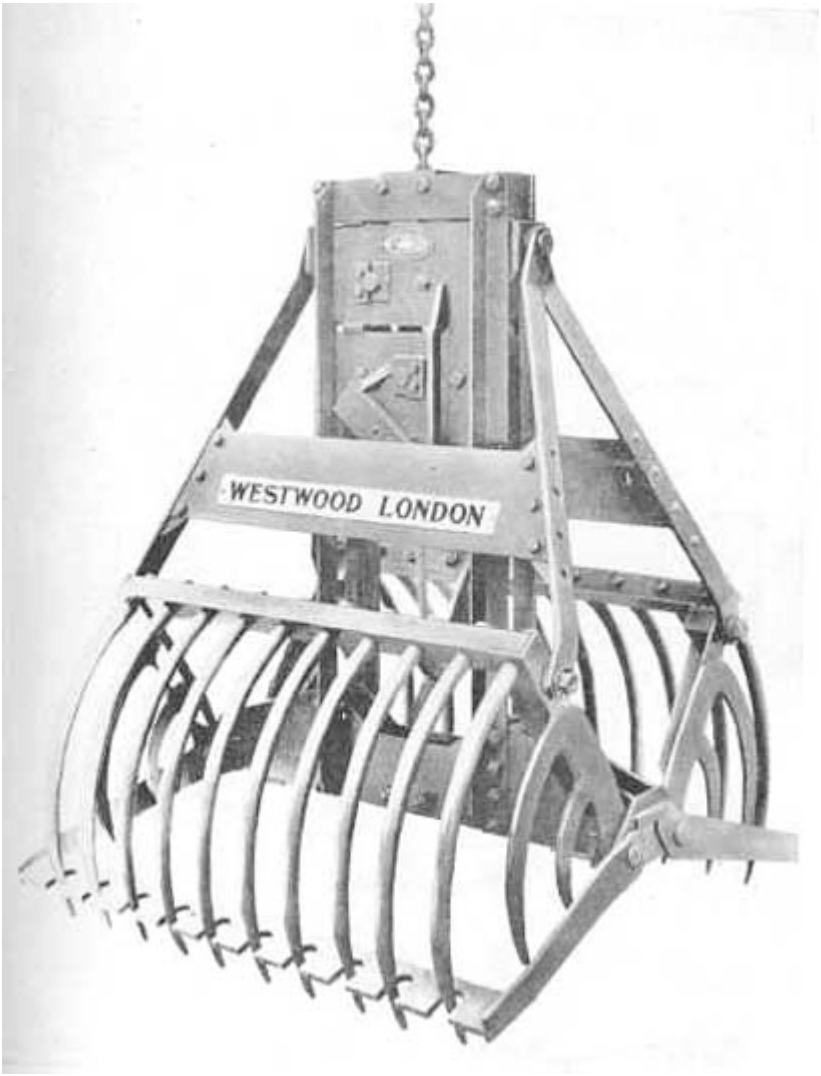
'12. In the spring undersow with the following *Four Years' Ley:*

12 lb. of Cocksfoot (Akaroa)
2 lb. of Italian Ryegrass
3 lb. of Timothy
2 lb. of S.100 Aberystwyth White Clover
5 lb. of Hants Late Flowering Red Clover
4 lb. of American Sweet Clover
2 lb. of Alsike
1 lb. of Yarrow 41b. of Burnet
3 lb. of Chicory
38 lb. per Statute Acre

'13. Graze with sheep and cattle the first year. Hay and graze aftermath the second year. Hay and graze aftermath the third year. Entirely graze the fourth year.

'14. Then plough under, taking a rotation of roots the first year, wheat or barley or oats the second. Rape and sheep the third year, with barley undersown with the above four years' ley for a further four years.

'15. It will therefore resolve itself into an eight years' rotation, where the fertility throughout all time will be organically and chemically fully provided for, if this system is faithfully and consistently followed. No artificial fertilizers will ever have to be bought, after the initial application of slag. Lime may, however, have to be added during the arable rotation, but, of course, lime is not an artificial fertilizer.



11. Details of grab. This grab will lift other commodities besides muck, including sugar beet, mangolds, etc.

12. Rapier Muck Spreader

'General opinion. A great deal of misguided insistence has been made by War Committees throughout Britain during the war to bring much marginal land, of very low fertility, back into speedy cultivation.

'They have often done this with very little knowledge or experience of the task with which they had to deal, and as the fundamentals of this important problem need to be more widely known, I will state a little of my own practice.

'Wherever artificials have been heavily applied as an initial dressing on land of this low fertility, and a cereal crop taken immediately, the land invariably "flops", and either refuses to yield further crops, or gives poor crops at best, ending eventually in utter uselessness.

'This land usually has remained derelict over vast periods of time, has become unbalanced in the constituents of fertility, and the heavy applications of estimated "deficiencies" is scientifically wrong. There is only one basis of fertility, according to Sir Albert Howard, and that is "A fertile land is one rich in humus."

'All the artificials in the world *will not make humus*. They will, however, compel poor land to give up speedily its meagre store of humus, and will then leave it worn out and exhausted.

'Land, therefore, of low humus fertility content must be treated as a "weak patient", where strong and heavy applications of artificials do not build bodily fitness, but exhaust such stores of energy as there might be.

'The task should be to build up bodily fitness by such plant food additions as are humus making—e.g. the system outlined herein—and in due time this land will yield heavy returns to both farmer and landlord, and so long as this sound method is continued will continue so to do.

'This outlined system for the recovery of poor marginal land is the only one which any war committee should allow to be put into practice.

'Yours faithfully,

(Signed) FRIEND SYKES'.

Special Note

'Slag is necessary only to begin with to save time. Then the subsoiler and the deep-rooting plants will look after the phosphates very well indeed'.

CHAPTER VIII

INTRA-MOLECULAR RESPIRATION OF THE ENZYMES

I can hear every farmer in England, almost without exception, exclaim as he reads the heading of this chapter, 'What a mouthful! What on earth is the fellow talking about?'

Let me explain. If I were asked to say, in very simple language, and in very few words, what were the basic meanings lying behind the word farming, I would say as follows. (1) The complete care of the land in all its phases, which includes good cultivation and humus refertilization. By this the capital value of the land is maintained. By adequate cultivation, subsoiling, good ploughing, good cultivation, harrowing, and so forth it is kept in a state of healthy balance. Comprehensive as all that may be, it does not cover farming. The next item that has to be considered is the conservation of farming products, because farming consists of growing, in the six months of the growing season of the year, sufficient food for man and beast to see them through to the next growing season. To effect this result a process of conservation has to be created.

For a longer time than possibly history can record, conservation of grass has taken the form of haymaking; and although we know very much more about the food values of growing grasses than our forefathers used to do, our methods of haymaking leave much to be desired, and some of us are making hay which is not nearly so good as that made by our forefathers. It may also be said generally that the conservation of foods, whether for man or for beast, is only yet in their infancy.

At the present time, so far as man is concerned, conservation takes the form of canning, bottling, preserving, sugaring, salting, and sundry other devices; and the latest phase of all comes under the mysterious and rather complicated term—dehydration. It is one of the privileges of the scientist that, when there is something a little out of the ordinary which he is unable to find an ordinary commonplace term to describe, he is allowed to coin a word for himself; and the word dehydration is intended to cover up the work which is involved in the drying of vegetable matter of all kinds. Because hay is dried, that is to say grass is dried and turned into hay, I suppose the resourcefulness of man is limited to thinking that vegetables similarly must be so preserved. As a result of this, during the last two wars, work and research in connection with the dehydration of vegetables and farm crops has proceeded.

It has been somewhat interesting, and amusing too, that I have had approaches from consulting engineers and chemists in England and also America, both of them representing that they had special instructions to investigate the subject of dehydration. Some of them alleged that they were employed by the United States authorities. Then I found that these two people were simply consulting one another, and neither the British Government nor that of the United States seemed to know what they were after. I came to the conclusion that neither Government had commissioned anybody to do any investigation for them. They were all seeking for their own information. As a result they went from pillar to post, spent a lot of money, and so far as I am aware, up to the time of writing this book, no satisfactory system of dehydration has yet been devised for the conservation of either animal fodder or food for man.

I have spent several years in investigating the conservation of crops, and I have made hay in a variety of systems. All of these efforts have led me to the decision that not yet have we devised a satisfactory system by which we can really conserve the valuable food we grow in the spring and summer for the use of our animals, or for man, through the dead season of the year.

When Dr. Woodman and Professor Wood of Cambridge conducted their experiments in the artificial drying of grass, I, personally, took a great interest in their findings and discoveries. I was well aware that the grass growing in the early spring is possessed of a protein content up to something like 18 to 20 per cent, and yet when we come to analyse the hay which we make for our cattle we find that that content has been reduced to some 6 to 8 per cent. We have since learnt that because we are anxious to get bulk into our fodder we have a tendency to leave our grass growing too long, and sacrifice quality for quantity. Although this fact is now fairly well known and most intelligent farmers are fully aware of it, they nevertheless, go on making hay when the grass is at its longest, and the protein content is at its lowest. When the Woodman and Wood experiments at Cambridge were placed before the world, I thought that at long last we were going to have a natural concentrated fodder, made from food grown on our own land, which would sustain our cattle with the same bloom and vitality that we are accustomed to see them carry in the spring and summer.

The Imperial Chemical Co., to their honour, took a great interest in this problem, and were very ready to place the engineering department of their organization at the disposal of those two research workers. They eventually designed and devised a grass drying plant, but its capacity unfortunately was very small, and indeed scarcely more than a laboratory effort.

It did dry grass, however, and made a product which contained a high percentage of protein. Other people followed suit, and since I was unable to get deliveries of the I.C.I, machine, I was persuaded by a certain Peer, who shall be nameless, to try a machine in which he was financially interested. He represented that his machine had been exhaustively tried out, and the best on the market. However, it proved to be very unsatisfactory. It refused to dry grass grown on our farm, and after struggling with it for about three seasons we eventually had to abandon it altogether. The makers were sent for in the meantime. They were unable to do any better with it.

I felt we had been grossly misled, and that the capabilities of their dryer had been misrepresented. Unfortunately, the vendors and ourselves could not see eye to eye on this matter, and the subject finally resulted in a legal dispute which lasted some ten or eleven days in the High Court in London. It is not part of this story to tell the details of that case, except to say that I had the satisfaction of winning it; winning the issue on all points, and of being awarded the full claim for damages and costs. My reference to that case, however, has this bearing. It brought me into a very close study of the subject of grass drying, grass conservation and food conservation generally. It is true that I had given previous attention to this, but during the three or four years that I was struggling with this machine I spent a great deal of time in research on my own. One day when I was making ensilage—and I think I have read almost every book that has been written during the last twenty years on silage making—I came to the conclusion that some of the deductions that were set forth in those books might be erroneous; for example, they claim that the processes are largely chemical, and they do not, in my opinion give sufficient credit to possible bacterial changes, or enzymic changes. I satisfied myself, as a result of watching silage making over the years, that silage making is bacterial, or may not be chemical, but is probably enzymic. I also argued, that if I make silage I need to make it under an anaerobic condition. That is to say, in the absence of air. One needs to have the temperature very well defined. For instance, if there is a temperature below 85° F. silage with a butyric acid content is the result. If, on the other hand, I increase the temperature to between 90° to 105°, the much more desirable lactic acid silage is made. Again, if the temperature is from 120° to 140°, a vinegary taste eventuates, this is acetic acid silage. These various acids may be formed as a result of enzymic action, which are operative between these temperatures. By deduction— and perhaps by speculation—I calculated that if I reversed the process, and admitted air into the grass, as distinct from keeping the grass airless when making ensilage, I would then make hay instead of silage, and perhaps I would be able, if I carried out the process efficiently, to use the heat generated by the activity of the enzymes to dry the crop.

13. Rapier Muck Spreader in action

14. Rapier Muck Shifter, removing muck from underneath a low building

I spent a great deal of time and thought in this direction, and one day, when it became necessary to employ the services of a consulting engineer in connection with the lawsuit that we were fighting about the aforesaid grass-drier, I had the good fortune to meet that very able agricultural consulting engineer, the late Mr. Borlase Matthews. When I told him of my thoughts and my conjectures, he informed me that many years before he had taken out a patent to cover some such processes and that as a matter of fact, he had had some measure of success in following out those theories.

A professional man of standing and qualifications gave up his vocation in order to join in the formation of a company to exploit Mr. Borlase Matthews's ideas, and Mr. Matthews took out a patent for such discoveries as he had then made. At that particular time, however, good as these theories may have been, they were not adequately tried out, and the decision to give up a safe professional life to indulge in the development of an undertaking founded upon the patent Mr. Borlase Matthews had taken out was, from a business point of view, not altogether a wise one.

This enthusiastic gentleman became thoroughly obsessed with the value of Mr. Borlase Matthews's discovery, and in his eagerness and full belief in its soundness he went to the length of approaching a number of eminent engineering firms of considerable capital and, I am told, succeeded in getting two of these firms to put down between them a sum of something like £150,000.

I am not able to give the reader the full chapter and verse of all that took place, but after opening up with a fanfare of trumpets, and the assurance that the farming millennium had at long last arrived, everything in the garden did not prove to be as lovely as was anticipated.

Instead of these theories proving as sound as they looked on paper, they became the subject of considerable further experiment. This finally led to serious trouble; lawsuits were eventually instituted and the enterprising enthusiast lost the day.

This story was briefly told by Mr. Borlase Matthews, himself a man whom I believe of the highest integrity. The embodiment of modesty and understatement, if he lacked anything at all it was lack of the courage to claim for his good ideas all the qualities they sometimes merited.

When he told me of his own theories and discoveries, I asked him what further experiments he himself had done. He had successfully dried crops according to his own system over a period of years: he told me that the quality of hay that he had made was of the highest; and that, not content with haymaking alone, he had regularly dried his own harvesting crops, such as wheat, oats and barley in similar fashion, and had always finished up with a product of the highest class in quality, getting invariably malting prices for his barley. I suggested, therefore, that he should work in conjunction with myself on an experiment to see if his ideas could be advanced to full practicability and economic management, and to ascertain whether that system of conserving green grass was perhaps not Nature's own method by which grass should be conserved. It was agreed between us that we should work together to this end. He had never designed an entirely satisfactory mechanical appliance for making this scheme the success that it promised to be, and I made drawings of a machine which eventually proved a success in my own operation.

And then we began to make hay. I shall never forget the experiment, and the experience; and as this story—a very human story—provides both great scientific interest and some degree of agricultural history, I shall recite it.

We cut the hay—an exceptionally heavy crop that year—during the last two or three days in May. We cut it one day, and swept that green grass into a rick, a rick twenty feet by twenty feet, the very next morning.

When we did this, of course, my men thought that I had suddenly gone right out of my senses, as I subsequently heard of a discussion in the local public-house—from subscribers to that institution. Those, however, are things that any research worker has sometimes to submit to. They amuse rather than disconcert. But the men were very obstinate, and they said that fire was bound to result. I disagreed with them. They said they would like to bet on it, and they offered to give me an even-money bet £1 to £1. I said I would give them ten to one: and so I did.

As a result of reducing the whole problem to one of sportsmanship, my men fell into the experiment with a fair measure of interest and attention ; and it is a hint to other readers who might get into difficulties with their obstinate staff, that if you can make a 'bet' on the subject, you can occasionally dispose of a great deal of difficult opposition.

There is one fundamental point of difference in theory between Mr. B. Matthews and myself. He was of the opinion that the changes effected in the drying of the crops were bacterial—I agreed they may have been, but I suggested, with great respect, that perhaps they were not bacterial, or only partly so, and that they were more probably largely, if not entirely, enzymic.

There is one mechanical and fundamental fact that it is as well to state here, so that the reader can understand first of all what enzymes are, and then what kind of functional part they play in the theories I am setting forth.

Enzymes are a number of complex organic substances capable of effecting, by catalytic action, the transformation, in most cases hydrolytic, of some other compound or compounds; a soluble ferment. The enzymes have also been called unorganized, unformed or chemical ferments, in distinction from organized or living ferment, such as yeast. It is now known, however, that the yeast plant secretes from an enzyme zymase which decomposes the sugar in alcoholic fermentation, and it is probable that the other so-called living ferment acts by the same means. Enzymes have an optimum temperature of action which usually lies between 30° centigrade and 50° centigrade. When heated to 100° centigrade in the presence of water they lose their activity. They are soluble in water, but are precipitated by alcohol, and are carried down when other compounds are precipitated. Such precipitants are never pure, and the exact knowledge as to the composition and physical problems of enzymes is certainly lacking. It has even been claimed that what are called enzymes are in reality only properties of other substances, but that is perhaps not generally accepted. A structural correspondence is thought to exist between enzymes and the bodies which they decompose. Enzymes are divided into several classes—those decomposing carbohydrates, such as diastase; those decomposing proteids (proteolytic), such as pepsin; those decomposing glucosides, such as emulsin; those

decomposing fats (lipolytic) such as lipase; those producing oxidation, such as laccase; those producing coagulation, such as rennin.

Now, for a long time I have been greatly intrigued with the activity of the enzymes, and I have felt that they have been exercising, and are continuously exercising, a great deal of influence throughout life, which is very little understood. I am of opinion that some day, some really capable scientist will get on to the lines of enzymes, and will probably harness them for the good of mankind, and for the livestock of the world in a way that has not yet been discovered. I put these thoughts to my friend Mr. Borlase Matthews and he began, he said, to see a new light on the subject which he had not thought about before, and he agreed to join me in experimental work to see what we could discover, carrying on his work, which had been so unfortunately frustrated by the company-promoting fiasco.

And that brings me back to the subject of my actual experiment, which was conducted at Chantry, the difficulties we experienced, the way we carried out that task, and the final results we arrived at.

First of all, we made a rick of twenty feet square, which is, as most readers agree, a fairly large rick. Then we made some underground conduits. After that, we designed vertical flues which were built by means of 'formers'. As the green grass was assembled round these formers, the formers were lifted higher and higher and went on until we reached a point half-way up the rick. We had four vertical flues so constructed and one in the centre of the rick going through to the roof. The centre flue did not communicate with the underground conduits.

Then I designed a machine which would drive air at the rate of 10,000 cubic feet a minute into the rick, from a power plant. Then we began the assembly of the rick itself. The green grass was swept by the ordinary tractor hay sweep (turned upside down) to the elevator, and there carried upwards on to the rick.

It is important that such rick building should be begun and completed in *one day.* You must start early in the morning, and finish that night. Therefore, do not contemplate a rick of too great a size.

Having built the rick, we then began our mechanical control. We inserted a number of thermometers. It is important that the rick temperatures should be maintained at good heat but should not exceed 50° centigrade.

The enzymes become operative when the heat of the rick rises above 30° centigrade. The details of doing it were exactly as follows:

The rick was allowed to heat on its own until it got to about 50° centigrade ; at this point I knew that the rick was getting very hot. I also knew that I was likely to stop the enzymic action if I allowed the rick to exceed 60°. I therefore had to be ready with my mechanism to reduce the temperature of the rick as a whole when 60° had been attained.

At this point I applied my power. Air was driven in at the rate of 10,000 cubic feet per minute, and in the course of a few minutes the steam began to come out of that stack in a way that surprised the natives. Scarcely anything could be seen for thirty yards around the rick. Clouds of aqueous vapour were finding their way out from every wall and from the roof. It was terrific. This continued for about an hour. During the whole of this time the thermometers were watched, and the temperature gradually came down.

When it got down to about 40° centigrade, I ceased operations. Before that the noticeable vapour stopped. Then the rick was left for twenty-four hours: during this period the temperature was carefully watched, and it was observed that it was rising hour by hour.

When it reached the maximum of 60° centigrade, we started again. Once more clouds of vapour left the rick and the temperature was again reduced. When it got to 40° we stopped, and we waited for another twenty-four hours.

In this way, we carried on for about fourteen days. Two ricks were treated. At the end of the fourteenth day little heat was showing in the rick. Little heat continued afterwards, and we came to the conclusion that it was out of danger and was not likely to fire, although it was always under my own watchful eye to see that no untoward development took place.

By now the rick had settled considerably. It was thatched and left until the following December, when we were all very curious to see what kind of hay we had got. We cut out the finest hay. A lovely bouquet. Its colour was apple green. All the leaves and the flowers were preserved exactly as they were cut. Nothing had been lost, and when the food was fed to the dairy cattle the results were most interesting.

The milk went up 33 per cent, the butterfat 25 per cent. The colour of milk turned from the rather bluey-white, that one is accustomed to in the depths of winter, to that rich deep cream which as a rule is only seen during the month of May.

Here then, at long last, it would appear that we had discovered a method of conserving some of Nature's crop, and of carrying it through into the winter, preserving all the original goodness. We carried out several practical tests in feeding this material to the animals, and we found that the fodder itself was extremely sweet

and palatable. It had a most pleasant smell. It could be fed in bulk to animals without fear of causing them any digestive disturbance—a characteristic very different from that of artificially dried grass which has to be fed with discrimination and care, and cannot ever be fed in unlimited quantities. The Thoroughbred stock fed on it—and all the stock did well, and looked well upon it. Their coats shone, the animals were full of bloom, and in good health. When the milking cattle themselves discovered where the rick was they actually broke down their fencing in order to get at it. There was practically no waste in the manufacture, every bit of hay right to the outside of the rick was consumed and consumable, although on the extreme outside there was a certain amount of mould—a kind of pink mould— but even this was eagerly and ravenously eaten by the animals when it was fed to them and without ill effects.

It will be seen, therefore, from a practical point of view, there would here appear to have been made a discovery which may lead to a revolution of agricultural thought and practice. I believe that 1 have only begun to scratch the surface of this important subject, and that much yet needs to be learnt about it.

Although I set aside a certain amount of this material for analysis, it was, owing to an unfortunate mischance, not analysed. I am, therefore, not able to give a chemical analysis of what that hay contained, but I am satisfied with the far more useful test which we ourselves conducted on the livestock itself, when they responded to it in the most desirable way that one could wish for. Mr. Borlase Matthews has conducted the same kind of experiment with oats, wheat and barley and he tells me that he has had equally satisfactory results. His methods were to cut the crops and, when the binder had finished on the morrow to carry the crop straight into the barn, or into a rick, which was ventilated by vertical shafts in a similar way to my own. He informed me that he had never had a failure with any of his corn crops.

In the meantime, let me discuss the theory that I think may lie behind this discovery.

First of all, the action is perhaps enzymic. The enzymes are operative between the temperatures of 30° and 50° centigrade. The heat, which the enzyme creates, is made use of to dry the whole of the rick, and this is successful so long as the temperature is kept between 30° and 60° centigrade. If a higher temperature than 60° is allowed to develop, there is not much risk of a fire taking place—the fire-point I think is somewhere in the neighbourhood of 300° F. There is no doubt about it, that if it really is enzymic action that we are making use of, the temperature must not rise above 60° centigrade. Because if that happens it might not be easy to start the rick heating again and the result might not be the same. It is of the utmost importance, therefore, that in trying this experiment the farmer must see to it that the rick is not allowed to reach a higher temperature than 60° C. There is nothing to worry about in getting below 30° C. as the natural tendency is for the enzymes to develop and by their activity to generate heat. What appears to be taking place, I imagine, is something like this. That in the crude starch we have a chemical formula which is $C_6H_{10}O_5$. As a result of the heat that is developed, disruption of the water content H_2O takes place. These two elements—hydrogen (2) oxygen (1)—are absorbed by the starch, giving a possible further chemical analysis of $C_6H_{12}O_6$. My reasons for guessing at this possible chemical content are based upon the fact that the hay is possessed of exceptional sweetness. This, of course, adds to its palatability, and provides one reason why the cattle eat it with avidity.

There is a well-established fact known to all botanists, that 'living plants or parts of plants, placed in an atmosphere devoid of free oxygen, continue to give off carbon-dioxide gas for a longer or shorter time before death occurs. This production and evolution of carbon-dioxide by living organisms in the absence of free oxygen is termed anaerobic or intramolecular respiration.' Hence my application of this term to this curing. First of all, botanists tell us that the length of time which plants will live under these circumstances depends upon the kind of plant and the vigour of its growth. During intra-molecular respiration, carbohydrates and fats disappear from the tissues of the plant just as in ordinary respiration in the presence of abundance of oxygen, but the production of carbondioxide is accompanied by the formation of alcohol and other compounds. On the other hand, my own suspicions are that it is a possible development of the sugar system. It would be interesting, and amusing, to think that my livestock had acquired a new taste for alcoholic beverages, and that was one of the reasons why they ate this hay with such avidity; and it is interesting also to note that if cows are fed with alcohol, both their milk yield rises and the butterfat increases. I have indicated how these two increases took place as a result of the feeding of this hay.

Some time ago when discussing the feeding of alcohol to cows and the influence of alcohol on both butterfat and milk yield, with Lord Teviot, I was amused by the story of a very high yielding Jersey cow which he had once owned and whose butterfat was phenomenally high. He made a practice of showing this animal at agricultural shows, and generally succeeded in winning first prizes or championships. On one occasion, however, a competitor just knocked his performance sideways. After the show was over, and the prize money had been duly distributed, it became known that the cow against which he had been competing had, some little time before the test, been given a bottle of whisky, and as a result of this the butterfat was, I believe, some two or three times as great as is usually given. Such is the effect of alcohol on a cow's

production. It affects both the quantity of the milk, and the butterfat. It is just possible that in this system of haymaking which I have described as the intra-molecular respiration of the enzyme system, we may be manufacturing alcohol, and it may be due to increase of an alcoholic presence that such a noticeable increase of milk and butterfats was recorded.

Sir Albert Howard suggests that there is a further possibility—the effect of the long continued moist heat on the enzymes, and their by-products on the cellulose and lignin. It may be that these are partly pre-digested and therefore more useful to the ruminant stomach.

It was not possible for me to repeat this experiment in later years due to excess of work and an insufficiency of labour to get through the year's tasks. I had, however, to do something better than we were doing to harvest both our hay and corn crops. My attention was drawn Jo an advertisement appearing in a Scottish agricultural journal of the Proctor System of Tripod Harvesting. I already knew about this method, but had never practised it. I determined to give it a trial. I began by cautiously ordering a sample lot of 200 tripods from Mr. Proctor at Blair-gowrie, Perthshire, and he offered on the telephone to come south and give my men instruction in their use. Under his guidance we began haymaking very late in June—normally we should have almost finished Haysel by this date but the 1945 season was the wettest in living memory in this part of Wiltshire. We cut the mixed ley in the morning, tedded it soon after cutting, then swept it to the tripods, where it was assembled, and thus we put away most of what we had cut that day. Well, I thought, if this works out all right, this is an even better method than that devised by Borlase Matthews. It is relying upon air and enzymic changes for the curing. We did thirty acres, in catchy weather, when ordinary haymaking would have been quite impossible, and so pleased was I with the results that we ordered a further 800 tripods with which to do both the hay and the corn harvests.

The weather in this part of Wiltshire was on its worst behaviour from the end of May right up to the end of September. Scarcely two consecutive days fine, we have never known such trying experiences in thirty-two years. Without the Tripod System we should have been in dire despair. All our neighbours were in terrible straits. We harvested our crops, between the showers, and put them safely away into the tripods, where, defying the penetrating rain, they have stayed until they were ready to be threshed. And what of the condition and the quality of the crops?

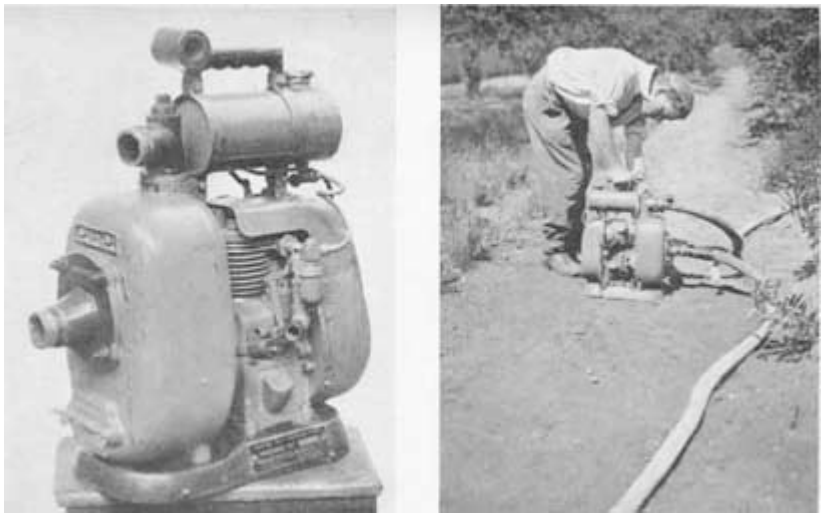
The hay is equal to that made in the Borlase Matthews system. The animals eat it with relish, and never leave either leaf or stem. Its colour —a nice green—is preserved, so are all the leaves and the flowers. The corn, however, is perhaps the greatest revelation. The straw is bright golden colour, of a feeding value I have never seen before. The quality of grain is the finest I have ever threshed. The quantity, too, is surprisingly high, for with this system the handling is so appreciably reduced that more grain gets into the bag, and being less exposed to the sun, through no stooking, is plumper, better in quality and lustre. This Proctor invention has been in vogue in Scotland for nearly ten years, and I am amazed that the Ministry of Agriculture has not made it compulsory upon farmers to use this method for both hay and corn harvest everywhere, especially throughout the war, when it was so vitally necessary to harvest heavy crops.

The difference in costs of haymaking by the Proctor Tripod and that usually in vogue in the south of England is negligible, and in a wet season would certainly weigh heavily in favour of the former. The quality of the two products bears no comparison whatever. The Proctor system makes hay of the highest quality and palatability, while the slovenly south of England system gambles upon fine weather, and never makes a product of high protein content. The difference is most marked, and the effect in appearance on all the livestock perhaps its most pleasing attribute.

Compared with corn ordinarily harvested by binder, the Proctor system is not a quarter of the cost. The resulting product is even more noticeable in the corn in favour of Proctor than in the case of hay. I am not able to make comparisons in cost with the combine, but it would not surprise me to learn that the Proctor Tripod ran it very close. Again the comparison in the quality of the finished product gives everything, everywhere, all along the line, in favour of the Tripod system.

Here then is a method of harvesting especially well suited to the British climate, where crops of the highest quality and quantity can be recovered, and I urge all farmers throughout these islands to make use of the Tripod without delay.

We have harvested hay, corn, clover for seed, and American sweet clover for seed by this method in 1945, the wettest year recorded in half a century, and the quality of our crops are the best we have ever known.



15. Water is an essential in composting. Rapier Water Pump, capacity 4,000 gallons an hour

16. Compost heaps at Chantry

CHAPTER IX

HARVESTING METHODS EXAMINED

It has been well and truly said, that Britain has the finest growing climate in the world and also possesses the best natural soil, but is cursed by the worst of harvesting weather. Every practical farmer will, I think, endorse these words.

How often we have been encouraged throughout the year to go and look at our lovely growing crops, and with what anxiety we face the crucial moment when we shall be called upon to cut them, stook them, leave them to harvest; and finally to cart and put them into a rick, and thatch them!

There is a space of time between the cutting and the thatching which with big harvesting in war-time varies from three to six weeks, and in England it is useless to expect a period of fine weather that will extend so long as six weeks. If we are fortunate we might get twenty-one days : usually it is not much more than that, and seldom even so much.

Under these circumstances it behoves every practical farmer to make a very careful study of every kind of harvesting method that modern science and engineering have made available to him. A great deal of thought and study has been given in the United States and Canada to the problem of harvesting, and much of our best harvesting machinery comes from those two countries. There they have a dependable weather, which is very different to anything to which we are accustomed in these islands. It does not always follow, therefore, that their machinery is always well suited to the conditions over here.

The latest invention with which we are all familiar, and which has been operating in my own particular district longer than in any other part of England, is the Combine Harvester, a machine of American and Canadian origin. Some of the latest developments of this type of harvesting machinery are indeed admirable.

At the time that I write this book, I believe that a census of such machines operating in Great Britain—largely increased, of course, during the war—is in the neighbourhood of 3,000. This is an enormous number, but experience of this type of machine is far from uniform, and I have serious doubts whether we in England have yet devised the right type of machine for recovering our harvest. A system of harvesting, which includes the use of the binder and the employment inside the rick of the enzyme as curing agent, may well prove to be the system better suited to this country and, perhaps, even better still, the Proctor System of Tripod Harvesting.

Since however the latest mechanical invention, the combine harvester, has made such a profound impression upon the agriculture of our land, I think it is first of all important that we should give consideration to its merits. I do not propose here to make invidious distinctions between one make of combine harvester and others, because I believe there is some measure of excellence among them all, and for the purposes of this chapter I am going to assume that they more or less all function fairly well. I am going to leave the reader to suit his own idiosyncrasies, and to choose the combine harvester which he thinks is suited to his particular farm. I propose to treat the subject of combine harvesters and combine harvesting, rather than any individual machine. If farming is ever reduced to a problem of figures alone, the combine harvester has much to recommend it, for from such calculations as have been placed before me from time to time, it would appear that it reduces harvesting costs enormously. On the other hand, there are many other problems which it does not dispose of; some of them indeed are actually created by it, and I think it is important that I should enumerate some of these.

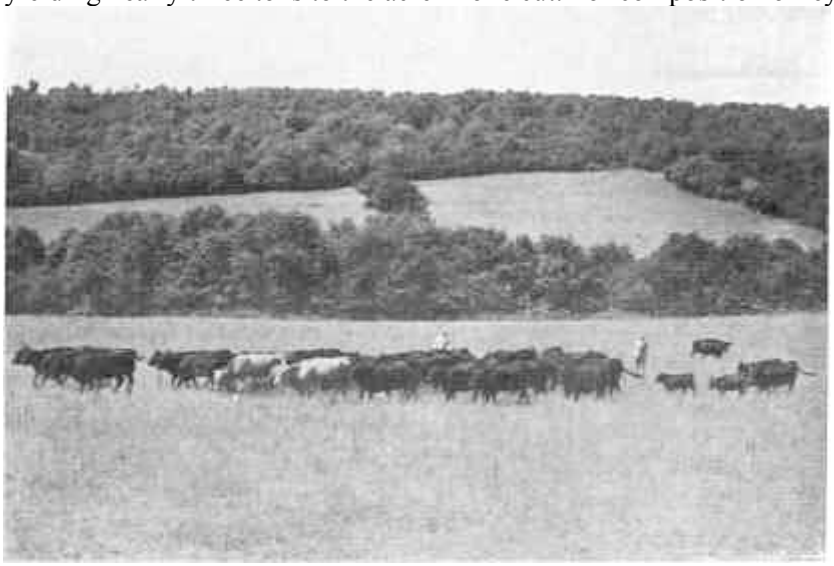
First of all, to make oneself really safe, and to run a combine harvester efficiently one undoubtedly needs a dryer. Without this one is gambling with the weather to a dangerous extent. Then, when we come to drying, I am not entirely satisfied that the last word in dryer designing has yet arrived; in fact, I am quite sure that the dryer manufacturer himself would be the last man to make this claim.

Taking my own farm and the problems surrounding it, where annually I have something like 350 acres of corn to harvest, the machine that I should need would be the Massey Harris No. 21 with a 12-ft. cut. This machine costs, with various appointments, most of £1,000, to which must be added about another £1,500 for the cost of the dryer, making a total expenditure of £2,500. Then in addition to that, the machines that are designed, and are in operation in England so far, are mostly of what are known as the flat-land type; that is they are designed for land which is not too steep or hilly, so that a machine can run on a fairly even keel. But on this farm I have some 200 to 300 acres of stiff hilly land, where I believe the ordinary machine would fail to operate, and I have been advised by experts that on this particular farm 1 should have to buy what is

known as the 'hillside machine'. This type of machine has certain more or less automatic levelling devices, which allow the threshing to be done on a level floor, no matter what kind of land it may be working on. Such a machine, however, costs a goodly sum more than the normal type, and as it would be in the minority it is more than likely that the agent would have difficulty in carrying spare parts. Spare parts for all classes of farm machinery are an object of interest to every farmer, for he knows how often he is running to the dealer for spares for one thing and another. Unless adequate spares were kept I should find myself with a big machine idle, and unable to operate because spare parts were unobtainable. This was a factor in preventing me, several years ago, from joining the band of combine harvesting men who have increased so much in recent years. I am sure that a 'hillside machine' is a necessity on this farm, and it is not reasonable to expect agents to carry all the spares that might be needed to keep just one such machine in full working order. Therefore, so far as I am personally concerned, I feel there is no alternative but to leave combine harvesting to other people. Assuming that my problems were a little more normal, and my land was a little more level, could I then, or would I then, be inclined to buy a combine? To-day, personally, I would not; for I am not satisfied, as yet, that it is the most perfect system of harvesting for the English climate, and because it creates problems within and without itself which still remain to be dealt with. For instance, there is the straw problem. I have not yet seen any satisfactory system devised by which straw is economically and efficiently disposed of. I have gone into many fields where the combines have been operating, and seen them left in the most unmentionable and disgusting state of straw disorder. That kind of farming does not appeal to me. Furthermore, it is my practice, almost invariably, to undersow all my corn crops with some form of green stuff usually Trefoil, if some other clover crop is not being grown, and this would add enormously to the difficulty of dealing with the straw that is left behind. Of course, the artificially minded man would tell me immediately that all I have got to do is to spread some three or four hundredweight of sulphate of ammonia to the acre, and the straw that the combine harvester has thrown about will quickly be decomposed and can be ploughed back into the land for future fertility.

I have already said sufficient to tell the reader what I think of the application of sulphate of ammonia to the land of England in general, and to my land in particular. It simply won't do; and, if I want to put myself permanently out of business, all I have to do for a very few years, is to apply liberal doses of sulphate of ammonia and that will be the beginning of the end of this farm. Therefore, the straw problem is not disposed of, so far as I can see. I know, of course, about the pick-up baler, and here again one is involved in a capital outlay running into considerable figures, for none of the machines that I have seen comes anywhere near what is called a cheap contrivance. And I don't think they can be cheaply made, for they are heavy machines, and are bound to cost quite a lot of money. Then there are other problems also. We have the threshing on the field of all weed seeds. Some of these are friendly weeds, and others are perennial and very undesirable. I think that the combine man is going to have a very weedy farm in a few years time.

17. A new ley yielding nearly three tons to the acre in one cut. For composition of ley see Chapter I



18. Pedigree Galloway Breeding Herd

19. Cutting and hand-tying a valuable crop of American Sweet Clover for seed

That again, to my mind, is not an act of good husbandry. As the straw problem is of paramount importance in my system of farming, where I am always on the look-out to make more and more compost at every point, I could never be persuaded to abandon the valuable straw crop, which nature takes the trouble to grow for us, and throw it away in a reckless manner. I see evidence of this sad state of affairs everywhere throughout the combine country to-day. In the autumn I seldom make a journey to Hungerford station, on my way to London, but I see examples all over the place of fires of straw ricks. This is very wicked indeed. Nature has grown a crop, which has taken vitality out of the land, and such resourcefulness as the farmer possesses allows him to burn it, and to return all that valuable product back to the atmosphere, instead of composting it and ploughing it into the soil.

It is of much more importance to me, as a farmer, that I should conserve my fertility and return everything to the land that I can possibly find in the way of waste vegetation. To burn straw ricks is one of the most heinous crimes which any farmer can commit, and the day may not be far distant when punishment imposing severe penalties may be meted out to people who are so lacking in farming resourcefulness as to destroy the bounty of Nature by the burning of straw and destruction of other humus-forming material.

Preservation of fertility, therefore, as I see it, does not run hand in hand with the combine harvester, as it is used in this year of grace 1944. I shall be asked, having regard to the vagaries of our English climate, where the old methods of harvesting have proved to be anything but satisfactory, what I can suggest that will secure to the farmer a more reliable collecting of the harvest for which he has worked so hard. After some considerable study I have come to the conclusion that the following methods of practice are those which suit my particular farm, and which are in keeping with the maintenance of fertility—the subject of paramount importance to all farmers and all those who have interests in the land.

My methods I would set out as follows. The farmer should be equipped with an efficient Power-take-off-binder, of much better design and strength than those with which I am already acquainted. Few items of farming machinery are so disgracefully and shabbily made as the binders which I have had to do with. We have two binders on this farm, the names of which I will not mention, both of them power driven, and both comparatively new machines—one new in 1939 and the second in 1943. I have seen those two machines break down at the same time in the middle of harvest. I remember one year one of those machines broke down no less than sixteen times. The loss and inconveniences of these stoppages when you have a big gang of men working is very serious indeed, and it is a lasting disgrace to the binder manufacturers that such machinery is put on to the market; yet farmers have no alternative but to go and buy them. It is high time that one of the great engineering firms, of whom there are many, should get down to designing a really reliable tractor-drawn power-driven binder, that will not break down as long as it gets reasonable treatment. If that machine can be designed I shall be a buyer very quickly. But the difficulty should not be insuperable and assuming that it can be successfully overcome, the power-driven binder would be the order of my day. Immediately behind the binder the sheaves would be swept to tripods. If that is done, I think that my

harvesting, which usually hangs out some five or six weeks, can, with the same strength of men, be successfully harvested and gathered in in less than half that time. That, in my judgement, is by far the cheapest and the best system for the ordinary English farmer harvesting his corn. The total cost of 1,000 tripods and two sweeps is about £500.

As I now know this corn-curing system is successful I need no combine harvester. There is still, however, another problem yet to be dealt with—the problem of threshing. As one looks at the almost antediluvian contraptions that are lying about this country in the form of threshing machines, some of which are sixty to eighty years old, one is really astonished to see that they are still functioning. It says much for the excellence of design, materials and workmanship of some of our oldest threshing machine makers, that their machinery has stood up over such a long period and is functioning to-day. But when I consider that their design has not changed for forty or fifty years, I am rather ashamed at the thought that British engineers are not more progressive. It may be argued, of course, that agriculture was financially in such a bad state that few people could afford to buy new machines, and that new designs, therefore, with the experimental work that they always involve, could not be indulged in. With this, of course, I am bound to agree; I have already emphasized on a number of occasions in this book my feeling of surprise that there are any farmers or farm workers left on the land after the way the nation has treated them during the past hundred years. I am equally surprised there are any agricultural engineers.

It is therefore only natural that the designs of the threshing machines should have altered so little during the last half century; in fact one could almost say there is no substantial alteration whatsoever. I have had three threshing machines to deal with during the course of my farming experience, and the first two were made by a well-known firm of threshing-machine engineers. They differed very little, one from the other, although one was a comparatively modern machine, bought within the last three years.

Their fault, however, lies principally in the fact that they need such a large staff of men to work them, and this is where the combine harvester has shown so many advantages. I cannot think of any item of farm operation which does so little, and needs so much labour to perform that little, as does the old-fashioned threshing tackle. This is one of the principal reasons, I think, for the success of the combine, for it requires so very little labour, whereas the old-fashioned threshing machine needs ten, eleven or even twelve men sometimes, to run the complete operation and this cannot be tolerated in modern farming.

'Some of the difficulties and inherent deficiencies of the combine have very clearly demonstrated themselves in the harvesting years of 1944 and 1945. They have brought home to all owners of a combine the difficulties of using one successfully in the climates of England and Scotland. It has also tended to intensify the antipathy of the milling and malting trade to the product made by this method. Here it ought to be stated that both the milling and malting trade have been very unfriendly towards this system of harvesting our corn ever since it was introduced into this country in 1929, and the seasons 1944 and 1945 were such as to make them feel an intense bitterness and dislike for the method generally. As a result of a display of temper and violence that has been shown at public meetings, a great effort has been made to try and increase the knowledge of those farmers who are new to combine harvesting, so as to turn out a better product, and it is interesting to see what has been learnt during the peculiar seasons of 1944 and 1945' (Warburton).

Of course, the combine harvester, as enthusiasts tell you, is the greatest time and labour saver yet introduced into the country; but they do agree that it needs to be properly used before it can be proved such a great factor in the husbandry of our land. They maintain that it is the most important implement used throughout the season and their contention may be true. If corn can be grown economically then, of course, a balanced agriculture in Britain can be obtained. If it cannot be economically grown, we may see our land revert to the shrub, the bush, the rabbit run, and the dereliction that was so much in evidence during the 1930s.

One feature of the combine harvester which speaks well for its efficiency, and at the same time is a serious disadvantage, is its ability to thresh both wheat and barley when they are far from ripe and full of natural sap.

Then the crop dryers, which have been introduced to augment the difficulties of harvesting in this peculiar climate, they too come and help the combine harvester further down the street of bad blunders. Wheat which contains more than 14 per cent natural moisture can, by artificial drying, be easily reduced to this percentage, but it is very often completely lacking in gluten and consequently will not make bread.

In the case of barley the sample that eventuates is of poor quality and grows most unevenly in malting. The brewer does not like it, and it is known to give a poor extract.

These are no imaginary complaints made by the milling and malting trades. These are real and definite criticisms. Whether they can be successfully overcome remains to be seen, but at the moment the criticism made by these two trades, who are the users of these products, are undoubtedly well founded, and at the

present time they are loudly expressing the fear that with the many thousands of combine harvesters, and the large number of crop dryers involved, they are going to get a product over the years which is inferior to anything to which they have been accustomed.

In the long run, let it be said, the farmers of England are going to suffer; we are going to get our homegrown grain condemned, purely and simply because we are persisting in harvesting by a method that the milling and malting trade definitely do not favour.

If, of course, there is a real chance of overcoming the drawbacks to which I have referred, and if the combine harvesters can be demonstrated to be the best system, then in fairness to both farmers and consumers alike, that system eventually ought to and may prevail.

At the moment, however, there is a genuine strife going on between the millers and maltsters on the one hand and those who are determined to go on with the combine on the other. Altogether, I believe, there is in this country some fifteen years' experience available of combine harvesters and it is interesting, so far as I am concerned to know, that much of the early pioneer work was done within a few miles of my present farm. Mr. Roland Dudley of Linkenholt was the first man in Britain to buy a combine, and Mr. Warburton of Shillingford was the first man-in England to demonstrate such a machine when he was a salesman for one of the American companies. Mr. Dudley actually bought the machine which Mr. Warburton demonstrated, and I believe that that identical piece of machinery is still in operation on Mr. Dudley's farm. Mr. Dudley, I need scarcely say, is an enthusiastic combine harvester, and nobody can speak with greater authority than he about the merits and demerits of this system of harvesting. I have often spoken to him and while he praised its advantages, he is still far from satisfied that the combine, as we know it, has yet reached its ideal design for conditions in England.

Mr. C. H. Schwind, who farms some 2,000 acres in Cambridgeshire, has considerable experience in the use of the combine harvester, both before the second German war and during that period. He says, 'The farmer can no longer expect, his miller to take his combined corn straight from the field as he used to in pre-war days, as a revolution during the last four years has entirely altered the position.

'Combines have now become so numerous that the corn trade is bound to be flooded after every harvest. The miller could not be held responsible to deal with the result of a revolution which had been caused directly by the farmers. The farmers would have to continue to deliver the corn as the miller needed it.

'So the would-be combine harvester owner must not just think of his £1,000 combine harvester. He must add to this some £1,200 for a dryer, and ten shillings per sack for storage accommodation. At least that is how the facts appear at present, and it would seem wise to keep to the binder until the problem of how to deal with flooded markets become clarified.

'Speaking of the disposal of straw,' Mr. Schwind went on to say, 'it was possible to burn it, but this is wasteful, and in any event you could not burn straw that was undersown with clover and seeds. He had tried to plough it, but this had proved impracticable. Baling certainly removed it from the field, but it did not find an outlet for the straw. The straw as a problem was still there. A machine recently invented for chopping the straw in the field might have possibilities, in so far as it would ensure the straw being ploughed under.'

Mr. Schwind was reading a paper on mechanization, and in summing up he reminded his audience that mechanization did not mean keeping animals off the farm, adding that he had a lot of sheep on his land, and you could also keep bullocks if you did not mind losing money.

Taking it by and large, it would seem that the combine-harvester, so far as Britain is concerned, cannot claim to have completely solved the farmer's great problem of finding the best system of harvesting in this difficult harvesting climate.

One of the elementary features of harvesting both grass and corn crops, which is all important, would appear to have been entirely overlooked by both scientist and engineer in their efforts to find a solution to this difficult and complex problem of harvesting these two crops in our changeable and undependable climate.

The subject to which I refer is *'solar energy',* and I think I cannot do better than quote the recent writings of one of our leading scientists, Sir Albert Howard, on this interesting feature of our everyday life, and of which we are all almost entirely unaware. Sir Albert says, *inter alia,* 'That the prime agency in carrying on life on this planet is sunlight, because it is the source of energy, and the instrument for intercepting this energy and turning it to account is the green leaf. This wonderful little example of Nature's invention is a battery of intricate mechanisms. Each cell in the interior of the green leaf contains minute specks of a substance called chlorophyll and it is this substance which enables the plant to grow. Growth implies a continuous supply of nourishment. Now plants do not merely collect their food, they manufacture it before they can feed. In this they differ from animals and man, who search for what they can pass through their stomachs and alimentary systems, but cannot do more; if they are unable to find what is suitable to their

natures and ready for them, they perish. A plant is, in a way, a more wonderful instrument. It is an actual food factory, making what it requires before it begins the processes of feeding and digestion. The chlorophyll in the green leaf, with its capacity for intercepting the energy of the sun, is the power unit that, so to say, runs the machine. The green leaf enables the plant to draw simple raw materials from diverse sources and to work them up into complex combinations.

'Thus from the air it absorbs carbon-dioxide, which is combined with more oxygen from the atmosphere and with other substances, both living and inert, drawn from the soil and from the water which permeates the soil. All these raw materials are then assimilated into the plant and made into food. They become organic compounds, i.e. compounds of carbon, classified conveniently into groups known as proteins, carbohydrates and fats; together with an enormous volume of water (often over 90 per cent of the whole plant) and interspersed with small quantities of chemical salts which have not yet been converted into the organic phase, they make up the whole structure of the plant—root, stem, leaf, flower and seed. This structure includes a big food reserve. The life principle, the nature of which evades us and in all probability always will, resides in the proteins looked at in the mass. These proteins carry on their work in a cellulose framework made up of cells protected by an outer integument and supported by a set of structures known as the vascular bundles, which also conduct the sap from the roots to the leaves and distribute the food manufactured there to the various centres of growth. The whole of the plant structures are kept turgid by means of water.

'The green leaf, with its chlorophyll battery, is therefore a perfectly adapted agency for continuing life. It is, plainly speaking, the only agency that can do this and is unique. Because animals, including man, feed eventually on green vegetation, either directly or through the bodies of other animals, it is our final source of nutriment. There is no alternative supply. Without sunlight and the capacity of the earth's green carpet to intercept its energy for us, our industries, our trade, and our possessions would soon be useless. It follows, therefore, that everything on this planet must depend upon the way mankind makes use of this green carpet, in other words on its efficiency.'

The foregoing scientific facts, even when they are known to the farmer, are often misconstrued, and he erroneously assumes that because the sun is the source of our very life use should be made of its further agency in the conservation of his crops. He, therefore, submits his grass in the cut-swath, and his grain in the stooks, to further action by the rays of the sun to dry them. Now this is fundamentally wrong. This craze for dehydration is of all misconceptions the most mistaken.

It is quite true, of course, that water content has to be reduced in both grass and grain, otherwise neither will keep. But the simple process of water elimination, either by the sunrays or by artificial heat, is not the alpha and omega of food conservation. If it was where does the balance of protein content go when we analyse the green crop, and the same crop when dry, no matter whether sun dried or otherwise. I know that artificially dried grass shows two or three times as much protein content as sun dried hay, but I also know that the artificial product has to be fed sparingly to livestock, whereas the original grass, with a still higher protein content, can be fed without restriction.

Artificial drying, to my mind, is not the answer to food conservation, for when it leaves foods—like dried grass—in a dangerous condition to feed to cattle *ad lib,* the resulting product cannot be ideal.

On the other hand, when grass is sun dried, its protein content is so low that it cannot be regarded as a high grade food at all. Then what does the sun do?

During the period of growth it is a veritable life-giver. As soon as the plant is mature, the chlorophyll agency has passed, and the sun begins to shrivel and destroy. At this point it needs to be taken out of the sun's reach, and curing and conservation sought by other means. Here, in my view, Nature provides her intra-molecular respiration to come to her aid, and in the respiration of the cellular life of the plant, during which she consumes large quantities of oxygen, she generates the needed heat with which to evaporate the surplus moisture. When this crop is placed upon the Proctor Tripod, oxygen in abundance is provided through the scientifically designed system of natural ventilation. Sufficient heat is continuously generated to keep the plants in active respiration until death supervenes, and this moisture is dissipated through the natural passage of air through the loose mass of material assembled around the tripod. I am quite satisfied that this is what is taking place, while the resulting product is not only a sight for every farmer to see, but one which the animals eat with an avidity even more arresting. This latter, after all, and not chemical analysis, is the true test of the value of any food. In other words, what do the animals think about it?

With grain, as well as with grass, the newly cut corn can be put away into the tripod every evening, and there need be little or nothing left out overnight to risk the vagaries of the weather. Furthermore, when those sheaves are taken from their tripod and threshed, they are of a colour, and the grain of a quality, such as few farmers have ever seen. Here then, at a low capital cost—for on a farm like this of 750 acres 1,000 tripods

have done our hay, corn, and heavy clover seed harvests and cost about £500 all told—is a system for every farmer to adopt.

And if *quality of product* is a subject of any importance the Tripod system stands alone. In days gone by the British farmer has not been exactly famed for the quality of produce he has always put before his consuming public. Because of this many foreign and colonial supplies— especially in the grading of fruit—-have found their way into the English market. If the farmer in the future is going to hold his own he will have to supply better quality produce than any to be bought from any country overseas.

He will not do this with the combine harvester so far as grain is concerned, as data provided in this chapter from the malting and milling trades so plainly indicate. Neither will he achieve his desired end by gambling on a fine harvest and being compelled to leave his stooks out in the wet, and sending into the mills a grain containing from 20 to 30 per cent of moisture. Foreign grain will never be considered by either maltster or miller if British grain, harvested on a tripod in good order, is available. No foreign product grows on better land than that to be found in England. There is only one thing at fault—our systems of harvesting. So far as the year 1945 is concerned I can truthfully say that we have not had one sack of spoiled grain in this exceedingly wet year, and had we not had the Proctor Tripods we feel certain we should have had few dry ones.

Reading this chapter before publication, Sir Albert Howard wrote:

'The prophet is always at the mercy of events. Nevertheless I foresee the speedy failure of the combine and the dryer. This system will founder on the age-old experience of the Orient. Grain must finish ripening in the ear. Something passes from the straw to the grain during the curing after cutting. We must *not* interfere with this passage or we shall lose quality and the power of reproduction. Drying freshly cut grain in the stack by allowing it to heat up and then by blowing air through the rick might easily prove successful, or by the use of Tripods.

'The combine and the dryer are doomed.

'The miller and the maltster are right.'

CHAPTER X

SUBSOILING

Under this title of Subsoiling I intend to cover some very wide issues. I shall never forget the time when I came to Wiltshire in the early days and I ordered my subsoiler. With this implement I was already very familiar in the other counties where I had worked and in many parts of Britain, but subsoiling in Wiltshire, I believe, was almost unknown. The agent who supplied the machine looked at me, as I said before, as if I was a specimen fit for the pages of *Punch.* He saw that I had observed his consternation and said:

'What on earth do you want a machine like this for? In the course of a hundred years, during which my firm has been in existence, we have never supplied such an implement before. Why do you want to use such a thing in a God-forsaken chalk-ridden country like this?'

That was all he knew about the subsoiler, and the purposes for which it was designed. He did not know that its use meant to the average farmer an increase of at least two sacks of corn to the acre. He did not realize that with some other farmers it might make all the difference between being able to grow no crop at all and growing a crop of barley of perhaps fourteen sacks to the acre. All this was unknown to him, but it was common knowledge to me, and if there is any mechanical piece of equipment which this farm should be grateful for, it is the subsoiler, an implement made by Ransome, Sims & Jefferies, which is illustrated in these pages, and which I have put to universal use.

It requires a powerful tractor and usually only the caterpillar is suitable ; not because so much power is needed but rather because of the grip on the land which cannot be made by a wheeled tractor. I usually subsoil my land two feet deep, with a single cut every four feet. It is important that the tractor should go in its lowest gear, and that the work should be done slowly, because it is undesirable that any of the bottom soil should be brought to the surface. If the speed of the tractor is very slow this practically never happens. The purpose of subsoiling is to crack into fragments the underground colloidal pan, so that air and water can drain down into the deeper strata: by capillary attraction, when the weather is hot, moisture rises through those cracks, reaching the roots of the crop near the surface. Moreover, the deep-rooting plants like cocksfoot grasses, sweet clover, sainfoin, burnet, lucerne and chicory, and others, appreciate the subsoiler for they go down to considerable depths and collect minerals which may not always be available in the surface soil. The use of this implement renders the artificial manure bag a thing of the past, for if the farmer uses the subsoiler, there is no argument left in favour of artificial manures—so vast is the store of minerals and trace elements which he opens up and which were not available before.

Subsoiling costs vary, of course, on different lands; but on land like this which we are now farming at Chute the costs as a rule are in the neighbourhood of 20s. to 25s. per acre. We try to subsoil once in eight years. By the use of deep-rooting plants during the four years' ley we carry out Nature's own subsoiling, and then during the arable period of cultivation one subsoiling is carried out: that is all that is necessary, and the 25s. per acre costs can thus be spread over the eight years of the rotation which we now follow. Thus the annual cost only amounts to 3s. per acre, and this is not a serious expense. The machine itself has an almost indefinite life. Certain spare parts, like the landside, wear out quite frequently on our land; also 'points' and one or two other like wearing parts. But these are easily replaced by a few minutes' fitting and are not very costly in maintenance. The subsoiler is *a sound piece of economy on the farm and it ought to be found on every farm in Britain, where the soil is deep enough to permit of its use.*

So much for the physical and commercial aspects of the subsoiler itself. I now propose to show in detail what it does for the farmer in its practical and scientific application, for no implement, not even the plough itself, can contribute to good farming to the same extent.

To appreciate the value of the subsoiler, let us begin with the elementary subject of the feeding of the plants. This is entirely different from the feeding of animals. The animals may live on a diet of grass in summer and in winter on a pile of straw or mangolds, hay, silage or any other farm product; at any rate, both the quantities of food and the nature of it, can be seen and examined by the eye.

'Whence does the plant derive its food and of what does it consist? Barley-meal is not entirely unlike the bacon which can be obtained from it, but there is nothing in a garden soil to resemble the material found, shall we say, in a cabbage or a carrot or potatoes.'

Now the business of the farmer is to provide suitable feeding conditions, which means *soil condition* for his crop, and naturally he can do this best when he really knows what the crop requires. At the present moment, many farmers are unacquainted with farming properly as distinct from, shall we say, cow-keeping,

or poultry-keeping, pig-keeping, and so on; but the real farmer, the farmer who keeps these animals and also tills the soil, grows his own feeding stuffs and food for humans as well. Such men are the real farmers and they need to know the materials of which the crop is composed and how it grows. To an ordinary student of an agricultural college this information naturally becomes available, but there are tens of thousands of farmers in this country who have never been near an agricultural college some of whom are farming satisfactorily, others more or less satisfactorily. But comparatively few can really get down to the subject and tell an inquirer, for instance, what the plant needs by way of food and how it gets it. I am starting with these elementary facts to show what part a subsoiler plays in helping Nature to feed plants, the seeds of which we sow in their due seasons.

'To begin with, every plant contains water, even dry seeds containing 12 per cent. Timber contains 40 per cent of water; green forage and potatoes, 75 per cent; turnips and cabbage, 90 per cent. If we wish to expel the water we can do so by artificial drying or by using the rays of the sun, and the resulting product, no matter how the drying is done, is what we call 'dry matter'. For instance, a ton of potatoes will yield about 5 cwt. of dry matter and a ton of wheat will yield somewhere about 17½ cwt. The interesting point, however, is something which, strange though it may seem, very few farmers seem to know. They talk, for instance, about returning to the soil all that was taken from it, and I think some of them really believe that about a hundred per cent of a crop has actually been obtained from the soil, whereas, as a matter of fact, only 5 per cent of any crop comes from the soil, the other 95 per cent coming from the atmosphere. I propose to submit hereunder a table of analysis, such as can be found in most modern agricultural textbooks, showing the composition of the matter of a wheat crop, together with the materials that it needs to make perfect growth.'

The figures apply generally to all crops, but the wheat crop may be taken as an example. The accompanying statement shows the approximate composition of a thirty-bushel crop of wheat and the demands which it makes upon the soil for its support.

COMPOSITION AND REQUIREMENTS OF A WHEAT CROP

Thirty-bushel Crop	*Grain*	*Straw*	*Total Crop*	*One Acre-Foot Soil Contained*
	lb.	lb.	lb.	lb.
Natural weight	1,890	3,360	5,250	—
Dry matter	1,606	2,856	4,462	3,500,000
Necessary soil constituents	166	113	279	
Comprising:				
Nitrogen (= nitric acid)	131.0	62.0	193.0	15,255
Phosphoric acid	15.0	6.0	21.0	1,925
Potash	9.0	20.0	29.0	19,075
Lime	1.0	8.0	9.0	56,770
Magnesia	3.6	3.0	6.6	14,525
Iron oxide	0.4	1.0	1.4	99,785
Sulphuric acid	6.0	13.0	19.0	2,660

Taking the grain at 63 lb. per bushel, and allowing 112 lb. of straw for each bushel of grain, the weight of the crop at harvest would be 5,250 lb. This will contain about 15 per cent of moisture, so that after drying the weight is reduced to 4,462 lb. Of this weight only some 279 lb. will have to be drawn from the soil, and the balance of the crop—equalling 4,183 lb.—will have been formed from the air and not from the soil at all.

Although a crop does not draw much of its raw materials from the soil, still the soil materials are highly important, because unless these are available the crop cannot feed from the air. The air is as good over barren sand as over the richest fields, but it is only the latter which can produce large crops.

The *soil materials* required by a crop always contain seven different *constituents*. If any one of these seven be wanting, the other six will not enable a crop to feed out of the atmosphere.

It is that soil constituent, therefore, which is scarcest, relatively to the crop's requirement, which determines the smallness of the yield. This principle is known as the 'Law of the minimum', and is the foundation of modern methods of applying manures. Such manures are intended to make good the deficiencies in one or other of the seven essential constituents of plant food which are drawn from the soil. (Any student at a modern university will be instantly familiar with the scientific facts and references made in this chapter, as they are reasonably commonplace in an advanced course in present-day agricultural scholarship. I am indebted to the courtesy of Mr. John W. Paterson for his kind permission to make quotations from his book Science in Agriculture.)

'It will be noted that there are no less than seven necessary soil constituents here. It is interesting to know that one of the arguments used by the merchant of the sale of artificial fertilizers is that you are robbing the soil of certain mineral constituents and he arranges to give you what he calls a 'complete fertilizer'. The 'complete' fertilizer contains the minerals, phosphate, nitrogen and potash. In addition there is lime, magnesia, iron oxide and sulphuric acid, but I do not remember any of the so-called artificial 'complete' fertilizers which claim to include magnesia, iron oxide or sulphuric acid. Now these are a necessary constituent of crops; if, therefore, we are growing, say, a wheat crop, and we are going to cater artificially for the material which we take out of the land, surely, we ought to replace all of these elements. If the argument is used that they are there in abundance already and need no replacing, I cannot see why Nature, in her bounty, and in the provision she makes for these other elements, should fail to make equally good provision for phosphates, for potash and for nitrogen. Nature does provide all these things, and provides them bounteously, though it needs scientific farming in order to be able to tap them in such a way that they become available. Unless land contains all these elements—the elements set forth in the foregoing table—a crop fails to grow satisfactorily. In other words, it fails to draw from the air the necessary 95 per cent which forms the bulk of the produce grown.

'By way of a good illustration of this, the Sahara Desert fails to grow crops, although the air above it is precisely the same as the air overlying the good soils of the world. Because the Sahara Desert does not possess the nitrogen, phosphate, potash, lime, magnesia, iron oxide and sulphuric acid content, the soil will not grow crops; that indeed is the reason why the Sahara is a desert and why wherever bad farming is indulged in to a sufficient extent desert conditions are produced; the land is deprived of the necessary constituents to grow crops, which thereby lose their ability to extract from the air the remaining 95 per cent of their food components.

'The elementary lesson to be remembered is this, that the soil material required by a crop always contains these different constituents. Any one of these seven being wanting, the other six will not function properly to enable the crop to feed out of the atmosphere. Not only must each of the seven soil constituents be present, but each must be there in an amount which is not less than the crop requires. Fortunately for man, and for the permanent existence of the world as a whole, we know that there are unlimited quantities of these various minerals in the world's soil.

'The next point we need to understand is the method by which these minerals are made available. They become available in solution; that is to say, a crop can only take any one of its seven soil constituents in the form of solution; only in that form can it find its way into the roots of the plant. It will therefore be seen that the water supply which we usually get in the form of rain is a very important factor, for without rain we cannot dissolve the various minerals and we are unable to feed the plant. This is where, again, subsoiling comes in to help us, for it allows the rainfall to go through to lower strata, by breaking up into fragments the lower geological conformation. This water can then rise by capillary attraction with the heat of the sun and becomes useful in the dissolving of the minerals and in making the consequent solution available to the plant.

'When we compare the amount of each constituent present in the soil with the amount of the same constituent required to produce one crop, it will be seen that there is in each case nearly a hundred times more than enough to produce one crop. Take phosphoric acid for example. The figures show 1,925 divided by 21, being equal to 91, so that there should be enough phosphoric acid to produce 91 crops. This content is quite characteristic of ordinary farm soil in any part of the world. Why then should crops frequently be unable to get all the soil constituents which they want? The reason is that they take them through the roots only when they are in solution, and in soil the great bulk of the food material is very often present in insoluble forms, that is, in such a condition that the crop cannot immediately make use of it.'

This is where many other factors, besides chemical factors, come in to help Nature in her difficulties, and the earthworm, that great servant of man, is without doubt the most important functionary in the preservation of life. For the earthworm, assisted again by the subsoiler, will traverse all the broken land within a considerable distance of the earth's surface. The earthworm, broadly speaking, lives on two kinds of food: (1) the mineral of the soil, (2) the vegetation under and on the top of the soil. The earthworm has a crop and gizzard, very similar to a chicken, and he consumes his various minerals and plant foods in much the same way. The solution to be found in its crop is highly acid. As these minerals receive their measure of digestion, they pass down the alimentary tract of the worm: they come in contact with the calciferous gland, and through it an alkaline solution is made available. The food eventually finds its way out of the worm in the form of the well-known worm casts on the surface of the soil. Furthermore, those worm casts usually contain about seven times as much available phosphoric acid as the surrounding soil, five times as much available nitrogen and eleven times as much available potash. The tonnage of worm casts to the acre has long ago been

established by calculation and such figures are accepted by the scientific world, for Darwin it was, who told us that with land that was reasonably well stocked with a population of earthworms, no less than ten to fifteen tons per acre of worm casts are made each year, and this highly fertile mixture of soil minerals and plant food, because of its solubility, is immediately assimilable to the plants growing on the land. It will therefore be seen that the worm is the most important cultivator in the whole farm. Its population, under all circumstances, must be maintained, and no act of husbandry must ever be indulged in which will diminish its numbers. This is perhaps the most important fact that I would leave with the readers of this book, for there is no doubt that some of the artificial fertilizers, particularly those like sulphate of ammonia, do kill the worms. The same thing is said of superphosphate and also of sulphate and muriate of potash. About the latter I cannot personally speak with authority, but I do know that if you take a bag of complete artificial fertilizers, mix it with a large amount of soil and then put worms in, it will not be very long before every worm that you have introduced is dead. Perhaps no greater argument can be advanced against the use of inorganic fertilizers than the fact that they destroy the worm population. The worm has perhaps been man's greatest friend for all time.

It will be appreciated that the part the subsoiler plays in cracking up the underground pan and in making it possible for the worm to travel far afield for its own supplies of minerals is a very important one, and that if the subsoiler did nothing more than this its use would be justified.

Worm casts are probably of 'organic origin'. The effect of worm casts on crops, on soil, on the permanent fertility of the land is immense; they are, in fact, humus makers.

Rainfall is indispensable to fertility and a uniform rainfall is the most desirable of all farming conditions. These things, however, cannot be regulated by us, the mere occupants for the time being of the land of our fathers. All that we can do is to make the best use of the rain that comes; and in this subsoiling helps us enormously, for it allows the water falling on the surface of the soil ready access to the lower strata, before it has had time to evaporate back into the atmosphere, and if the water can get into the lower strata it is quite likely that the deep-rooting plants already mentioned, and the cereal plants like wheat, which is said to have forty-five miles of root on it, will go down deep for all the moisture they need.

As a rule a dry season suits the wheat crop, and the reason for this is simply the wheat plant's ability to go down deep for its moisture, and I am certain that the heavy crops of wheat that I have had grown on this farm have been partly due to the subsoiling.

'The rainfall of Britain varies enormously. On the west coast of Scotland and in the English Lake District we find as much as 80-100 in. per year; in Falmouth, 44 in.; in *Manchester,* 37 in.; in Bristol 34 in. Along the south coast Dover receives 28 in. On the eastern shores we have Edinburgh with a record of 24 in., Yarmouth with 25 in. and London with 23 in., while the lowest rainfall of the whole country, 19 in., is claimed by certain parts of Cambridgeshire. One inch of rain is equal to 100 tons of water per acre, so that a 30-in. rainfall means in the course of a year 3,000 tons of water having fallen on each acre of land.

'But we have another factor to keep in mind, which is hardly less important to the farmer than his local rainfall, and that is the rate at which this water evaporates back into the atmosphere. Evaporation is the converse of rainfall, and in countries where the power of evaporation is low a low rainfall may be more than sufficient. Evaporation is increased by low humidity of the air, or by high temperatures or by wind, and it varies much in different parts of the world. In different parts of Britain the average evaporation from a lake will vary from 25 to 75 per cent of the total rainfall in the district.

'Rainfall and evaporation do not keep an even pace throughout the year, and in a period of considerable rain much of it percolates through the ground: and this is where the subsoiling helps us again. It is important to ascertain how much of the rain falling on land is actually evaporated, and how much of it sinks into the ground under average conditions. Rothamsted has kept a record over a period of some sixty years, and with an average rainfall of 29.158 in. it was found that 50.6 per cent drained away to 20 in. of soil during that period, while the balance of 49.4 per cent was evaporated into the air. In the warmer months owing to the greater evaporation less of the rainfall is lost by drainage; thus in the half-year from October to March 71.5 per cent of the rainfall received was lost by drainage while in the warmer April to September period only 27.9 per cent drained away. This land was never under crop—it was kept purely and simply for recording the rainfall and the evaporation.'

There is another fact too, not to be forgotten, and that is that the geological process of the weathering of rocks and denudation, which originally supplied the earth with its covering of fertile soil, is still going on. It has been going on for all time and it will go on for evermore. This weathering is slowly, but very definitely, providing the earth's surface with further supplies of mineral-sufficient soil. This does not absolve the farmer, of course, from providing a good husbandry, especially when we remember the amount of minerals,

taking the world as a whole, that are continuously being taken from the soil in the form of milk, meat, and other food.

Every townsman ought to learn to appreciate that the elimination from all the human bodies goes down the lavatory pan, through the drains, on to the sewage farm, into the rivers or into the sea. It is, of course, high time that we should cease to indulge in such scandalous and abominable wastefulness. These products ought to be carefully preserved, mixed with no end of available vegetation of all sorts and kinds, and made available to the farmer, at reasonable prices, by the local authorities so that the farmer could return them as a valuable fertilizer to the land.

It is a matter of historic interest that the borough authorities of Southwark, part of the London county, have been carrying out this practice now for several years. Every year they sell thousands of pounds' worth of pulverized town waste to farmers, and so are able to lower the rates to the benefit of the ratepayers in the district.

The townships of Maidenhead, Leatherhead and Hammersmith have carried out other schemes. It is only a matter of time for many more boroughs and cities to do likewise. I have taken part at Andover with our muck-shifter in demonstrating the composting of town refuse, and from that demonstration great results are expected.

Perhaps one of the most important benefits to be derived from sub-soiling is the development of humus in the soil itself. Humus is the name

20. A grand crop of Victory oats

21. Yearlings—Galloways and Guernseys

22. Orthodox method of harvesting. A system now superseded by the Proctor Tripod

which is used to cover all the compostable vegetable matter in the soil. Unless this supply is renewed, by regular additions of vegetable matter, such as a crop's refuse, farmyard manure or compost, the quantity of humus in the soil will definitely decrease. 'We all know that the best part of any farm is nearly always the farm garden. This desirable result is brought about by the frequent application of farmyard muck or compost, coupled with thorough cultivation. By means like these almost any kind of soil can be made fertile. Manure or compost makes humus and turns a dead into a living soil, and by degrees will convert a desert into a land most fertile.

'In a state of Nature the humus supply in soil is the work of countless small animals, insects, bacteria, fungi, and micro-organisms working on the surface deposit of dead leaves and other falling vegetation. When the soil is well furnished with mineral content, such as soils do possess, every crop is better than the one before it, and the good pasture always goes from good to better. A suitable climate is always necessary to effect the best improvement in any soil. With a poor soil or climate the annual refuse of one season is sometimes barely sufficient to restore the natural wastage of humus, and the next crop is poorer than the one before: under this sort of neglect the poor soil goes from bad to worse until only an inferior class of herbage can be maintained.

'In addition to these advantages humus confers a variety of physical benefits on the soil and improves its capacity to hold moisture from the rain. It loosens up stiff soil such as clay, allowing the free access and circulation of water, while it binds coarse sand more closely together. Humus, especially when wet, usually gives a darker colour to soil. There is little humus as a rule in subsoil, although I have seen humus sometimes

at a considerable depth, but the change down from the soil to the subsoil is generally marked by a lighter colour.'

As I have explained in the chapter on compost, the transformation of vegetable matters to form humus and the further changes of humus within the soil are brought about by various forms of life and by bacteria and fungi. The number of these amounts in some cases to five millions per cubic inch of soil. Some kinds of bacteria can decompose the humus in wet soil and in the absence of air, and this happens on my four years' ley of which I think so much. But under those conditions decomposition is much slower, and not to be compared with the decomposition achieved by the Indore composting process. Still, it is practicable : we farmers have to accomplish two things; the picture we always have to bear in mind—while we desire to grow good crops, healthy crops, and food that will feed a man well and keep him healthy and fit, we also have to knock a living out of the land by making our harvest pay. In other words we are carrying on an economic business, and the system of manufacturing humus by means of a four years' ley of clover and grass is one of the most economical methods of building up a high organic or humus content of the soil, and one which every farmer in one way or another ought to try to adopt.

In any system of ley farming the vegetable matter decays within the soil and forms humus more gradually than by direct composting. In the latter stages of decay the valuable nitrogen, phosphoric acid and potash supplies become available to the crops. Farmyard manure or compost, of course, can be spread over the sward, and this helps growth. Where, however, fresh straw is ploughed in shortly before planting a crop the immediate effect is always to produce a temporary lowering of fertility until there has been time for the straw to be converted into humus.

The bacteria causing decay set to work vigorously upon the fresh straw. They increase rapidly in numbers. They are living organisms, and it is to be remembered that like the crop plant, they require the same elements for their growth—namely, nitrogen, phosphoric acid and potash. Within the soil they thus compete for these things with the oncoming young crop, and the crop suffers from the competition. This injurious effect of fresh straw is only a passing phase because the activities of the germs slow down as the decay advances; and in the course of time the soil is benefited by the mineral constituents of the decomposed straw as well as by such dead bacteria, these being in a condition which eventually makes them available for future crops. The ultimate result, therefore, of ploughing inert straw into the soil is beneficial, but it is temporarily damaging and should not be indulged in because of the interference with the immediate crop.

The amount of humus varies considerably in different soils. It may form the bulk of the dry sample, but in ordinary soils it may not be more than 5 per cent. This, however, by suitable farming, such as I think we are following, can be considerably increased. I am sure that we are increasing it all the time; in all our crops the effect is almost dramatic.

It shows itself, besides, in the increased healthy stamina and growth of all the livestock on the farm—in the Galloway cattle, the Guernsey cattle, the Jersey cattle, and particularly in the racehorses, for we are now producing a class of racehorse, both in quality and in size, such as we have never grown before.

Subsoiling and humus content are closely bound up with the nitrogen which humus and the soil generally contain; moreover the chemical changes in the decay of humus are bound up with the supply of combined nitrogen required for all the growing crops. There are three actions to be noted—nitrification, denitrification and the fixation of free nitrogen.

'Ordinary crops, such as wheat for instance, cannot use the free nitrogen in the air. They must obtain their combined nitrogen from the soil. Humus supplies this. Indeed, the soil's stock supply of nitrogen at any time is always contained in the humus. A soil without humus, therefore, is probably without nitrogen, but humus cannot directly satisfy the demands of the crops for combined nitrogen. The nitrogen is not in a proper form of combination, and, moreover, it is too insoluble. Crops cannot use it. The nitrogen of humus must first be changed into simpler compounds of nitrogen within the soil (Paterson).

From what Paterson tells us it will be seen what an important part the subsoiler plays in the preparation and the manufacture of humus, and in the chemical development in its many forms. Having regard to the fact that the subsoiler is a creation of comparatively recent times, it is really surprising that fertility has been maintained as well as it has been throughout the ages.

Then we are told that in the fixation of free nitrogen—one of the most important acts that take place in our soil—there are two kinds of bacteria operative, one which is aerobic and another which is anaerobic. These two are able to combine with free atmospheric nitrogen, and leave it in the soil for the use of crops.

These nitrogen gainers are to be found in humus and work only when easily oxidizable humus is present in the soil. This again emphasizes the need of subsoiling. For with subsoiling the soil is enriched by nitrogen, apart from any nitrogen originally present in the humus. The ploughing in of stubble or straw can cause some gain of nitrogen from the air.

It may be mentioned in passing that all the various changes which take place in decay and development of humus in the soil, and in the nitrogen of soil connecting therewith, are each of them the work of microorganisms, fungi$_s$ earthworms, and bacteria. If a soil is in any way artificially sterilized, whether it is by heat or an antiseptic, or by sulphate of ammonia, nitrate of soda, nitro chalk, or even by phosphates or sulphates and muriates of potash, these changes are, if they are not suspended altogether, most definitely interfered with.

A good supply of humus stimulates the bacterial life of the soil.

Another important matter in which subsoiling helps the growth of crops and the ordinary respiration in the presence of free oxygen in the atmosphere is what is called anaerobic respiration.

'One of the most familiar physiological processes in living animals is respiration. The oxygen of the air is inspired into the lungs and carbon dioxide gas is breathed out into the atmosphere. So long as life exists respiration goes on continuously, and one of the certain signs of death is the cessation of this process. Respiration, however, is not confined to animals, but is a function of all the ordinary plants, and is as necessary to their existence as it is to the existence of animals.

'In ordinary farm and garden practice, plants above ground always obtain sufficient oxygen for all their requirements, but the roots of plants are often seriously injured through want of a suitable supply of fresh air in the soil.'

Seeds, for instance, buried too deeply do not obtain sufficient fresh air for normal respiration, and either do not germinate at all or do so in an unsatisfactory manner. Among the many advantages of subsoiling, this fact of introducing oxygen to the soil itself to increase plant growth is of enormous importance as will be shown by a practical experience which I shall describe later in this chapter.

When I first came to Chantry I brought a Yorkshire farmer friend to view the property, and in supreme disgust, after we had surveyed the whole estate, he turned to me and said:

'I think that you are either ready for a lunatic asylum, or that you know much more about farming than ever I hope to learn. This is not a farm—it is just space out of doors—and worse material would be difficult to find.'

If I have at all altered the appearance of the countryside where I now live it is, I think, due partly to my knowledge of the part which respiration plays in the life of a plant. In the early days of our occupation here, every summer we used to suffer from very severe droughts. All the countryside was like a desert—burned, scorched and arid. We still suffer from the same spring and summer droughts, but the whole of my countryside is now one beautiful mass of green.

What makes this possible? The answer is one word—the subsoiler. If I am to explain how the subsoiler has effected this change, I must first explain the meaning of the term *transpiration ratio.*

From all parts of an ordinary land plant there is a continual invisible loss of water in the form of vapour.

'The loss of water in the form of vapour from living plants is termed transpiration. An average crop of cabbages gives off an estimated three to four tons of water per acre per day.'

Every farmer should know something about the transpiration ratio and current, because it affects his industry perhaps more than any other single factor. If subsoiling is carried out in a systematic way on every farm, let us say, at least once in eight years, and is combined at other times with the growing of the deep-rooting grasses and legumes, all the physical arrangements are satisfactorily completed for permanently maintaining a transpiration current of water. That brings us back to the subject of rainfall and I would here repeat that, remembering one inch of rain makes a tonnage of 100 tons to the acre, a 30-in. rainfall would therefore provide that acre with 3,000 tons of water; but if 50 per cent of that water is evaporated as a result of climatic conditions, it means actually that some 1,500 tons only of water which fell upon that acre penetrated the ground. Now if subsoiling is done, a greater proportion of the rainfall really does run through and into the subsoil and is more or less retained there. If, in addition to that, an adequate supply of compost or farmyard muck, or humus made by the manufacture of sheet compost, has been made available through the system of ley farming having been adopted, there is a further physical reservoir for collecting and holding much or all of the water which has fallen on the land.

23. The Proctor System of Tripod Harvesting

24. The Tripod cock completed. Note ventilating shaft. Crop of Hampshire Late Flowering Red Clover for seed

25. Tripoding American Sweet Clover *{Mellilotus alba)* for seed

26. A special sweep brings a complete Tripod 'hut' to the thresher

When we study figures showing what the transpiration ratio calls for in the production of a crop, we are really appalled at the amount of water that is needed for the growing of all crops.

'One eminent authority tells us that:

'The effect of manure upon transpiration ration—

Wheat	Without manure 850 tons of water
	With farmyard manure 530 tons of water
Barley	Without manure 680 tons of water
	With farmyard manure 480 tons of water
Peas	Without manure 830 tons of water
	With farmyard manure 530 tons of water'

(Paterson)

Thus, we are always forced back to the necessity for manuring, and manuring always with all the humus we can lay our hands on. In addition to this we must subsoil, so as to retain most of the rainfall that the

Almighty hands down to us. By suitable manuring with farmyard muck or compost a crop can make a better use of the water present in the soil.

At this juncture I can almost hear impatient stamping of feet of thousands of my reading audience, exploding with a desire to tell me, that while all this discourse on Subsoiling is of academic interest, it is a sheer waste of time so far as they are concerned, because the soils upon which they are farming are of no more than four inches over the bare rock.

My reply is, there are none to whom this matter is so important as to those so situated.

It is out of the question, of course, that the Ransomes Subsoiler can be brought into operation. But I hope that I have made it clear that of all Subsoilers there is nothing yet man-made that can equal Nature's own deep-rooting plants for effective subsoiling work, although they are slower in action in the early stages.

But it is a matter of importance that the Shallow-land Farmer, overlying the rock, should incorporate the Four Years' Deep Rooting ley. He will find roots like chicory, sweet clover, lucerne, sainfoin, cocksfoot, burnet, will establish themselves, will batten on to the rock faces, seeking any slight crevasse. Down these they will send their penetrating gimlet-like feelers, splitting and breaking the rock. With the dissolving juices from the plant's own eliminating-root-system they will further denude the rock, reducing it to infinitely fine particles, separating its minerals, absorbing the solvent of them, making passages and fissures as they probe, eventually so reducing the rock that other micro-organisms and even earthworms can enter; thus plants and other living inmates of the soil will work together to take from that rock the minerals and trace elements they need, bringing these into general circulation in the topsoil, partly through earthworm casts, and partly through the growth of the plants, which, being consumed *in situ* by the grazing animal, return those minerals to the soil in dung and urine.

At this point my 'artificially minded' critics, whose recent plea, 'Yes, we always agreed that *humus* was necessary. We seek not to displace *humus,* which is indispensable, but to augment the supplies of *humus* by the additions of those minerals which the world's insufficient supplies of *humus* are failing to return to the soils. And here in this instance of the shallow-land farmer, here is a case where the addition of artificials is called for. Obviously limited supplies of phosphates and potash which should be augmented by the addition of those ingredients.'

Now if this was the alpha and omega of the whole of this argument there might be very little left for me to say, but this angle of thought of supplying deficiencies by chemical and mathematical calculations is fundamentally unsound, and springs out of the brains of those who are not farmers in practice, and whose association with the soil is usually through the fleeting acquaintance with it in the laboratory experiment. For if they were really practical farmers, endowed with keen instinct for natural observation, they would know the elementary basic law, common to every form of life, whether it be the lowliest micro-organism of the soil, plant, animal or man—*the line of least resistance.*

If this topsoil of only four inches contains what the modern soil-scientist calls 'deficiencies', so far as the plants are concerned, this means that they have to work doubly hard to secure the nutrients that they need. If they do not find what they want in the 'four inches', then they turn to the rock, probe about for its soft-places, cracks and fissures, eliminate their organic juices (their dung and urine) reduce the rock by denudation, fragmentate its minerals, and get out of it what they need. As explained, this is then brought into general circulation in the topsoil through the grazing animal, and so the mineral content of the topsoil is not exhausted, but is continuously and copiously increased by this process, one of Nature's own.

If on the other hand we take advice of the soil-scientist—he will say, 'But here is the very case for the usefulness of the artificials. The plants need it, let them have it *easily,* out of the bag.' And acting on his advice, we do; the plants instantly turn their hard-working roots *upwards* instead of *downwards.* True to their basic natural law, they take *the line of least resistance.*

And this is no creature of my own imagination, for every mycologist of experience will confirm these facts. It is being everywhere proved that the provision of artificials means *less work for the soil organisms to perform,* and this may eventually bring about the complete desolation of the world's soil and the extermination of all living matter, including man.

If, for instance, we apply Ammonium Sulphate to clover, the clover roots cease to form nitrogen-forming nodules. Indeed, why should the clover work hard to get its nitrogen from the air, when it can get its supplies so much more easily from the bag? But if this insane practice is continued unabated and with increasing force, we will one day have a soil without nitrogen-forming-bacteria, and when that happens man is right at the end of his tether, for without nitrogen we cannot live. It remains one of the most curious defects of nature that animals and higher plants—although passing their lives bathed in air the greater part of which is nitrogen gas—are yet unable to use this nitrogen, although they need it to build up their own living matter. Their only agency through whom this indispensable life-giving element can be obtained are certain bacteria of the soil,

certain algae and perhaps fungi. Without the services of these lowly organisms man cannot survive. 'How slender is the thread upon which the whole economy of life depends.'

Leaving all the theories, practices and arguments to the scientists to whom, let me say, we all owe so much, and getting down to a practical level, we are all likely to agree that an ounce of fact is worth a ton of scientific theory. I will, therefore, conclude this chapter by giving some of my own experiences of what can be directly attributable to subsoiling and good cultivation, and I will begin with one thirty-acre field.

It was down in permanent pasture for more years than many of us can remember. It was ploughed and pressed by the previous tenant before he left the farm, and sown to oats. The whole field was a failure. I then took it on, realized what was the trouble, and determined at once to subsoil it. I subsoiled about ten acres of the thirty when my subsoiler broke. On the part which had been subsoiled I ultimately grew something like fourteen sacks of barley to the acre, while on the rest of the field there was practically no crop at all—it was as much a failure as it had been the previous year in oats. The following year the field was fallowed and subsoiled—it was then sown to wheat and some thirteen sacks to the acre were ultimately obtained. This was entirely due to subsoiling. No manures of any kind in any of the operations were applied.

Another field was down in permanent pasture, ploughed up, and on the upturned sod an oat crop was sown. Twenty acres of the thirty acres failed to produce anything. Although the seeds germinated they failed to develop, and we got no crop at all for twenty acres. Again, subsoiling was practised and the following year a very heavy crop of wheat followed and that was succeeded by a further very heavy crop of barley. In both cases no artificials and no farmyard muck or compost were applied to the land—the improvements were entirely due to subsoiling.

Another field of fifteen acres was well known for producing nothing at all. Again the subsoiler was applied and although it is naturally a very poor field, and needs a lot of manure of the farmyard muck kind to put it right, we are now getting quite good crops—once more, entirely due to subsoiling.

I will content myself with just one other notable example of the value of subsoiling and its immediate effects. One field of twenty-five acres was ploughed up from an old pasture. On the upturned sod seeds were sown and over twenty-two sacks of oats were reaped. Previous to this, an analysis of the soil had been taken and deficiencies of lime, phosphate and potash, were recorded. This analysis was made by a party who gave me a chemical prescription to put the field right. I did not act upon that prescription; on the contrary, I did just as I have stated. After harvest the land was immediately ploughed again and Vilmorin 27 wheat was sown; between thirteen and fourteen sacks to the acre were harvested. By this time the couch and other perennial weeds had so suffocated the field that it became impossible to think of growing another crop, and we were bound to give it a summer fallow. The land was ploughed several times, cultivated and harrowed. It was also subs oiled and then the next autumn it was sown again to Vilmorin 27 wheat and an even greater crop was harvested. This field on a second chemical test was alleged to be deficient in phosphates, a most necessary element if a good crop is to be grown. But after subsequent cultivation and subsoiling, all these ingredients were found to be present, and the land has been restored to health and balance without the addition of either farmyard muck or artificial chemicals. This proves to me as a farmer, that there is in the soil a reservoir of mineral fertility of all the necessary kinds, if the farmer will only tap it and set it to work, with the appliances that are now available in this age of mechanical invention. If, in addition, the farmer will refertilize by habitual applications of farmyard muck, by growing a variety of grasses, deep-rooting clovers and legumes, and will graze heavily, he will maintain the phosphatic, potash and nitrogen content of his soil and he will be able to hand it forward to succeeding occupiers in a better condition than that in which he found it.

I should like also to explain the subsoiler's contribution to the maintenance of fertility, and reasons for ignorance about this matter. Among any diseases of mind from which the average farmer may suffer there is no conception more fundamentally mischievous than *'the top six inches of the soil complex'*. This is accepted almost everywhere. All calculation estimating the soil's fertility is based upon what the top six inches contain. Analyses never go below this depth for their samples, and conclusions reached only refer to this thin layer of earth.

Why allow scientific investigations to begin and end with this small amount of soil? Examine Nature's ways and ascertain whether she confines her own efforts, and the uses she makes of the minerals of the earth, to these top six inches. What happens in the forest?

The tree goes down in search of its ingredients to an enormous depth, sending down tap-roots and feelers everywhere, combing the subsoil in all directions for the minerals and trace-elements it calls for. Each year the tree faithfully adds rings of growth to its girth, and in the autumn sheds its copious crop of leaves. These contain the phosphates, potash and trace-elements in organic form which the tree has taken from the depths below. In this way the mineral content of the surface soil is increased in ever growing proportion, and by the

annual decay of leaves a continuous supply of humus is provided near the surface, where that all important material should always remain.

In my understanding as a husbandman, where I have contrived at all times to imitate Nature as the supreme farmer, I create a four years' ley, containing all those deep-rooting plants like sweet clover, sainfoin, lucerne, burnet, chicory, cocksfoot. Here is an array of tree-like agents, who go deep down into the depths for their minerals and trace-elements. The resulting green mantle covering the earth is consumed *in situ* by animals, and through their dung and urine all the essential minerals eventually find their place, mingled with accumulating humus, and come into circulation in the surface soil. The activity of the earthworm further augments the supply of minerals provided by the deep-rooting plants.

With a system of alternate husbandry such as the four years' ley, four years' arable, where the subsoiler finds its place to break up the plough-pan to enable the deep-rooters to establish themselves, and find easy access to a new and enormous store of untapped minerals, there never can arise a deficiency in any kind of mineral food.

And if farming lasts a million years, so long as husbandry faithfully copies Nature's cycle as exemplified in the forest, with its Law of Return, no mineral or humus deficiency will ever be found.

The subsoiler is the preliminary implement to bring a neglected farm —or one soaked for years in artificials—back into good healthy balance, where a new store of deep minerals will be tapped, a vigorous manufacturing of humus set agoing, and all be an essential initial process of the humus-and-mineral-sufficient farm of the future.

CHAPTER XI

CULTIVATIONS-AND THEIR PURPOSES

Cultivation ought to be so well understood by all farmers that there should be no need to refer to the subject at all; but having attended quite a number of War Agricultural Executive Committee demonstrations, I find that there is still a lack of knowledge among many farmers as to the real value of cultivations. I have frequently been asked how it is, on such high land, of obviously little value, I have succeeded in growing such exceptional crops, and I have had to explain that in great measure it is due to cultivations, thoroughly carried out.

We all know that good cultivation is necessary in order to get the best results out of the land. 'In early times the operation of ploughing and harrowing were usually very badly performed, and I am sorry to say that some of the work that I see carried out even in the year 1944 leaves much to be desired. In the old days this inefficiency was partly due to the lack of proper implements, and sometimes to the ploughman. In 1733 there lived an English farmer, not more than six miles from where I now live, namely Jethro Tull. He called attention to cultivations and told the world that his large crops were obtained simply by his thoroughness in ploughing and general cultivation. Tull even went so far as to claim that good cultivation was of itself sufficient to maintain the fertility of the soil, and that where it was practised the need for manures would never arise. This, of course, is going much too far. He could scarcely be more wrong, but a valuable service at any rate was done to the farmers of his generation by drawing attention to his system of thorough cultivation, the value of which, up to that time, had not been properly appreciated.'

The first act of cultivation is to plough the land. It is the first step, and it needs to be done, in my opinion, in a very thorough-going and workmanlike fashion.

'The purpose of ploughing is to loosen the soil and then invert it, thus exposing a fresh surface to both sun and air. The eventual result is that water and air can enter the soil quite freely, and the various processes are started whereby food minerals are rendered available. Ploughing also affords a means of burying weeds, crop residues, and farmyard manure, compost and so forth, under the surface, so that they are converted into humus at the place where they do most good.

'Another important object in ploughing is to secure what the farmer calls a good tilth, and this problem is not always easily achieved, especially on clay soil. Here, as indeed everywhere, autumn ploughing is desirable in order to obtain the pulverizing action of probable winter frosts, and also to assist drying out in spring. Ploughing if done up and down a slope assists drainage; the surface should be left rough to produce the likelihood of surface caking. In spring, the shallow cultivation or cross ploughing on such land, followed by harrowing, will usually provide a crumbly tilth for spring-sown crops.'

The most important contribution I can make to this subject of ploughing will be a description of my own system and of the ploughs which I use. On different lands, different ploughs function better than others, and I have found as a result of experiments that the plough best suited to my own peculiar conditions is the one which is made by Ransomes, Sims and Jefferies, and known as their four-furrow Multi-trac; it is a tractor-drawn plough, fitted with semi-digger body of the I.R.D.C.P.T. type. This plough is illustrated in these pages and I would draw attention to its design. It is of the Scottish semi-digger pattern, and well suited to my peculiar land. The plough points are divided into three parts, instead of all being in one piece and this, on my stony land, results in great economy in plough-point replacements. The plough point itself, which wears most, costs 1s. a replacement, whereas a complete ploughshare, which has to be scrapped when only worn at the point, usually costs about 4s. or more.

As a result of employing this particular kind of plough my cost of ploughing has been reduced considerably on these lands. This plough is remarkable for extremely strong design in detail and for utter freedom from trouble in every way. The ease of and perfect adjustment emphasizes its scientific design. Ransomes, Sims and Jefferies are probably the largest plough makers in the world; perhaps the most knowledgeable people on the subject of ploughing to be found in any country, and they make no less than two hundred different models of ploughs. The reader will readily appreciate what a vast difference there must be from one county to another, from one land to another, which calls for so many different designs. And once, when I was discussing this matter with their managing director, Mr. Henry Deck, and ventured to make a suggestion that surely all these designs were not necessary, he told me that in his experience each of all these different designs had its peculiar advantage, and that he was not prepared to take a firm line and say that they were not needed.

Having said so much about the ploughs that are used and their design, I now wish to draw the attention of all cultivators of the land, to the extreme importance which I attach to ploughing 'shallow'.

What do I mean by the word 'shallow'? In my view, which is based upon my own experience and observations, the highest degree of fertility in most soil is very near the surface. When I say this I do not include the mineral content of the soil and I am referring more particularly to the humus composition. With certain exceptions most plants are somewhat shallow-rooted and spread their feelers throughout the surface soil in search of the foods which they need. If, therefore, a four years' ley sward is ploughed under much too deeply—say nine inches—that sward is put below the usual depth to which the average shallow root will penetrate. Furthermore, it brings to the surface a soil of another composition altogether, sometimes entirely devoid of humus content, which lies near the surface soil and under the influence of frost and sun soon becomes exhausted of its moisture. While a soil containing a high percentage of humus will absorb an enormous quantity of water, a soil of purely mineral content is unable to retain moisture.

From every point of view it is desirable that the humus should not be buried too deeply because, apart from its great refertilizing qualities, its ability to feed and breed countless micro-organisms, and its many other faculties working for the good of the land, one of the most important functions of humus is its volumetric capacity to absorb water. I estimate that one cubic foot of bone dry humus will absorb fully 60 lb. of water. It is just like a sponge and will absorb its volumetric capacity without in any way altering its shape or physical characteristics. Thus it provides a continuous reservoir of moisture upon which the growing plant can draw. But if this humus is ploughed too deeply its tendency to draw moisture into itself—like blotting paper—is such that it will probably make the soil now lying above it drier than if there were no humus in the land at all. It is of the utmost importance therefore, if the full benefit of humus farming is to be enjoyed, that deep ploughing should not generally be practised. At Chantry we try to plough no more than four inches deep, and we thus keep the whole of our surface soils full of humus—I believe this is the real secret of the mammoth crops which we are growing.

Another important result of this 'shallow' ploughing is the newly acquired ability of the soil to collect and retain water. Soil erosion, even on fairly steep banks, when the humus content is high, does not occur. Moreover, where the top few inches are heavily charged with humus, it is seldom to be seen that water 'runs off' either from the surface or through any pipe-line in the soil.

I had a visit some months ago from a very eminent Scottish farmer who told me that it was his custom to plough his land no less than eighteen inches deep. I told him that he was making a great mistake and that I thought on his rich soil that he would get equal, or possibly much better crops of every kind, potatoes included, if he did not plough so deeply. I urged him to use the subsoiler once in eight years but never to plough more than four inches deep. He was so impressed with what he saw at Chantry during his visit that he went away determined to put some of my practices into use on his farm.

When the world talks of cultivators, they instinctively think of Ransomes, Sims & Jefferies. Their 'Equitine' Cultivator is a veritable wizard. This machine, illustrated here, is the finest cultivator I have ever used. Its tines are hinged and movable and never block up with trash. They are continuously active, and keep the soil in perpetual stirring movement when the implement is in motion. It is not as well known as it ought to be, perhaps because it is a comparatively recent design; but there is no cultivator I have seen, either American, Canadian, Australian or British design, which is so scientifically designed and constructed as the 'Equitine'. It is one of the greatest innovations which I have made on the farm—my men would not like to be without it.

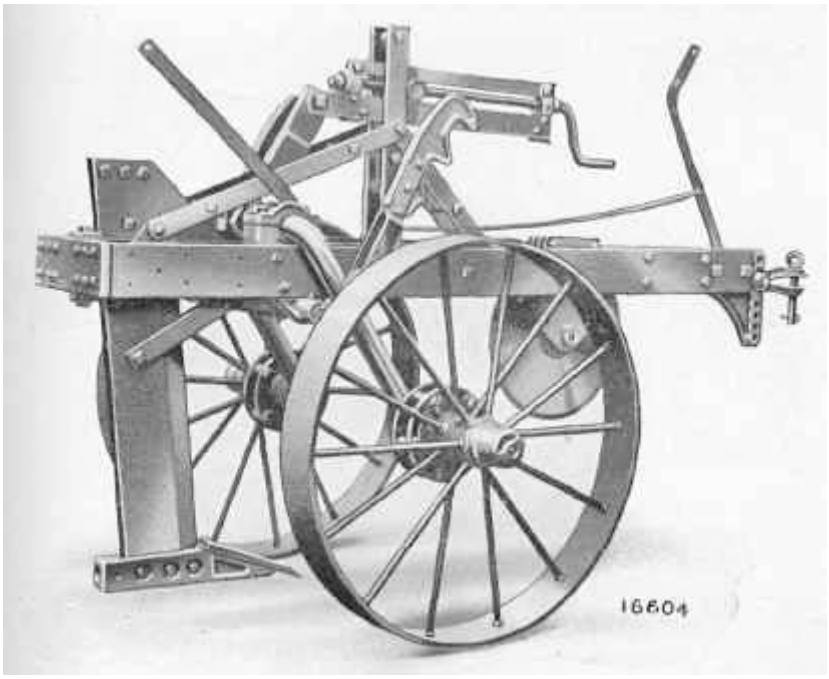
Like the plough which I have already described, this 'Equitine' cultivator is capable of the most fastidious adjustment and we are most diligent to see that we never work it more than about three inches or so in depth. This implement lends itself to either 'shallow' or deep cultivation, but its usefulness is especially marked in my experience in 'shallow' cultivations.

When we come to the harrow, I do not yet know anything which is better than the old-fashioned Zig-zag. My particular models are made by the Bedford Plough Company of Bedford and are run in section gangs no less than seven yards wide, which admit of a great area of cultivation being performed by a powerful tractor in a short time.

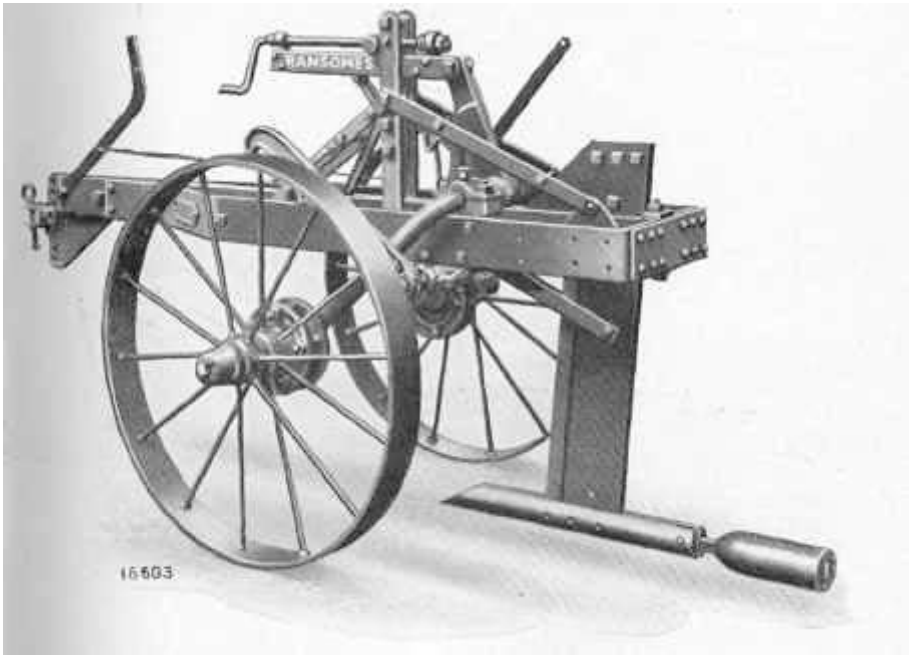
Another important item are the rollers. Rollers are of two kinds—the plain roller which is used for the grassland, and the ring-roller which is used for the arable. These are twenty-one feet wide, in three sections, and are pulled by powerful tractors.

Our complement of tractors consists of a 35 h.p. Caterpillar, 50 h.p. Case L.A. and two 30 h.p. Case tractors. These are the types we have found most successful and suitable to our farm. We have tried several others, including some of the lighter and cheaper tractors, but for our hilly land, we are bound to have

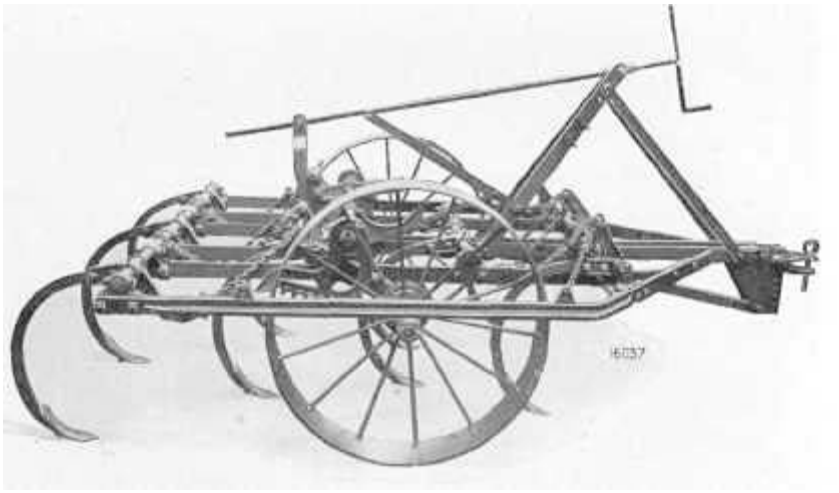
powerful machines. Hence all our tackle here is of the rather big and heavy type. For economy of working, operating in large fields up to a hundred acres, the advantage of this large tackle is considerable.



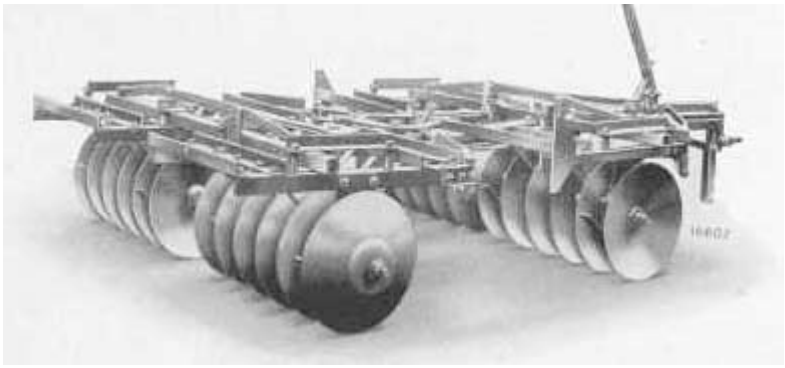
27. Ransomes CIC Subsoiler



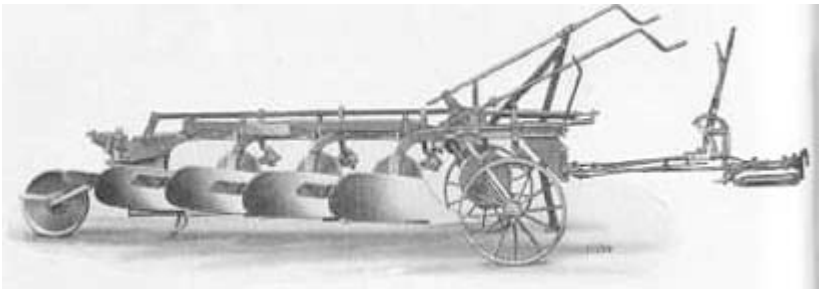
28. The same machine with different bottom fitments for mole-draining



29. Ransomes Equitine Cultivator.



30. Ransomes No. 3 Baron Discs



31. Ransomes 4-furrow Multi-trac Plough with semi-digger bodies

Good quality tackle is absolutely essential for good farming. Cheap tackle, apart from the fact that it often breaks down, leads to a degree of inefficiency within the working staff which cannot be estimated, and is bound to result in bad farming. We want our tackle as cheap as the manufacturers can let us have it, but this cheapness must not be at the expense of quality. Many of the implements that are to-day made for the farmer are not nearly so good as they might be, although this lack of quality is frequently due to the fact that the farmer will not lay out as much money on his tackle as he ought.

He cannot be entirely blamed for this, however, when we look back over the hundred years of farming decline through which he has tried to survive. He has had a thin time, and he has lived, so far as implements are concerned, by buying at farm sales one piece of discarded or derelict machinery after another, which some other farmer has either abandoned or has left behind him at his death.

Before the war only the best and the most far-seeing farmers ever thought of buying new implements. '1 goes to farm sales and what I buys there I makes them do me.' What that worn-out tackle eventually used to

cost them, by breakdowns occurring at critical moments when 'time is the essence of the contract', they never knew, for they seldom keep books or records of costs.

When a farmer is broke, it takes a long view to induce him to spend £150 on a binder to harvest a crop, which has been grown at a heavy loss. How, indeed, have the farmers survived? Can you complain of the mentality which directed them to farm sales where the rubbish being sold was all they could afford to buy?

CHAPTER XII

COMPARISONS OF MANURES

At my lectures I am frequently asked to make comparisons in manurial values. One question that some of my listeners often ask is 'What is the difference between the manurial value of fresh farmyard manure and compost?'

'Farmyard manure generally is made up of the solid and liquid excrement of farm animals, together with straw or litter. Animals cannot manufacture phosphoric acid, potash and nitrogen. The value of the manure, therefore, must depend to some extent upon the character of the food the animals consume. Indeed, the character of the food is easily the most important factor in determining the constituent value of *fresh* manure. When food is digested and assimilated by an animal, its manurial constituents are separated. In animals living on vegetation the phosphoric acid and the undigested nitrogen of the food appear usually in the solid excrements, while the digested nitrogen and most of the potash are excreted in the urine.

'Fresh farmyard manure takes much of its chemical value from the nitrogen which it contains. If the food is difficult to digest, the chief value will be in the solid excrement; on the other hand, if the food is easily digested the urine will have the greater value.'

When cows are in pasture, or fed on concentrated food, the urine will contain about three times the value of solid manure so far as chemical fertilizing constituents are concerned; that is why it is important to make a liberal use of litter so as to absorb the liquid portion and avoid losing this valuable part of the manure. The values of manure obtained from the consumption of one kind of food can easily be calculated, and there are many authorities which have established figures.

'Work-horses if fully grown return 100 per cent of the nitrogen, phosphoric acid and potash present in the original food and these are recovered to this extent in the manure.

'With fattening cattle or sheep the percentage is usually about 95, with fattening pigs 85 per cent, with milk cows 75 per cent.

'Much attention has been given in this country to the manurial value of one ton of different kinds of food. In Scotland, for instance, as recently as 1938 the following values have been arrived at as a working basis for compensation by valuers acting for an outgoing tenant:

'Linseed cake 25s. 6d. per ton, beans 19s. 11d. per ton, oats 9s. 11d. per ton, bran 21s. per ton, clover hay 14s. 1d. per ton, wheat straw 4s. 11d. per ton.'

These figures are quoted for illustration, and are indicative of the value of the manure resulting from the consumption of one ton of such foods. The values have to be calculated each year, as they are related to the varying costs of compound artificial manures.

The most expensive constituent in such manures is always nitrogen, and generally speaking, those foods supplying most nitrogen, in proteins for example, leave behind the highest chemical residues.

Farmyard manure decomposes rapidly, and during the process it loses weight, and also some of the fertilizing material. It is important therefore to learn how to treat farmyard muck if you would avoid unnecessary losses in this way.

It is suggested that in some experiments five tons of fresh manure were reduced to four tons when half rotted and to three tons when it could be cut with a spade. I am not in a position to check these figures because I have seen great variations of diminishing weights and volumes. There is no doubt that even when you are making compost the finished tonnage is very much less than what you start with in the raw materials of fresh farmyard manure. Rotted material—especially when reduced to compost—is much more active than fresh manure ton for ton, and if it is properly protected and made according to the specifications set out in this book the percentage of fertilizing ingredients which are lost should be nil, while the increased population of refertilizing organisms of all kinds is of an incalculable advantage.

This does not mean, however, that a farmer, because he makes compost, can be reckless in the treatment of his fresh farmyard muck. On the contrary he should exercise the greatest possible care at all times, and use great skill in his methods, and see to it that no undue losses are sustained. I have often been in farmyards, and seen that valuable dark brown liquid draining away from a manure heap, a liquid which is rich in fertilizing substances, particularly potash and nitrogen.

Such avoidable losses are criminal, and a farmer who stands by and coolly sees such invaluable fertilizers go down the drain, and then foolishly buys the presumed equivalent of that wasted material in an inorganic salt, is neither a good farmer nor a good business man—he is extremely stupid, and yet there are few farmers in this country who have not been guilty of this crime at one time or another. There may be

losses by volatilization, and these again are the result of changes brought about by bacterial organisms and sometimes due to the heat they develop. The losses in manurial constituents are principally confined to nitrogen which passes off as ammonia. The nitrogen loss in this way is estimated to amount sometimes to as much as one-half of the original nitrogen content. This escape can be enormously minimized by care in management, but it is greatest when the heap is loose, and allowed to become too dry. Compacting the heap and moistening it with a portable water pump, whenever necessary, reduces this loss considerably. Add a little ground limestone or chalk, but it is unwise to add any burnt lime (calcium oxide) to the manure heap during composting. One of the best ways of fixing ammonia is to mix a few shovelfuls of loamy soil from time to time over the compost heap as it is being assembled. By this means ammonia is readily absorbed by the covering of the earth, and I strongly recommend, both from the point of view of making as much compost as possible and of avoiding this possible loss of valuable ingredients, that this practice should be rigidly followed; for it must be remembered that as a source of plant food good farmyard manure is particularly rich in available nitrogen, and this can easily be demonstrated, at any time, by observing that wherever it is applied to the land there is always a dark green foliage.

As to the loss of nitrogen in the manufacture of compost—a question which always comes up at my meetings—first of all, the student should realize the fundamental truth that the farmyard manure heap and the compost heap are not the same thing.

In a farmyard manure heap some of the nitrogen wastes have not been built up into microbial tissue because there is invariably hopelessly insufficient vegetable matter in the form of waste straw or other waste vegetation. If such wastes come in contact with quick lime or slake lime, they may and probably will give off ammonia, and so lead to an inevitable loss of nitrogen, and at every one of my meetings I emphasize the absolute necessity for this reason of not introducing either quick lime or slake lime into the compost-making process. Furthermore, it is not new even to the most uninformed farmer that lime and muck should never be put on the land together.

But the addition of carbonate of lime is a factor of another kind altogether. Carbonate of lime usually contains only half the percentage of lime contained in the average calcium oxide, quick lime, or slake lime. The carbonate of lime acts much more slowly, and it does not cause the same intense chemical disturbance. On the contrary, the carbonate helps to keep the mass of farmyard manure from becoming too acid, a condition which checks microbial development.

This latter necessity calls for the introduction of a 'base' which helps the fungi to build up the nitrogenous wastes into mycelium, where the nitrogen is automatically safe and properly cared for. Eventually the mycelium, a living organism itself, dies and finally amalgamates with the lignified cellulose to form humus. In humus, all the nitrogen and other things are safe, and are not leached out of the soil or destroyed by any spare carbonate of lime or calcium oxide that may be available.

It is well to remember that the safest 'base' to use in composting is ordinary soil. This, however, needs a slight qualification inasmuch as soil, in order to do its work properly, itself needs to have been got into good condition by the necessary subsoiling, cultivations, and the usage of deep-rooting leys, legumes and grasses. But before this stage is reached we have often to deal with sour and acid soils, and in these cases powdered chalk or powdered ground limestone become the next best expedients to use as a 'base'. Again, I must draw attention to the fact that ground limestone is sometimes very impure and contains all sorts of other elements besides calcium.

It must be our aim always to replace the old wasteful muck heap by the more scientific compost heap, and in this way to manufacture real humus as soon as possible after the dung has been dropped in the cowsheds or stables or piggeries.

In some of the experiments that were carried out in India, so far from there being a loss of nitrogen as a result of the manufacture of compost, there actually was a considerable increase of nitrogen fixation—even up to an extent of 25 per cent in some of the experiments at Indore.

Briefly stated, therefore, if the farmer who makes compost carefully is particular to see that his compost heap is adequately aerated by the specified number of turnings, and the water supply is adequate without being excessive, and he introduces plenty of soil, but not too much, he will find the manufacture of compost, as compared with that of farmyard muck, will all the time improve his chemical analysis of the final product, for all the nitrogen will have gone into microbial tissues of the organisms which break down the vegetable wastes and, finally, into the finished humus.

I must admit here that I have had some little difficulty in convincing farmers that the final product of humus, which is made out of farmyard manure as to one part, and waste vegetation in the form of straw and other things as to four or five parts, could be an even better 'chemical' fertilizer than the original farmyard muck.

The old and ignorant misconception that the greater the amount of excrement and urine to be found in the farmyard muck the greater its fertilizing value, requires much eloquence to dislodge. The farmer simply cannot believe that straw, as he understands it, could ever be as good as the excreta and urine. And yet this fundamental fact needs to be grasped by everyone.

In the manufacture of compost there are biological changes taking place, as well as chemical changes which render the finished humus— even from a purely chemical point of view—of far greater value than the original excreta and urine. I cannot emphasize this point too strongly. As a result we have a finished product of enormous refertilization value, and (what is still more important) the pabulum for the myriads of organisms in the soil through which the plant receives its sustenance.

This issue goes right down to establishing the fundamental difference between the methods of refertilization provided by the artificial manures on the one hand and by humus on the other. Quite apart from the fact, insisted on by the soil biologist, that the artificial, because of its manifold obvious incompleteness, does not make good the soil deficiencies, perhaps its greatest offence lies in its direct methods of feeding the plant. These methods are fundamentally incorrect. This is undoubtedly one of the basic causes of the failure of artificial fertilizers, quite apart from their definite lack of *genuine* nutritional values.

Nowhere in Nature does direct and intensive feeding take place. Whereas the feeding of all forms of life is invariably circuitous, the solutions which are immediately formed by applying artificial fertilizers are fed in large quantities to the young growing plant. They have the effect of most noticeably boosting the plant's growth in its early stages, often leaving it to wilt in the event of a drought and, definitely, to 'lodge' if the latter part of the growing season is wet. This kind of experience seldom happens to the plants when they are humus grown. They are sometimes a little slower in their early stages of growth, but their root system is much more substantial, far more extensive, much deeper, and they are thus able to grow in a dry season with a persistency quite unknown in those plants which have been assisted by artificial manures. The humus grown plant finishes up vastly superior both in quantity and quality to the produce raised by any method of artificial application.

This fundamental point is of the greatest possible concern to every farmer and indeed to every human being. This is not a farmer's problem alone, nor even a national problem; it is a grave international responsibility. It is more than sad to think that not one of the great scientific institutions devoted to agricultural investigation in any country in the world has yet begun its first biological experiment whereby a test, with cattle as its medium, in order to ascertain the true food values of the crops which are grown under these two systems, could be carried out.

All independent thinkers are in agreement with the modern soil biologist that such tests are long overdue, and it is my earnest hope, and one of the basic reasons why I have been induced to write this book, that these urgent trials may be initiated without further loss of time.

CHAPTER XIII

MYCORRHIZAL ASSOCIATION

It is my practice, two or three times a year, to visit a certain estate in the north of England, the property of an old friend. On each visit it is a matter of ritual for me to spend an hour or two at least with a very brilliant head gardener who has been in the family service for several years. He tells me that he finds my experience and knowledge of farming stimulating—as a gardener he likes to compare notes with me as a farmer, and many an interesting hour have we spent together in the course of the years.

Two or three years ago I had occasion to visit the property, and I was walking through the gardens where a crop was growing. It was very healthy, there was an abundance of fruit and everything about it showed evidence of the master hand. But as we went from one section to another there was a marked change; the crop was a fairly thick one and the variety of fruit was the same, but there was a noticeable difference.

I immediately turned to my gardening friend and said, 'Let us go back into the other garden.'

After we had returned there, he told me that he had prepared the soil underneath the fruit himself, with compost and leafmould and soil from the garden, but that the soil preparation for the fruit in the section we had just left had been different. 'Oh,' he said, 'that is Mr. Smith's. Her ladyship has allowed her nephew to have the use of that and his gardener is looking after it.'

'Well,' I said in reply, 'this is very interesting,' and I pointed out to him hundreds of fine threads of mycelium which were running all through this section which he was looking after himself; the soil underneath was a mass of them and you could trace them to the extreme surface of it and then back again right into the stem of the plant. They were most noticeable.

I also drew the gardener's attention to the wonderful quality and luxuriance of the crop generally, and then I took him back to the second section which was now looked after by the other gardener. Here there was a coarsely prepared soil around the plant. There was a certain amount of undecomposed horse manure and I was told that an artificial fertilizer had been used to assist in the growing of the crop. There were no threads of mycelium anywhere to be seen, and the quality of the fruit as well as the weight of it, was not to be compared with that in the first section, although the botanical variety in both cases was the same. I then said to the gardener:

'Now, the part of the garden which you are looking after yourself is an example of what is known as mycorrhizal association—in other words the "living bridge" which Nature provides for the conducting of the sap and solutions of nutriment in the soil through a tubular or cellular thread to the plant. Some 80 per cent of all our garden and farm plants are now known to be mycorrhiza-formers, and wherever you get organic manure properly decomposed, and the compost in an advanced humus condition —in fact, wherever pure humus has been created by careful and skilful preparation—there you have these white threads of mycelium which are part of this almost mystical mycorrhizal association and function as a great feeder of the crop. Here you have two crops, one a real gem both for quality of fruit and for weight, and the other showing an inferiority which is simply incredible. And now let us go one step further. Let us take a plate and cut a pound or so of fruit from each crop. Let us eat it, and see what we think of its flavour.' This we did, and the flavour of the fruit from the first section was full and delicious but when we came to eat the fruit from the second section, we could not distinguish the fruit —no flavour, unappetizing, not good to look at—and we might as well have been eating anything.

The gardener and the farmer refertilizing with compost encourage the fungi to produce this mycorrhiza—for a mycorrhiza is a fungal growth— and if fungal growth is encouraged, it forms a bridge and a nutriment for the plant, which no artificial fertilizer can provide. It has been proved conclusively that the application of artificial fertilizers prevents the growth of the kind of fungi which are mycorrhiza formers. It has been further proved in many parts of the world that mycorrhizal association, with its growth of mycelium threads with which to feed the plant, is an essential part of vegetable life, and of this I can say much more.

The word mycorrhiza was not used until about the year 1880, and I would like to acknowledge my indebtedness to Dr. M. C. Rayner who has made such valuable contributions to our knowledge of mycorrhizal association; to her I am indebted for the following story of the first discovery of mycorrhizas:

'. . . The name goes back more than half a century and originated as follows:

'The gastronomic delicacies known as truffles are the underground fruit-bodies or sporophores of certain fungi native in woodland soils, found growing among tree roots, especially those of oak and beech. Truffles are highly prized for their culinary virtues; their relative scarcity and the difficulties of collection owing to their subterranean habit have always given them a high market value. Methods for increasing their numbers

artificially and controlling their distribution in woodlands would be, therefore, a matter of considerable economic interest.

'About the year 1882, the German Court of the day, desiring to promote the cultivation of truffles, requested A. B. Frank, Professor of Plant Physiology in Berlin, to investigate and report upon the natural distribution of truffles, in particular, to examine with special care the character of their invariable association with the roots of certain trees. So far as their main purpose was concerned, Frank's researches led only to negative results; the factors that determine the distribution and growth of truffles in woodlands were not discovered and are still unknown. He made botanical history, however, by his discovery of the fungus-roots of trees.

'Frank observed that a large part of the active root systems of oak, beech, and other members of the family Cupuliferae, and likewise of those produced by pines, spruces and many other coniferous trees, were made up of rootlets of very characteristic appearance and structure. These rootlets are short and of relatively large diameter, sometimes simple and unbranched, more often grouped in branched systems of definite types. This is notably the case in pines, in which the branching takes the form of repeated dichotomy, so giving rise to crowded clusters of forked rootlets each about an eighth of an inch in length. The structure of these short roots is remarkable, the essential features being as follows. Each consists of a short lateral rootlet enveloped in a covering of fungal threads or hyphae interwoven to form a sheath or mantle continuous over the whole root surface, including the tip. From the inner side of this investing mantle, hyphae grow inwards between the cells of the root cortex; viewed microscopically the appearance in thin transverse sections is that of a continuous network between the cells, the so-called Hartig net. This fungal net extends to a variable depth but never invades the central conducting tissue of the root, nor—save in abnormal cases—do the hyphae composing it penetrate the cells between which they travel.

'Frank recognized that these novel structures, at that time quite unknown to botanists, were composite organs, partly root, partly fungus, and he named them accordingly "Mykorrhizen" (sing. Mykorrhiza) or fungus-roots, the descriptive name which they still bear. Those having the structure just described were called by Frank ectotrophic mycorrhiza to distinguish them from the endotrophic mycorrhizas discovered subsequently, in which the mycelium penetrates the root-cells forming coils or branch systems within them, but which lack the investing mantle and net. Young mycorrhiza were variously coloured, whitish, pinkish, yellow or different shades of brown, the whole mycorrhizal system being strongly developed in the upper layers of forest and woodland soils rich in humus, with a covering of organic detritus in progressive stages of decay. They were often observed to be closely associated with coarse threads of fungal hyphae traversing the debris and it was evident from the characters of these hyphae and from those of the mycorrhizas themselves that a number of different soil fungi were concerned. The mycorrhizas of trees were correctly regarded by Frank as specialized organs and were believed by him to play an important physiological role in the nutrition of the host trees.

'Frank's enthusiasm for these researches was communicated to his colleagues and students, the closing decades of the nineteenth century providing proof of their interest by the publication of many papers on the subject. It soon became apparent that invasion of the roots of vascular plants by mycelium of soil fungi was a regular phenomenon, affecting an immense number of species growing in the most diverse situations and belonging to widely separated families. It became evident also that the association of root tissues with mycelium, whatever its physiological implications, was remarkably constant and uniform in character, especially in certain groups, and was therefore unlikely to be either casual or accidental in origin.

'By the beginning of the present century, it had been learned that forest trees, orchids, and members of the Heath family were conspicuous among flowering plants in this respect, and it is now known with certainty that more than 80 per cent of flowering plants as a whole, including a great majority of the crop plants of both temperate and tropical regions, are mycorrhizal in habit. In the Heath family, the fungi have been isolated from the roots of a number of different species, grown independently in pure culture and identified. The same is true of a large number of orchid species, although the exact affinities of the mycorrhizal fungi of orchids are still rather uncertain. In both these families of plants the mycorrhizas are of the endotrophic type and curious and specialized relations of the root fungi with seedling development have been demonstrated. The mycorrhizal associations formed by a majority of vascular plants, including some trees, for example, ash, poplar, walnut, cypress and a number of other coniferous species, also belong to the endotrophic type; the fungi concerned are believed to be members of a closely inter-related group, widely distributed in soils all over the world, but their systematic affinities require confirmation.

'The ectotrophic mycorrhizas of pines and many other forest trees, discovered and accurately described for the first time sixty years ago by Frank, continued to attract the attention of botanists. Stahl, Professor of Botany at Jena, devoted much attention to the subject, confirmed and extended earlier observations, and

worked out a new theory of symbiotic nutrition to explain the mutualistic relations that he, in common with Frank, believed to exist between the root fungi and their hosts. Frank had indeed gone so far as to describe the fungi as "foster-mothers" of the trees!

'During the past twenty years, knowledge has accumulated rapidly in respect to the identity of these fungi, their behaviour when isolated and grown independently, and the reactions shown by seedlings of the host trees when brought into contact with mycelium appropriate to the species. The identity of many of them has been experimentally proved, especially of those forming mycorrhizas with pines, Norway spruce, and larch. The mycorrhiza-formers of these trees and also of oak, beech, hornbeam, chestnut, birch, alder, and hazel are members of a group of soil fungi familiar to all because their sporophores are the common toadstools of woodlands and forests. They belong to the Hymenomycetes, many to the same gill-bearing family as the common mushroom, and species of the genera Amanita, Lactarius, Russula, Tricholoma and Boletus have been identified as the root associates of pine, spruce, larch and other trees. Two peculiarities of these root associations are worth noting; one, the fact that the mycorrhizas are easily recognized by external features and can be identified without difficulty by naked eye examination; the other, the multiple habit shewn by the hosts, each tree species being able to form mycorrhizal associations with a number of different fungi.

'It is not proposed to discuss here the problems of plant nutrition involved in the mycorrhizal habit, or even consider in detail those presented by the symbiotic relations of forest trees with their root associates. It must be noted that the atmosphere surrounding researches on this subject has always been clouded by controversy. In spite of Frank's prestige as a botanist, the views he held on the significance of mycorrhizas in tree nutrition provoked violent disagreement, particularly on the part of members of the newly formed school of plant pathology. To them, the root fungi were pathogens, invading the tissues parasitically and filching from them supplies of organic nutrients. How this interpretation can have been seriously maintained in view of the constancy and stability of the structural features and the patent fact that mycorrhizal activity and abundance of mycorrhizas are correlated invariably with healthy growth and maximum vigour of the host trees, unaccompanied by any symptoms of disease, is difficult to understand. Maintained it was, however, and the controversy thus begun has never entirely died down.

'To the writer, it appears that plant ecologists have tended to overlook —certainly to underrate—the importance of soil fungi in general as potential factors in plant ecology. It is reasonable to regard the mycorrhizal habit in trees as a specialized ecological relationship, the distribution and activity of the mycorrhiza-formers being closely bound up with the whole complex of biological action in soil, especially with those aspects relating to the breakdown of organic materials and the formation of humus. That trees belonging to certain groups show a multiple habit suggests that the capacity to form regular and stable root associations with different species of soil fungi is in itself an ecological adaptation bound up directly with other edaphic factors.

'In the establishment of a new ecological unit during afforestation, sometimes all goes well and the complicated soil factors become automatically adjusted to form a stable system. Often there are difficulties, and it has been learned that disturbance of soil factors is apt to be quickly reflected in mycorrhizal equipment, the incidence and structural features of the mycorrhizas thus becoming a valuable index to the suitability or otherwise of soil conditions, and often a useful guide to the application of correct methods for their modification.. . .'

I have now given the reader considerable evidence of a technical character to show that mycorrhizal association has an important bearing on all agricultural activities and he may well ask for a plain statement of the practical lessons which have been learned.

Well, throughout this book I have made numerous references to the interdependence of the soil, the plant, animal and man. The health of all four is entirely governed by the health of the soil. If the soil is toxic, if the soil is out of balance, that is bound to affect the crop. The crops are certain to be out of balance; they affect both animal and man; with the result that a standard of poor health, or symptoms of that condition, are to be found right through, from the soil to the plant, animal and to man. This cannot be rectified by ordinary medical practice or by that of the veterinary surgeon or the chemist, who all merely make good certain estimated chemical deficiencies. The remedy applied to these chemical deficiencies is almost invariably some form of inorganic salts or drugs.

Dr. Rayner has found that the application of phosphates to the Ware-ham soil did not rectify the toxicity and alleged deficiencies of that soil. She did find, however, that the application of organically prepared humus destroyed that toxicity, encouraged the formation of mycorrhizas and the development of the fungus that was necessary to the growth of the trees, and produced healthy trees. Similarly, if organically prepared humus is applied, it will be found that the toxicity of the soil will be very quickly remedied, and improved

growth will soon begin to show on plants of every kind which are mycorrhiza-formers, either in garden or farm. I have several instances in mind and one of them occurred a day or two ago in my own garden.

When I first came to my present house, I had to deal with the problem of providing myself with a garden, and after casting about in various places on this windswept hillside we eventually decided on one of the worst points, so far as wind was concerned, because it happened to be geographically convenient to the house. But a more unsuitable, or a more unfriendly soil, it would be impossible for man to go and dig. It breaks the heart of the stoutest gardener; it consists of large flints and a clay soil overlying the chalk.

This soil has now been developed into quite a friendly material compared with what it was originally, first of all by being ploughed and subsoiled, and cultivated so that we could dig it by hand, and finally by being given liberal coatings of compost. To-day, the garden is growing the finest vegetables I have ever seen, and they are in striking contrast to those grown anywhere else in this locality. They are the subject of much comment by all the people who have seen them and the flavour, on which all our visitors comment, is most marked.

Another instance that I have in recollection dates from a visit to Dr. Picton of Holmes Chapel in Cheshire about eighteen months ago. When Mrs. Picton took me into her garden where she was picking raspberries, I was astounded by the size and the superlative flavour of the fruit. Mrs. Picton told me that the plants had been bought by her son in a market and were without a name or pedigree of any kind. 'But the land', she explained, 'was carefully prepared by double digging, then a layer of compost, made with farmyard muck, was put underneath, and into that soil and compost these canes were planted. That is the only explanation. It is compost and thorough aeration of the soil that has produced this luxuriant food.'

I was immensely impressed with this story, and when I came home I prepared some land similarly in my own garden, and put in some of our own raspberry canes, of no special variety, with compost treatment. I am now growing fruit of the same quality as I saw in Cheshire.

Two days ago, when two cowmen chanced to be passing the garden and looked over our hedge, one remarked to the other:

'Mark, have you ever seen vegetables like that in your life? You have never any like that in your own garden.' Mark looked over and said:

'No, I haven't.' Now this man Mark is one of our best local gardeners.

There was actually a second crop of raspberries in heavy growth at the time, some of which were ripe and fit to pick: and this was on 1st November. This crop was gathered—a large bowlful—and eaten raw—on 5th November 1944, making a dessert more delicious than anything I remember for many a long day.

To sum up this chapter, the farmer needs to know that 80 per cent of the agricultural crops that he grows are now known to be mycorrhiza-formers. This means that all acts in farming must be conducted to the end that mycorrhizal association can have its full play. The white threads of mycelium contribute enormously to the growth of the plant, for apart from the fact that they are the living bridge through which the plant can draw its nutriment, they in themselves are a living substance, food for the soil, as well as for the host plant itself.

Any soil which is not forming mycorrhiza is definitely in bad condition This can only be remedied by the application of humus, artificial fertilizers being definitely lethal to mycorrhizal formation

CHAPTER XIV

LIVESTOCK ON THE FARM

The activities on our farm can be sharply divided into two divisions —under the headings cropping and livestock. In the absence of artificial fertilizers livestock must be kept, otherwise the fertility would soon be at an end, especially on this high, thin land.

I have said sufficient in other parts of this book to show the need for carrying a variety of species of livestock; for mixed farming must be the order of the day on this farm, as it is in nature, and we have seen that nature left to herself is the supreme farmer. Therefore we carry here as great a variety of livestock in peacetime as the economic management of the farm will permit.

Our livestock can be divided into these groups—thoroughbred horses; Channel Island cattle for milk production; pedigree Galloway cattle for the production of breeding stock and for beef; half-bred border Leicester Cheviot sheep and poultry. This is the complete range of livestock.

It is our practice first of all to allow the dairy cattle to have the cream of the leys—they are the first to go on to a pasture. They are very selective in their grazing habits, and walk round the field in search of those grasses the maturity of which on that particular day is most suited to their fanciful and fastidious appetite.

If they are to sustain a steady milk-yield cattle cannot be left very long in the same field. On a fresh pasture they invariably increase their output for the first day or two but after four, five, six or seven days their milk becomes either stationary or more likely to decline. They begin to call out, by undoubted discontent, for pastures new.

The field is then visited by sheep, who are the next most selective members of the livestock population on the farm. They too will do a great deal of promenading round the field choosing the grasses which they like, and they are not the best of graziers in consequence. Their dung and urine, however, have great activating qualities, and although analytically the chemist may tell us it is more or less the same as that of any other animal in so far as it contains a proportion of lime, nitrogen, phosphate and potash, the bacterial contents of the sheep's dung are definitely different from those of the dairy cattle, and seem to have some rectifying, balancing quality which keeps the organisms left by the milking cattle in their proper place and subjection. Consequently it is important that one should copy nature's system by having different livestock to succeed one another—hence the use of the sheep.

I am going to refer presently to the economics of all these animals, but for the time being, I will deal solely with their manurial, refertilizing and activating values.

Following the sheep, we have the beef cattle. These are, in my view, the ideal graziers, for they come along with their big broad muzzles and sweep every tuft of grass before them. They do not appear to have the same fastidious discrimination for one plant as against another, perhaps because their sense of smell is not so acute or their taste not so highly developed, perhaps because they have never received, as breeding stock, much—if any—of the factory made concentrates, which are—in my opinion—the real cause of the dairy cows' dietetic fastidiousness. Whatever the true cause, the fact remains that the Galloway cattle are the finest mowing machines in the world for sweeping down the whole of the vegetation on a field. They eat almost everything, and appear to like weed as well as they do the grasses and the clovers.

They are great servants of the farmer. The Galloway cattle, as a breed, have other merits in that they thrive on poorer herbage than any other cattle in the world, even including the Highland cattle from the mountains in the west of Scotland. There are no cattle anywhere so hardy, none which will live on such poor fare, nor any that will give such a return to the farmer for the food with which they are supplied.

Although they will live on such tack, and do well on it, I doubt whether there are any cattle which will respond more rapidly to good feeding. They put on weight amazingly well, they carry a minimum of bone, and when they go to the weighbridge for their final test they surprise everybody by the enormous weight that they yield, with a killing-out percentage much higher than that of any other breed. Our Graders say 'they weigh like lead'.

As the salient points of breeding beef cattle are not nearly so well known to farmers as they ought to be, I feel sure I shall be forgiven if I set forth the generally accepted characteristics which the beef animal should possess to give the best returns to both breeder and feeder, and finally the butcher.

In general the beef animal should be well covered with flesh and very blocky and compact (these last two points tend to reduce the proportion of bone present). Good development of the muscles and fat over the hind end and along the back (producing a broad back) means a high proportion of valuable cuts, provided the neck and fore-end and brisket are not over-developed. Meat should extend well down the legs to reduce the

proportion of waste bone. All bone should be fine wherever it is clearly seen. For example head, horns, legs and tail; for coarseness in these parts is taken to represent coarseness in hidden places. No bones should be at all prominent, e.g. loin, hooks, pins, shoulders—because the bones are hidden not by the frame being under-developed but by a good covering of meat.

I am well acquainted with all our beef breeds of cattle in these islands. They are the finest in the world, but I know of none which better conforms to the above standard of excellence than the pedigree Galloways, and this in every detail. Later in this chapter I will give the Smithfield record to show how favourably they compare with all the other breeds of beef cattle.

It is our practice to breed nothing but pedigree Galloway cattle, and to sell the females to other breeders for breeding purposes when they are a year or two years old, and to keep the best of the bulls for sale for breeding. The bulls which do not come up to our standard of excellence are steered and carry through to the finishing of beef about which I shall say more later.

Now we come to the most interesting class of livestock which we have on the farm—the thoroughbred horses. They too, provide their own contribution to the refertilizing of the farm. Of this too I shall have more to say. After these we have the poultry.

This branch of our farm is not so highly developed as I one day hope it may be. It has scarcely been developed at all during the war because of insufficiency of labour and general war-time difficulties. Similarly we carry as a rule an adequate number of pigs. So far as pigs and poultry are concerned, I believe that every farm should only carry so many as will consume the second and third quality corn which is not suitable for milling or first-class feeding. The real function of both pigs and poultry on the farm is to act as consumers of waste material. If corn has to be bought to sustain either pigs or poultry then their role on the farm is uneconomic.

All this variety of stock works in one with the other, each performing its part in refertilization, each consuming a class of vegetation or food which may not be liked by one of the other species. In this way the whole of the farmer's platter is licked clean and sound economy effected. Any farmer who is a monoculturalist, whether of crops or of one selected class of livestock, is not farming as he ought to farm. Nature nowhere believes in monoculture and monoculture should not be practised by any farmer.

Let us now consider the respective merits of each class of livestock, beginning with the thoroughbred horses. When the average reader learns that we are thoroughbred horse breeders he will conjure up for himself an idea that we are fancy fanners—dilettante farmers—rich men who have more money to spend than they know what to do with. I would like to disillusion my readers on this point.

We breed racehorses for no other reason than that we hope and expect they will contribute to the general financial results of the farm. If they failed to do this, then so far as we are concerned, we should have to go out of racehorse breeding. If I were to answer the question, 'Is this a good line to go in for?' by saying simply yes or no, without a considerable qualification, I should be guilty of misleading. If a man has a considerable knowledge of the families which go to make up the stud book of the thoroughbred horse-breeding industry; if he is a very good judge of a horse; if he understands the commercial side of marketing those thoroughbreds; and of placing those horses into the hands of the trainers who can serve him best; if he understands these things, and perhaps another score of things, all more or less necessary to the success of thoroughbred horse breeding; then I say 'Yes, undoubtedly horse breeding is a very profitable line.'

In other words, all those qualities which make for success in any human affairs are needed in measure overflowing to make farming successful. If a man knows his job thoroughly; if he knows most of the moves in the game; if he is competent in every detail; if he is indeed a master man, then his business, whatever it be, will be profitable. This applies to racehorse breeding as it applies to everything else. If, therefore, the farmer has the knowledge that is needed and, in addition, a fair amount of capital, he can embark upon the breeding of racehorses in the hope and expectation that he will do well out of it.

Again, here I might be asked, how much would you have to spend in order to get in a good mare. And I would here say that you might be lucky enough to buy a good mare of the highest class for perhaps as low as 500 guineas. Equally, you might have to pay 10,000 guineas for that same mare.

There is no scale or yard-stick by which these animals can be accurately judged. There are certain families in the stud book which are known to be great breeders of winners, and among these families is 'the No. 1 Family', in what is known as the Bruce Low Numeral Pedigree Chart. This family, No. 1, is by far the best winner breeding family in the stud book.

Mares of this strain are difficult to come by. You might spend ten or even twenty years in search of a mare from this line of breeding, and you would only eventually get one by great patience and probably by paying a very high price.

There is only one way of making thoroughbred horse-breeding a sound economic proposition, and that is to have a knowledge of the blood line that one wishes to follow, and if it is classic breeding then it is the No. 1 Family, for this family contains more classic winners than any other, or even of any group of families put together.

If a farmer is determined to go into classic stock, then he will have to buy a No. 1 family mare. That will take some finding and, when found, the price may be a heavy one.

If a man founds a stud and is fortunate enough to get hold of the right kind of mare which, mated with the right stallion, will produce one winner after another, he can send his yearlings into the Newmarket or the Doncaster sales, and expect racing owners to bid very high prices for them.

Prices as high as 13,000 guineas were paid at the sales at Newmarket in 1944. On the other hand, there were some animals sold very cheap. It sometimes happens, of course, that some of these low-priced horses will win races. Even so, to buy them is a gamble. It is better to have the odds in one's favour by buying animals of good pedigree and outstanding individuality.

The history of racing shows that a high price does not necessarily mean that you have bought a good animal; equally, low prices are no bar to your buying a winner. It is a most inexact science—if science it be—you need a great deal of experience, a vast amount of knowledge and considerable judgement.

Then, after you have bred your animal, you sell it at a sale in the *hope* that it will go into the hands of a highly competent trainer. He, again, *hopes* that he will have the good fortune to place it in the right kind of race, and that the horse will be ridden by a very able jockey. And then perhaps you may—after some years and all these contingencies—be able to record that you have bred a winner.

It is a great gamble, but there is a fascination about horse racing which is many hundreds of years old. In fact I think that the origin of horse racing is deeper into the roots of our soil than any other form of sport. It is probably going back some thousands of years—this inherent love of the horse and the charm we experience in seeing horses race. It is something that we, as a nation, will probably never be without. It has an irresistible attraction and the more insecure the whole business seems to be, the more it appeals to a vast multitude of people.

No discourse on racehorse farming could be regarded as comprehensive which failed to indicate in figures the financial records over a long period of the racehorse industry—for a great industry it is indeed.

EXPORTS [1]

During the past sixteen years English thoroughbreds have been exported to forty-three countries:

	Thoroughbreds
1925-8 (inclusive)	5,499
1929-32	4,061
1933-6	3,941
1937-40	3,733
	17,234

Total: 4,284,169 Guineas.

[1] Bloodstock Breeders' Review.

YEARLING SALES 1925-39

	Guineas	*Average Guineas each*
1925	320,460	983
1926	344,990	1,061
1927	323,810	996
1928	398,130	1,157
1929	499,953	689
1930	300,965	447
1931	212,359	314
1932	217,959	355
1933	259,984	384
1934	409,741	601
1935	412,694	570
1936	412,346	565
1937	345,603	454

1938	340,280	476
1939	124,866	315
Total	4,924,340	

DECEMBER SALES 1925-39

	Guineas	*Average Guineas*
1925	353,287	464
1926	446,776	547
1927	389,206	506
1928	478,427	570
1929	319,220	398
1930	233,254	300
1931	163,528	193
1932	142,793	218
1933	164,329	218
1934	196,543	293
1935	207,276	290
1936	239,964	301
1937	218,369	279
1938	242,279	287
1939	111,599	
Total	3,906,850	

Total Sales, 1925-39 inclusive, is:

Yearlings	4,924,340 Guineas
December Sales	3,906,850
	8,831,190

And now for the dairy cattle; I am taking the livestock in the order of their importance, placing the horses first. The dairy cattle come second. They deserve this because of their financial contribution to the farming revenue.

We have had thirty years' or more experience of dairy work. It is the one branch of the farm which is a veritable treadmill—for seven days a week, and for fifty-two weeks in the year, and for every year of your life. Any farmer who ties himself to this task is assuming one of the most tiring and trying responsibilities which farming can provide. I recommend no one to go into dairy farming who is afraid of hard work.

This being so, it may be surprising that there are so many people engaged in it, for I believe I am right in saying that there are more farmers engaged in the dairy practice than in any other branch of livestock husbandry. There is only one explanation for this. Most farmers are inadequately supplied with capital, and they are seeking for something which will provide a quick turn-round of money. The dairy farmer enjoys this advantage more than any other type of farmer. He gets a monthly cheque, which helps to pay his wages and to cover some outgoings : without it he would need many thousands of pounds more capital. That is the one and only reason why there are so many people engaged in dairy farming. It is not because it is always immensely profitable, as I shall try to show. Some lines of it are anything but that.

In East Lothian and in Yorkshire, and many other agricultural counties, the dairy farmer is looked down upon; he is an outsider, so many think, and is spoken of not as a farmer, but as a cow-keeper. Men who refer to him like this know the trying restrictions and responsibilities associated with the dairy and they will not be bothered with it.

After thirty years' experience, it is the one branch of farming that I loathe and hate more than anything else. There is more trouble with the health of the dairy animal than with that of any other livestock. The restrictions which are quite rightly imposed for the production of clean milk are very exacting; then, the hard work associated with milk production, the long hours and the perennial toil of it all, early and late, are such that it becomes the most detested job on the farm.

Still, it is profitable if it is well managed. I believe I can throw a little more light on this subject than most farmers, for the reason that the average farmer does not keep adequate books to ascertain the cost of any of his acts of husbandry. At Chute we think we do, and we do know what a gallon of milk really costs us.

It is our experience that common milk, even if produced on a well-managed farm, gives little or no margin of profit. We are quite satisfied that if all the costs of the depreciation of the cow, and everything else is taken into consideration, there is no profit in the production of the ordinary common graded milk.

We therefore went in for 'attestation'. We did more than this; we elected to produce a superior quality of milk altogether, and that was the reason why we left the Friesian cows many years ago, and went in for the Channel Island breed.

With them we get every benefit both for healthy high quality milk, and also for a high percentage of butter fats. Claiming premiums on all points, we find ourselves selling (wholesale) milk at something like 8½d. per gallon more than is received for the ordinary common grades. We find, furthermore, that the exact profit we make on running our dairy herd is precisely what we get by way of premiums.

This would seem to suggest that the ordinary common milk can do no more than just pay its way, and that if the farmer wishes to make a profit he can only do so by going for all the premiums that are available for producing a better grade of milk product. This is as it should be.

In my view the farmer should not be encouraged to produce any kind of muck in the form of milk, and such milk production ought to be made diminishingly profitable. This would compel every farmer to produce a better grade, and as he improved his product he ought to be correspondingly better paid. On such a system the milk side of farming could be better remunerated.

In my opinion, although farmers stick to milk production as tenaciously as they do, milk is marketed throughout the country below the cost of production; and farmers are only milk producers because of the *necessity of receiving that monthly cheque.* That may be the real reason the nation is getting milk as cheap as it now does.

It is a state of affairs that ought to be remedied, and without loss of time. If I were on the council of the Milk Marketing Board, the one thing that I should demand would be that greater premiums should be paid for all kinds of 'attested milk'. If that were done, every farmer would soon see to it that his cattle became 'attested'. The health of our livestock throughout the country would rise. Milk production would no longer be, as it now is, the most hated job on the farm, but would attract better farmers and better farmworkers, and would soon be better organized throughout.

So much has been written by almost countless pens on the subject of the quality of milk and the desirability of obtaining a product which is safe for human consumption, that I almost hesitate to add any words of mine. But as the subject affects both the public and the farmer alike, a few words may not be out of place and I intend to emphasize briefly certain features which ought to be brought to notice.

Milk is so peculiarly constituted that it presents an ideal breeding and living background for all classes of mischievous micro-organisms. It is a food of the highest class, but it is so delicate and accessible to the action of germs that it needs to be produced under the best possible conditions. And when I refer to these conditions, I have in mind not only that the cowsheds and the milking parlours and the dairies should be scrupulously clean but I am also reflecting more on the health of the animals themselves.

After a very wide professional experience of farm surveying I am shocked to recall the conditions under which tens of thousands of cattle are expected to live and the dirt and filth in which they are sometimes compelled to wallow. I am shocked, too, when I read that 80 per cent of the cattle which pass through our markets are diseased, and again, when I read, as I did during the month of April 1945, of the shocking disclosures made in the House of Lords by Lord Bledisloe and by several other peers, when he introduced a motion on the subject of disease in dairy cattle. Milk is a most precious food and yet a great proportion of our dairy cattle appear to be suffering from very serious diseases.

The public, the farmers themselves, and the Ministry of Agriculture, should combine to create a comprehensive scheme whereby, as a first consideration, healthy cattle will eventually become the order of the day. Satisfactory surroundings in which to produce milk should be the second consideration. Moreover, a well-balanced price, if necessary subsidized, should be paid to the farmer in order to justify him taking all the utterly necessary precautions to produce a food for the public which will carry with it the threats of tuberculosis and a host of other complaints when fed to our children.

I cannot stress this point too strongly—it is of the utmost importance to the farmer himself that he should be made to realize how his very existence as a dairyman is threatened unless he can quite speedily produce a food which is beyond criticism. So long as we have such debates in either House of Parliament as that to which I have referred, a debate which was founded upon unassailable facts, the farmer cannot be happy in the knowledge that this information is going to spread far and wide among his consuming public.

In Britain the quantity of milk consumed per head is far below that which is recorded for America. There, strict regulations are everywhere enforced, and only milk from farms which comply with them is eligible for public consumption. The British farmer may think already that he is hampered and surrounded by

regulations, but believe me they are nothing compared with those which are in force in America; and the Americans are right for it is not in the interests of the farmer that dirty milk should be put on the market at all. Farmers who fail to comply with a very high standard of hygiene and health in their cattle should not be allowed to sell their milk to the public. That is a blatant fact and the sooner it is faced the better it will be for the dairy industry, as well as for the health of the public.

I have this to say about milk production: if a farmer determines to be a milk producer he should go in for the better class of cattle, such as Jerseys, Guernseys or Ayrshires. These three breeds, in my opinion, are the world's best dairy cattle. I say, moreover, that high milk yields should not be the objective, that the cattle should be normally fed, and not pushed to produce their maximum. So treated, the dairy cow will have a longer life, and mastitis and other diseases will quite quickly disappear from our dairy herds.

Mastitis in particular, I maintain, is the product of unduly high milk yields achieved at the expense of the cow's constitution. This is a grievous mistake, and one which calls for urgent remedial measures in dairy management.

Another thing which I would like to record, so that it can be checked by my readers' own observation, is my strong preference for the Jersey and Guernsey cows. There is a variety of opinions about this, but no matter what class of stock is in question, whether it is racehorses or Jerseys or Guernseys or Ayrshires, the discriminating buyer sees to it that he gets hold of the families that are the known best performers. If this is done with Jerseys and Guernseys, these breeds are, in my opinion, the most economical in the world. The best families give an amazing quantity of milk, and of a richness in butterfat which cannot be equalled by other breeds. So far as our own farm is concerned we have never had a reactor to the Tuberculin Test among the Jerseys. This is surely a gold medal for that breed as against all others.

The next class of cattle which engages my attention, and my admiration, are the pedigree Galloway Beef Stock. This animal is one which I like very much indeed. It claims my admiration first of all because it will, literally, live on the poorest vegetation to be found. The natural habitat of this noble beast is the region covered by the south-western counties of Scotland, extending from the Clyde to the Solway Firth and including the counties of Kircudbright, Wigton, Dumfries, Ayrshire, Renfrew and Lanark, together with a number of the border counties and the four northern counties of England—that is the home of the Galloways and is their real home. In these highlands, in those wild valleys and glens of the Carrick country, you find these long-haired fellows sometimes a bright long-haired black, at other times a lovely dun; there you find him, knee deep in water, living on lichen and grasses of low feeding value, or, as some of their admirers say, living on scenery and fresh air; thriving, rearing their calves, living to ripe old age, eventually themselves turning up at the butcher's block, and comparing well with all the other breeds in winning the championships at Smithfield and the Edinburgh fatstock shows.

This grand animal, almost a scavenger on the farm, lives on the roughest vegetation the Almighty has sent to sustain him. He is the animal of my choice when we come to the beef breeds, for I have found that he not only lives on my wild windswept downs over 800 feet above sea level, without any protection at all; there he lives and he thrives. But I have also found that when I have some good food, he responds to this with alacrity and puts on flesh at a rate which is really dramatic. He feeds to considerable weights and the quality in the meat is without equal. At three years old he is of the same standard as the finest of all our breeds. In fact, there is nothing more illuminating than the last returns in 1938 of the Smithfield Club's Stock Record—these are as follows. This table shows that steers between twenty-four and thirty-six months old run in the following order:

	cwt.	qtr.	lb.		
Sussex			14	2	11
Devon			14	1	14
Galloways			14	0	23
Aberdeen Angus			14	0	6
Hereford			13	0	17
1st Cross			13	1	7
Shorthorn			12	2	25
Highland			12	3	20

Here it will be seen that the Galloway cattle are clearly among the highest in the list, actually beating the Aberdeen Angus, the Hereford, the Highland, the Shorthorn and the First Cross.

This result tells the world more clearly than any argument which are the best beef cattle, and there is no animal which compares with the Galloway for economic beef production combined with quality of meat. This steer stands at the head of the list, and he appeals to me, particularly for the farm which we occupy,

because of his ability to withstand wintry conditions better than any other animal in the world. The very best of the heifers and bulls which we breed we sell to other breeders— those that are of superb quality; and all that are even slightly below that grade we turn into steers and feed to the fatness demanded by the butcher's block.

They give the utmost satisfaction. They are free from disease, according to our experience, tuberculosis is practically unknown amongst them, and they are hardy to a degree.

The men love them. I have yet to find a stockman who had an unkind word to say about the Galloways. There are those, of course, who believe that the Galloway Shorthorn cross, which produces the famous blue-grey, is an even quicker growing animal than the pure bred Galloway, but this is not our experience.

We think that the pure-bred Galloway is just as quick growing as his first cross, although the latter is indeed a noble beast and much liked by the butcher. The pure-bred Galloway produces less bone, kills out to better meat percentage, and is just as heavy in total weight at three years as the best of the other breeds, or even heavier, according to Smithfield returns, than the first cross blue-grey.

I regard the blue-grey, however, as one of the finest cattle, and so do all the butchers. I believe that he holds a premier place in the estimation of most butchers. Those, however, who are acquainted with the pure Galloway like him equally, if not better.

Another very important characteristic of Galloway cattle, possessed to a degree without comparison with any other breed, is their ability to stand feeding in the open stockyard. When all farm buildings are so derelict and out of date as they now are on every farm, the make-shift stockyard is a matter of necessity. This means that, at best, one can do no better than erect a stockyard in some reasonably sheltered place on the farm, where there is water, and where, with four strands of barbed-wire and posts, an enclosure can be cheaply and quickly created. The Galloway with his rich, double, thick coat will stand outside eating his food in apparent comfort, will build up weight, and genuinely thrive all the better for these outdoor conditions, which are far better for him than a stuffy, smelly, unhealthy, covered yard. Our animals live outside all their lives. Calving takes place in December. The calves live with their dams, and never know indoor conditions until they reach the butcher's block.

As a sheep farmer the Scotsman leads the world. In particular the Scottish border farmer is perhaps the world's best sheep farmer, and I recommend my pupils, when they leave this farm, to go to a Scottish sheep farm for a period of at least eighteen months, so as to learn the secret technique of the way the Scotsman produces his sheep and, so I believe, produces them at a profit.

Sheep farming, so far as we are concerned here in the south of England, is generally admitted to be not a very profitable line. Some carry sheep, many do not. At one time you could not go over the Hampshire and Wiltshire Downs without seeing a flock of sheep on every farm— to-day you can take a journey of a considerable distance and perhaps not see a single sheep. This is unfortunate, because the value of the sheep to this particular class of land is undoubted; but the fact nevertheless remains, as almost every farmer has to record, that they are kept at a serious loss. But the Scotsman seems to make a profit—I am afraid I cannot explain how this is so, but, as I say, my pupils probably will be able to find that out for themselves if they spend two years with the border farmer.

In the Border-Leicester-Cheviot first cross or half-bred—as he has now become to be called—the border farmer has produced an animal which I think is probably the finest sheep in the world. This sheep is one of the finest breeding ewes I have ever seen. We like to cover them with the Hampshire Down or Suffolk ram. Although we have no flock of sheep at the moment at Chantry, we have had them, and when the war is over I hope we shall have another flock of half-breds to take its part in maintaining the fertility of this high land. They will be chosen from the border country, and I hope that I may be able to find a border shepherd who will come and look after them. The sheep should have a place on land such as we occupy, and I hope that the National Farmers' Union and the Government of the day will so organize sheep products that sheep can be kept at a profit; although at the present moment the dice are rather heavily loaded against the sheep farmer.

The next items with which we have to deal on this farm are poultry and pigs. Pig population, as well as the poultry, is down to a minimum. For this there are two reasons: one, because we have not much waste food; two, because we have a hopeless insufficiency of labour. When labour is in control of the situation as unfortunately it is now, we have to cut our coat according to the cloth. But the pig and the hen are very important in the refertilization of a farm; their dung and their urine have a great value. They have a corrective influence upon all the other classes of dung that are dropped about the farm, and I favour the pig and the hen because of that value.

I do not advocate, however, highly specialized poultry farms, or highly specialized pig farms. Of all the mistakes that can be made in agriculture, I think these two are the greatest blunders, and I have seen so many

failures of them in the last thirty years that I would like to record here how much I disagree with the view that this class of farming can be made a success through specialization.

In the days before the war, the pig and poultry farmer had something of a harvest, while the wheat grower was at a great disadvantage. World prices were low, and because of that, poultry food was cheap, and so was pig food. If world grain prices are stabilized, the only wheat that will be available to feed pigs on will be the seconds and thirds from the threshing. This means that every farmer should carry a *minimum* of livestock of this kind, only sufficient to use up the waste grain that he receives from his threshings. In this way he will produce eggs, poultry and pig meat on an economic basis, they will make their contribution towards refertilizing the land. This is the way, I think, that both pigs and poultry should be dovetailed into the general farming programme. I do not care what figures may be provided by people to justify the monoculture of the one class of livestock or the other. Livestock should only be kept in so far as they fit into the complete scheme of the farm.

CHAPTER XV

THE VALUE OF GRAZING; THE RELATIONSHIP OF CLOVERS TO GRASSES; THE ABILITY OF CLOVERS TO FEED THE GRASSES WITH NITROGEN; THE INTERDEPENDENCE OF MANY SPECIES OF STOCK

Compost making is an inevitable process on a farm which produces, as we do, some fifty ricks of straw in the year, besides all the vegetable waste of every kind from the ditches, the hedgerows, roadsides, woodlands and various other places, all of which should be turned into compost. Compost is invaluable whether it is shallow-ploughed or disked into the arable land, or used as a surface dressing for the oncoming grasses and clovers.

The mechanization of compost making is the way by which it can be economically performed under modern conditions, when wages are such a serious item in the cost of running a farm.

At the same time there are other methods of building humus into the soil, and these methods need to be studied with a view to finding maximum economy in farm management. There is no method of manufacturing humus better than the four years' ley, and grazing that ley with a mixture of livestock in a highly scientific way. I propose very briefly here to set out a few practices so that farmers, who may not yet be familiar with the management of leys, can see how this is done on this highland farm.

The value of, and the scientific reasons for the periodical grazing of pastures containing large mixtures of clover (particularly wild white clover and American sweet clover), are the subject of discussion and writings by many authorities.

I am speaking purely and simply from my own experience as a farmer. One of the important functions of clovers generally, especially the wild white, is to form a dense sward, so that in the summer soil temperatures can be reduced and the humus can be preserved, it being a well-known fact that humus is most readily dissipated during the intense heat of the summer months. Uniformity of growth is always influenced more by temperature than by rainfall. Then, closely associated with the grazing management is the problem of the way in which nitrogen is collected by the bacteria in the nodules of all the clover plants.

One needs to know, at least in an elementary way, how that nitrogen, collected by the clover plant, is liberated for the benefit of the grasses with which the clover is growing. As long as clover growth continues to be unchecked, there is little or no nitrogen liberated into the soil, either for the benefit of the soil, or for the advantage of the competing grasses. Nitrogen collected by the bacteria in the root nodules is used at the outset by the clover plant almost entirely to promote its own growth. The more nitrogen that is available to the plant, the greater the leaf surface in the clover; and the greater the leaf surface exposed to the light, the more carbohydrates pass to the bacteria in the root nodules, and of course this is their living food. The more the carbohydrates pass to the bacteria, naturally, the greater is the amount of nitrogen collected by those bacteria. When, however, grazing animals begin to take part in the proceedings, and cut short the plant's life, somewhere near the crown of the plant, there is a suspension of Nature's processes for the time being, and something very serious happens to the clover plant as a whole; in other words, it receives a rude physical shock. When this happens to the plant the supply of carbohydrate to the living bacteria is cut off for the time being, the nodules suffer a great change, and actually change in colour. Many of them drop off their root stems, and are accommodated in the soil, and a large amount of nitrogen which they contain is then, for the first time, liberated into the soil, and becomes available for the benefit of the competing grasses.

From this it will be seen that close grazing affects the amount of nitrogen the grasses can obtain, and it also shows to the farmer the importance of grazing a mixed sward of grasses and clovers, so that the sward can be enormously developed and the fertility of the land be greatly increased, not merely by the dung and the urine of the cattle, but by the taking of nitrogen from the air and by making it available to the soil and, through the soil, to the competing grasses.

Furthermore, if a sward is adequately controlled, grazed efficiently, and quite heavily grazed, but not over-grazed, the clover plants can be allowed proper time to recover and begin building up their system of nitrogen forming afresh; but if, on the other hand, they are hit much too hard, they may become weak and the full benefit of their presence in the sward is lost.

Another interesting point which must be of concern to farmers is the amount of nitrogen that a clover plant will put into the soil. The actual quantity is bound to vary enormously according to the conditions that may be prevailing, but it is claimed that, under favourable conditions, a cow will consume something like

150 lb. of the green herbage of wild white clover in the course of some eight or ten hours' grazing; and that with her assistance an acre of good wild white clover is capable of collecting from the air and fixing an amount of nitrogen equivalent to about *half a ton of sulphate of ammonia dressing.*

It is even claimed that American sweet clover, which is regarded as the greatest of all leguminous nitrogen formers, actually contributes a greater tonnage of nitrogen to the soil than the wild white. In any event, it is simple for every farmer to understand that—provided he knows how to control and will take a great interest in controlling his grazing—he can get from the air in an organic form, a greater quantity of nitrogen than he ever dared apply in the form of sulphate of ammonia, an inorganic salt which kills his earthworms wholesale.

The proper understanding of the part that clovers play in our leys cannot be too closely studied by every modern farmer. He must try to learn that only when the clover is grazed and nipped down nearly to the crown, does it become the great servant to the soil that it should be. This is elementary, but it is important.

The next thing is to be sure of providing a greatly varied assortment of animals to succeed one another and to promote, through dung and urine, the activation which is effected by various kinds of bacteria. The desired result is sheet-composting, or humus formation in its most economic and efficient form.

MELILOTUS ALBA

Sometimes known as Bokhara Clover, at others as Huban Clover, but much more generally known as American Sweet Clover and widely spoken of by beekeepers as Honey Clover, this important member of the Leguminous Family deserves an exclusive niche in the hall of fame.

Although almost unknown to English farmers, this Melilot is the oldest individual in the clover tribes. Its history is shrouded in the far distant records of the past, for it was well known to the Chinese farmers of four thousand years ago.

In China it was grown extensively and its great virtues gradually extended its sphere to the adjoining Mongolia. Travelling westwards skirting the great Himalayan Divide, its progress and reputation continued through Persia, Arabia, to the shores of the Levant, along the coast of the northern Mediterranean, eventually finding use among the farmers of Italy through several centuries.

Somewhere about the year 1750, a quantity of sweet clover seed was exported to America, and in a comparatively short space of time its wide use, still travelling westwards, continued to the Pacific coast. Today its range covers regions as far north as the Arctic and as far south as the States of Central America. In fact so adaptable is it to every clime it would appear that its potential range is almost boundless.

In the United States it flourished with such freedom that it got out of control. It would spring up in the middle of a road which might be but little used, and break up the road surface with its deep-rooting power. It would appear as from nowhere on abandoned pit-hills and public dumps. It invaded private gardens, and was such a ubiquitous feature of the countryside that it was regarded as Noxious Weed Number One, and became so universally hated that two-thirds of the Governments of the States in the Federal Union passed laws for its effective extermination. Road-men were vested with special powers of trespass over private property to destroy it wherever they saw it growing.

Then, one day, someone decided to test this plant for the feeding of stock. It was found, so long as it is eaten young, that is, before it is eight or nine inches tall, all stock liked it, including horses, although they do not take to it as well as other livestock unless it is in a mixture with other grasses. If it is mixed they will eat it readily. Pigs seemed to graze it greedily and do well on it. Sheep too thrive on it, and cows like it as fresh fodder, as ensilage, and as hay.

Well, well, well, here was a noxious weed turned into a primary fodder crop, and it was, in the course of time, sought by everybody.

At one time Alfalfa (our Lucerne) was America's and Canada's principal fodder crop. To-day sweet clover holds that position.

It has, moreover, many advantages that lucerne does not possess. It is much more easy to establish. It is well known to most English growers that lucerne cannot usually be successfully grown without inoculating the seed with the necessary bacteria. Lucerne has not attained popularity among English farmers because of this difficulty. Sweet clover, however, establishes itself anywhere, and once it has been grown on land, lucerne will grow as a crop on that land following sweet clover. There would appear to be some bacterial affinity between these two legumes where sweet clover, with its robust constitution, prepares the land with all those living organisms without which lucerne cannot successfully be established.

Like lucerne it is one of Nature's subsoilers, but out-herods Herod by being far more vigorous than lucerne can ever hope to be.

It is a biennial, and in its second year of growth goes down into the bowels of the earth to an incredible depth, with thick vigorous roots. These break up the subsoiling pan and grow thereon nitrogen forming nodules. The roots decompose after two years. The resulting humus enriches the soil and becomes a moisture reservoir in so doing. The figures of atmospheric nitrogen accumulation in the soil which eminent American authorities attribute to the growing of a single crop of sweet clover are so fantastically extravagant that I hesitate to quote any of them. But I do not imply any doubt about the scientific findings of our botanical friends on the other side. Far from it. From my own observations I can state that there is no legume grown in England—not even our highly valued Kentish Wild White and Aberystwyth S.100—that can compare with American Sweet Clover in the nitrogen fertility that is left behind. It ought to find a place in the farming scheme of every agriculturist in Britain to his permanent good in the improved fertility and general usefulness of his soil.

During the past three years I have had a large number of visitors to this farm, and so many applications for seed of Melilotus Alba, that I am now growing this plant regularly for seed production with a view to meeting this demand.

Throughout America I have seen this legume growing everywhere, and over there farmers are universal in their praise for it as a fodder crop and as a fertilizing medium.

The methods by which I recommend its application to my theories of humus farming might here be recorded.

First, it is used as an ingredient in my big mixtures, usually in amounts of not more than four or five pounds to the acre. This quantity shows itself quickly, for it grows more rapidly than anything else in the sward, either grasses or clovers. In its early stages of growth its reputation for sweetness is well maintained. It is most palatable, for the stock eat it readily. It is punished fairly severely in its first year of growth, and although its presence is in evidence it never attains the vigour of development that is seen when it is more kindly treated in its first year of life. By dying out in its second year, it gives place to those more slowly growing species, thus performing the valuable function of providing quick fodder in the early stages of the new sward.

Secondly, I use it as a fodder crop. For this purpose I usually sow ten pounds to the acre in the spring in my rye crop, after the rye has received its first spring grazing. The rye is then allowed to go forward to seed. The sweet clover establishes a very vigorous and strong plant, and grows exceedingly in the thinned out crop of grazed rye. The growth is so good that when the rye is harvested, a proportion of sweet clover goes into the butts of the sheaves. This calls for reasonable drying in harvesting the rye; the sweet clover, however, does dry out quite quickly, and presents no difficulties. There will generally be a fair growth as aftermath following the harvesting of the rye and this can be either grazed or made into silage.

The second year is the great revelation, for growth starts early. The previous year's considerate treatment in the very early stages, followed by either grazing or cutting for silage, encourages at this stage of the plant's life considerable tillering. Each crown becomes the centre from which spring a large number of new strong shoots. With the oncoming of April these show exceptional growth, and by the middle of that month, or even earlier, the first cut of high-protein silage can be made. A second cut can be made in four or five weeks. And throughout the season—governed by the season itself—some four or five cuts for silage can be made. Each growth should be cut at eight or nine inches high.

There are other, and perhaps more important, possibilities that should be noted.

The first cut might be very heavily grazed with cattle or a mixture of livestock—on the quick 'on-and-off' method, using a large head of stock. Harrow the droppings of the stock as soon as they are taken off. Then allow the next foot of crop to grow. Cut it with the mower, and let it lie. Allow the next crop to grow through this lying layer. Cut that and let it lie. Meanwhile, with rains, the first cut will be well on the way to decomposition, the animal droppings and urine being used as activators, and sheet-composting of the quickest, cheapest and most effective type is here set in motion. Continue to cut each succeeding growth in the same way throughout the season, and at the end of October, after the last cut has been made, plough under the whole accumulation of sheet compost. Allow the whole to lie, undisturbed, until the middle of March, so that frost and snow may do their part in Nature's cycle, then cross plough, and on that soil the farmer will grow a crop of potatoes which, for both quantity and quality, will startle the natives, will make him a compost farmer for all time, and cause him to cancel all his contracts for artificial manures that he has ever made.

Here is Nature seen at her best, and the farmer carrying on a system of husbandry working with, instead of against, all her handiwork.

It is common knowledge that many cultivated areas in the tropics have lost much of their original fertility through their having borne a single crop, such as rubber or tea, over a long period of years and through mistaken agricultural practices in the past, when the chemist's prescriptions were regarded as infallible. Sweet clover could be used to renew the fertility of those much abused properties. And by following this technique.

Grow sweet clover between the trees, cut the crops lightly the first year, allowing the vegetation to rot where it falls. Cut the crop still more heavily the second year, never letting it be more than twelve inches tall, again allowing the cut to rot where it falls.

That, however, is not all. It has been established at many scientific stations throughout the world that if a green crop is grown on land that may be deficient in any one of the seven ingredients of plant structure or general health and make-up, and that crop is ploughed back into the soil on which it is grown, there is a tendency for the deficiency to be accentuated to the detriment of subsequent crops.

When, however, the crop is passed through the innards of livestock, a biological change of the greatest importance takes place, for the animals' dung and urine, which act as biological activators to all the living organisms of the soil, causing them to breed and increase their activities for the preparation and conditioning of plant food, the results are entirely different: deficiencies are reduced or eliminated, greater fertility occurs, humus is formed from an animal origin outside the soil, and a true balance in the earth, both chemical and biological, is obtained.

The tea planter, and his friend the rubber planter, must keep livestock in a stockyard, and must spread ten tons to the acre of Indore prepared compost, *after* the first cut of sweet clover. This is the only activator of an animal origin that is required. It will breed untold millions of the necessary fungi, aerobic and anaerobic bacteria, and all these, acting upon that grand crop of sweet clover accumulating on the surface of the soil, will make the humus that this much abused soil is in need of, will make good all deficiencies, and produce healthier trees and greater crops of better quality.

Send the chemists and soil scientists home, let them go to school again, and learn biology, and try to forget their inorganic chemistry.

We must not overlook the part that various animals play in supporting one another's health and in the economical consumption of foods, one species eating what another will leave behind. At Chantry we have noticed the readiness with which our Galloway cattle will eat the straw which comes from the boxes of our thoroughbred mares. For some time I was mystified as to why, when there was good hay available, the cattle would often go and eat dry urine-salt-saturated straw. Eventually, however, I saw an article on the feeding materials obtainable from the air in the *Farmer and Stockbreeder* by Mr. J. A. B. Smith of the Hannah Dairy Research Institute; he refers to urea which can be derived from the atmosphere, and which has not so far been used as feeding stuff in this country. Experiments have shown that under certain conditions it can function for ruminants as effectively as oil cakes, but Mr. Smith emphasizes that under existing conditions in Britain the addition of urea to rations will probably be of little value except where carbohydrates are present in excess.

Mr. Smith, with whom I had some correspondence, was able to account for the fact that straw from the thoroughbred boxes is preferred to hay by my Galloway cattle. 'I should think', he wrote in reply to my inquiry, 'that the explanation almost certainly lies in the fact that the straw as it comes from the boxes is impregnated with urea and with many other substances which are probably present in roughly the right amounts to render the straw much more readily available to the masses of bacteria in the rumen. The straw is therefore probably more appetizing and more readily digested.'

This is an interesting subject and will only further emphasize the part that Nature intended all animals to play, one with another, to keep the soil and vegetation in good and healthy balance, so that all can live, and the soil and the plants can remain in robust health.

To illustrate the interdependence of one species of animal upon another in the wild, I tell the story of the Canadian northern bear, for which I am indebted to Mr. Thomson of the Kingston Clinic, Edinburgh.

'. . . a Canadian hunter, while undergoing a fast, had told me about hibernating bears. According to the folklore of the hunter these bears are highly intelligent animals, able to build hide-outs which even an acute observer (if he is not an experienced hunter) cannot detect although he may be standing on top of one. These bears, during the summer, live principally upon fish and grass, but in the late autumn the bear suddenly changes all his feeding habits and for some time he stuffs himself with hay, twigs and pine needles, along with moose and caribou droppings.

'By this time his flesh, which was repugnant when he went to sleep, has become sweet and is considered to be the greatest delicacy of the north.

'Mr. Lynch was able to get two of his friends, who were Canadian Government biologists, interested enough to make investigations for him.

'All hibernating bears are partly vegetarian and graze freely among caribou and moose. As the suckling stage comes to an end, the cubs are weaned on grass. This grazing is never completely dropped, although, in adult life, the major part of their food is fish—salmon preferred. When these become scarce they eat pine cones, needles and twigs, along with droppings, as reported. At this stage they are still very fat and when they retire within their den the bowel is packed with vegetable matter. When an animal just settled for the winter was shot and the bowel opened the stench was described as "overpowering"; the flesh "nauseating, fishy and unfit for food". By the spring the bear's flesh has undergone a complete and remarkable change. It has become "the most sought after of all northern foods". Very little residue is found in the alimentary tract. But most amazing of all: "The bowel was odourless and quite sterile. No cultures of any of the usual intestinal flora or bacilli could be obtained." '

It will be seen from this interesting story of wild life how very interdependent we all are, one upon another.

The earthworm is the greatest servant of all; and then we have the bacteria, the micro-organisms and the fungi in the soil. As a result of the combined activities of all these living forces humus is formed and accumulates. Humus, in its turn, produces the sustenance of healthy living food for the denizens of the soil, and these in turn provide the food for plants upon which both man and beast can live.

All these processes of living existence are necessary for every one of us. This is the discipline of Nature. Nature has been described as a vast spontaneous universe moving in its own right according to its own order. In the spontaneous world of Nature order is manifest.

All the disease and disorder on our farms are the result of man's interference, because his acts of husbandry have been undertaken without regard to Nature's laws and examples. We need new thoughts. In other words, we shall achieve nothing until we have a new way of thinking.

A new knowledge of our universe is in the process of germination. The world will soon learn that the soil, the plant and animal, are woven together in a vast balanced cycle. Ignorance of this living balance leads man to abuse and destroy it.

A full understanding of all these important interdependent happenings will make the wise farmer determine that he will do nothing in his farming which interferes with this regular cycle of Nature. If he does so, he knows the chastisement which awaits him, for Nature demands her toll when she is grievously outraged.

Note by Sir Albert Howard

'The preference of Galloways for horse urine impregnated straw, reminds me of a common practice in the Orient—the dung of horses is used to feed the buffalo (the milch cow of the East).

'What a lot our nutrition experts have to learn and unlearn!

'How important it is always to ask the animal, and of course the plant.'

CHAPTER XVI

9,000-GUINEA BULLS; INCOME TAX; ARTIFICIAL INSEMINATION

I have been frequently asked by agriculturists, and by townsmen equally, to explain away the unreasonable and even ridiculous prices that have been realized during the last year or two for pedigree bulls. The impression that the townsman gets is an unfortunate one because he imagines that these prices indicate what the farmer realizes for his all various kinds of livestock. Unacquainted as he is with agriculture the townsman does not understand the great difference between a really high-class pedigree animal and some of the nondescript stock to be found on many farms. The false impression, therefore, is created that the farmer has been enjoying an unfair measure of prosperity, during the country's hour of need, and suggests that he is taking a mean advantage of the country's difficulties. No picture could be more misdrawn, and it is my intention in this chapter to analyse some of the prices that have been paid and to give what I believe is a true reading of the state of affairs in this particular regard.

During the last war, and during the present one no less, there has been an influx of wealthy industrialists into the ranks of agriculture. Some of these gentlemen find themselves possessed of immense sums of money which they are trying to sink in the purchase of livestock and farm properties because there are few other places where they can conveniently and safely place it. Many of these men, however, during the present exigencies are much more far-seeing than most people and, in particular, much more discerning about the incidence of income tax. For an example, I will take an imaginary case and call him Sir Thomas Blank.

Sir Thomas Blank has attended public auction sales and bought, say, three bulls, one for 4,000 guineas, another for 3,000, and another for 2,000, making a total of 9,000 guineas in all.

The townsman naturally asks whether a bull can be worth all that money, and the bewildered farmer equally asks why on earth does anybody pay such a price? Yet there is sense in this apparent madness.

Sir Thomas Blank has an income of something like £100,000 a year and with war-time taxation he pays 19s. 6d. in the pound. Having very large credit he borrows 9,000 guineas from his bank (assuming he has not got this sum of money lying idle) and in the course of about three or at the most four years writes off the whole of this sum in depreciation at the rate of 3,000 guineas a year. He is able to deduct these 'losses' from his taxable income. In fact, Sir Thomas Blank arranges for the Chancellor of the Exchequer to make him a present of three of the finest bulls alive.

If he paid 30,000 guineas for the bulls it would not matter to Sir Thomas Blank because the Chancellor would still pay the bill. This expedient, however, is only possible for those people only who are liable to high rates of taxation and is not open to the ordinary farmer.

I am not suggesting for one moment that Sir Thomas Blank is doing anything illegal; on the contrary, the Finance Act as it now stands is so framed that Sir Thomas Blank is doing nothing more than taking advantage of its framing. He is legally entitled to do so, and this Sir Thomas Blank is only one instance of a very large number of alert-minded industrialists who have come into the agricultural world during the war, bought expensive farms, equipped them with expensive machinery, carried out extraordinary repairs and improvements regardless of cost, and stocked the farm with the best livestock obtainable, knowing that the whole enterprise could be, more or less, paid for, thanks to this anomaly in our taxation.

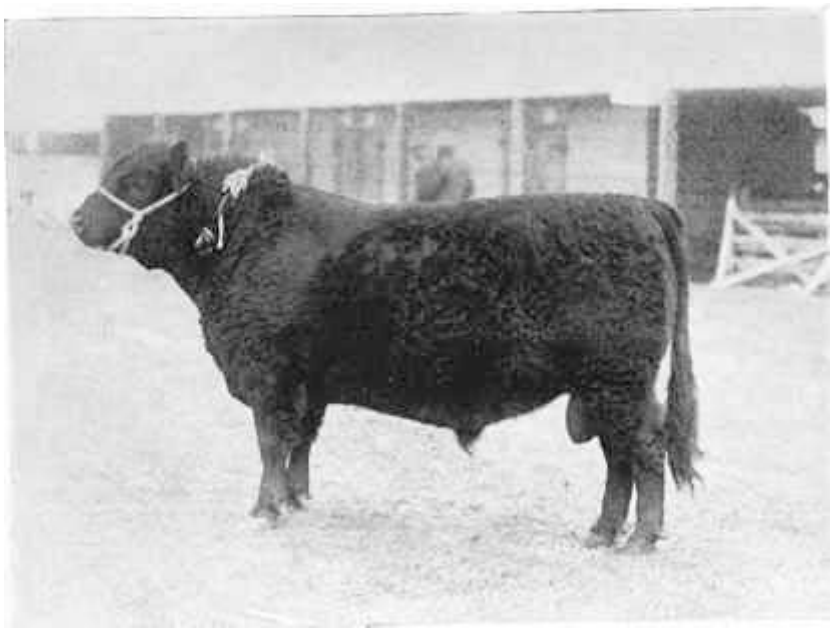
Those farmers who are fully aware of what is taking place are very resentful that their own personal poverty keeps them outside these exclusive practices and are envious, obviously, because their credit at their banks will not provide such facilities for them. If banking credit were equally available to the farmer, the farmer could do likewise. Banking credit, however, although more liberal at the moment than it has been for a long time, is not so unbridled that he can indulge in things of this kind and, furthermore, he is not always a payer of sufficiently high taxation and would not, therefore, be able to write off these expensive bulls, machinery, improvements, etc., so easily.

Let us examine whether the farmer is on the whole benefited by these very high prices. Clearly, these prices only apply to the most exclusive stock of which there is no superabundance, and those farmers who are in the position to breed such good class stock are immediately brought into the E.P.T. limits of taxation. This means that probably the whole, or nearly the whole, of the prices that are realized in the sale of these bulls is handed to the Chancellor of the Exchequer anyway; so that when this is the case, and I submit that it is the case in many instances, the Chancellor of the Exchequer after all is really not buying the bull but the breeder of that bull is in effect just giving it away to Sir Thomas Blank and substantially is getting little or

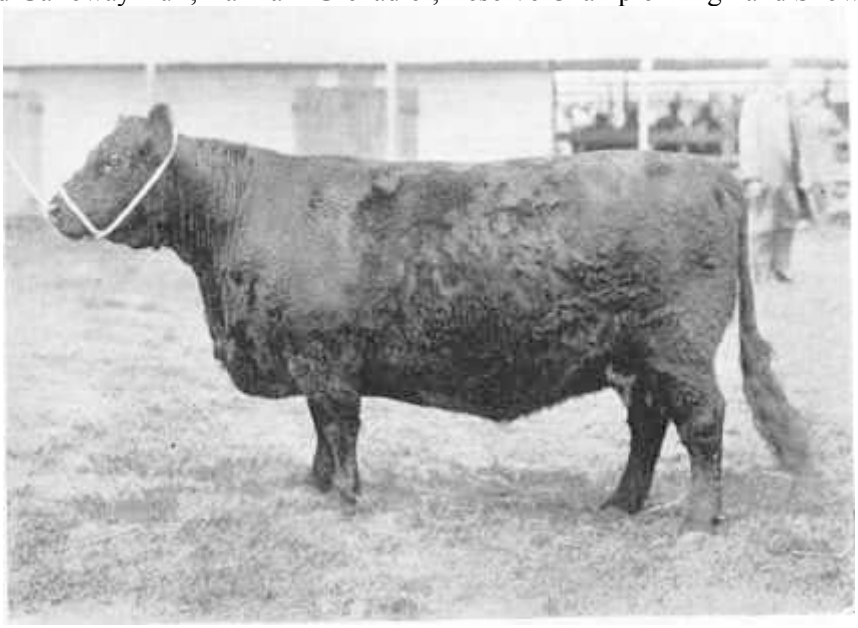
nothing out of it. So we have the alert-minded industrialist or financier invading the sacred precincts of agriculture, jumping on the back of the farmer and living on his fat during the war as he so often does during the peace.

32. Mike III. Galloway Steer. Born 5th January, 1930. Age, 1 year 10 months 3 weeks 5 days. Weight 12 cwt. 44 lb. Bred by W. Hyslop, Knockycoid, Barrhill. Property of James Craig, Holmston, Ayr

33. Eleven-month-old Yearling Galloway Bull



34. Two-year-old Galloway Bull, Barmark Grenadier, Reserve Champion Highland Show, Dumfries 1938



35. Galloway Matron. Elsie 2nd of Scroggiehall

These high prices for bulls prejudice the farmer in the eyes of the townsman who is given a false impression of the farmer's real prosperity. This, however, is not the only dire consequences to the cause of agriculture. Perhaps the worst feature of all is that they have raised the price of our good class pedigree stock as a whole to such figures that the farmer himself cannot go to the pedigree markets any more and buy a useful breeding bull at a price he can really afford to pay; and hundreds of small farmers all over the country have been forced into the dilemma of either buying a 'scrub' bull—thus depreciating the general level of their stock—or, alternatively, going to the artificial insemination centre and buying so many tubefuls of semen. This practice may prove to be one of the most mischievous that so-called scientific agriculture has ever dared to play with. It is one of the results of the artificial economic conditions which I have outlined.

If the livestock market can be left alone and if these interlopers from industry who are often more bent on amusing themselves and on seeking refuges for their capital, than really and genuinely interested in agriculture itself, there is a sufficiency of good-class bulls for the whole of the livestock requirements of the country. Of all the population of animals born, approximately 50 per cent are bulls and 50 per cent are heifers, and if the livestock population can be maintained and increased, as it can be, through the female

supplies, it can be more easily maintained through the male contribution. The high price of milk, however, is persuading tens of thousands of farmers to send their bull calves to the market at 30s. a time when they are but three days old. Nobody is encouraged to rear a bull for breeding purposes because the high cost of rearing with milk makes it uneconomic unless he has some favourable parentage with high milk yields or other achievements. So we have these troublesome economic factors bearing upon the problem from several angles, all resulting in the farmer eventually making use of artificial insemination as the cheapest system of maintaining his livestock.

How, and in what way, are we likely to suffer as a result of this venal practice?

Since Charles Darwin laid the foundation for the study of the various phases of animal behaviour in his classical work on the *Descent of Man,* much research has been devoted to this very interesting and absorbing theme. That cynical contemporary of Darwin's—Carlyle—crudely abused his work, describing it as the 'Gospel of Dirt'. Darwin's great achievements, however, have survived the test of time while the withering cynicisms of Carlyle have long since been forgotten.

It was Darwin who first recorded the fierce battles and strange antics which characterize many of the 'lower orders of creation' when under the exaltation of sexual emotion, and he maintained that these manifestations were fraught with tremendous consequences to the species.

The facts which he brought to light have led to interminable discussions by subsequent scientists which unfortunately are still not as widely known as they might be. The Victorian mind had a curious false modesty about the discussion of sexual details, either in reference to human beings or to animals. To most people of that time, therefore, this discussion was forbidden fruit, but a courageous minority, who ate thereof and were expected to maintain a discreet silence, found it difficult to remain altogether dumb. They spoke, whenever they ventured into discussion, in veiled language, and it was only through art and poetry, classical literature and the drama that accurate knowledge reached the light of day—even so the subject had to be discussed indirectly.

Now, according to Pycraft, we are told 'that the stuff of which living things are made is called "protoplasm". Textbooks of physiology give its chemical constituents with fearsome accuracy, and each of these constituents can be isolated in the laboratory, but "all the king's horses and all the king's men" cannot build them up again into living matter. The consistent inconsistency of protoplasm defies us; every statement we make has to be qualified by reservations and saving clauses. Its permanency is attested by its endurance through millions of years, yet we are daily reminded of its evanescent nature. Its power of reproducing itself according to type none can doubt, yet no two individuals are exactly alike.

'This line of inquiry, then, takes one back to the simplest living things, among which there is neither marrying nor giving in marriage, neither birth nor death. Life is reduced to its simplest terms—a speck of animated jelly is all that confronts one, and this is only to be seen under the high power of the microscope. It has neither mouth nor organs of digestion; no visible means of locomotion are traceable, and the special senses of sight and hearing are wanting; but taste and smell, of a nebulous kind, are there. Shape it cannot be said to have, for its bodily outline is constantly changing, thereby it moves. A long tongue of its jelly-like substance—of protoplasm—is thrust forward, and the rest of the body is, as it were, dragged after it. Whatever animal or vegetable matter it passes over, in the course of its wanderings, is drawn up into the semi-fluid substance of this diaphanous body, and its juices are extracted, the undigestible residue being left behind in the course of the morning's walk! In due time it becomes adult; further growth is impossible. When this stage is attained a strange thing happens. A certain minute, more solid portion of this body, which lies in the very centre of the mass and is known as the nucleus, begins to assume an hour-glass shape. Speedily the constriction becomes apparent across the whole body and, rapidly increasing, cuts it in two, as if by the tightening of some invisible thread. Here death is cheated, and records of births are unknown! And just as there are no parents so there are no children. But a foreshadowing of what is to be occurs even here. For every now and then two individuals, to all appearances identical, meet and promptly begin to merge the one into the other till they become one flesh. Here is the most primitive form of marriage in Nature. And here, in this union, or fusion, of separate entities of germ-plasm, we have the beginning of sex. Such unions are common among these primeval forms of life.'

At another point Pycraft goes on to say, 'After the instinct to feed the two most powerful are the desire for self-preservation—the avoidance of danger—and the desire to mate. These two are the dominating instincts throughout the rest of the animal world, not even excepting man himself. 'The tremendous power of "mate-hunger" has been overlooked by a strange confusion between cause and effect. Almost universally its sequel, the production of offspring, has been regarded as the dominant instinct in the higher animals. This view has no foundation in fact. "Desire" for the sake of the pleasure it affords, and not its consequences, is the only hold on life which any race possesses. And this is true both in the case of man himself and of the

beasts that perish. Wherever this instinct becomes weak, or defective, extinction speedily and inevitably follows. This "amorousness" is the motive power of "courtship" wherever it is met with; manifesting itself in the eccentric, and often grotesque posturings, or in the loud and often musical cries which constitute the study of courtship. Intensity of desire is indispensable to survival. . . .

'The desire for sexual intercourse is met with only where the co-operation of two individuals is necessary to ensure the production of offspring. Such individuals being free to roam, must have some incentive to seek one another at the time when their germ-cells have attained maturity. And this incentive is furnished by the glands in which these elements are produced: supplemented by the secretions of certain ancillary glands. These stimulating juices, known as the "Hormones". . . .

'But if we owe our existence to the gratification of what may be called our lower instincts, it is no less certain that all that is best in us we owe to our offspring. We meet with the beginnings of altruism, which the begetting of offspring entails, far down in the animal kingdom, and it attains to its full perfection in the human race. Here only, in its best and truest sense, love begins: though affection may be found, and in a high degree, in many of the lower animals. . . .

'Those whose business it is, for one reason or another, to study these emotions know well that "mate-hunger" may be as ravenous as food-hunger, and that, exceptions apart, it is immensely more insistent in the males than in the females. But for this, reproduction in many species could not take place: for the sexes often live far apart, and mates are only to be won after desperate conflict with powerful rivals no less inflamed. Thus it is idle to speak of an equality between the sexes in this matter, in regard to the human race. Dogmatism, and the frequent repetition of pretty platitudes, will not alter what Nature has ordained.... The male is dominated by the desire to gratify the sexual appetite; in the female this is counteracted by the stimulation of other instincts concerned with the cares of offspring. . . .'

Elsewhere Pycraft says that 'the secondary sexual characters of the female are chiefly negative characters, the absence of those which are conspicuous in the male. She retains more of the primitive characters of the race. This is the rule in regard to the animal kingdom. Wherever we desire to find the onward tendency of evolution, the latest developments of the race, we turn to the male; when we desire to learn something of the past history of the species we turn to the female and young. This standard, of course, yields by no means uniform results, for we find every gradation of progress on the part of the latter, till male and female and young are externally indistinguishable.'

From the foregoing it will be seen that when we interfere in Nature's own methods, as we are undoubtedly doing when we play tricks in the name of science and give it the 'high falutin' title of Artificial Insemination, we are taking 'rash and hazardous' liberties and may be called upon for a fitting chastisement. It is quite impossible to visualize the form in which this punishment may be meted out either to the present generation who began this iniquitous practice, or to the succeeding generations who have to inherit the results of our misdemeanours. It may well be that the male, in this case the bull, may decline in usefulness and capabilities of a glandular character which cannot be visualized, while in the female there might well be somewhat corresponding glandular reactions even so extreme as to involve the complete drying up of the ovaries themselves.

The underlying emotions which Darwin and Pycraft emphasize and which are as much to be found in the animal kingdom as in human life, cannot be entirely disregarded by man, and the practice of artificial insemination may have disastrous effects which none can foresee. It is interesting to note that at the artificial insemination centres they are experiencing a variety of troubles already. The bulls are refusing to work and are becoming obstreperous. To overcome this the veterinary surgeon inserts his hand inside the rectum of the bull and works upon his organs, thus compelling him to drain his semen without the usual muscular activity which in Nature accompanies such ejection. It is a revolting practice which the veterinary surgeons concerned simply hate to perform. They are finding, however, that the bulls are refusing to work and recourse to this disgusting expedient has been found necessary.

The female, too, finding no reciprocal satisfaction such as the usual sexual orgasm provides, in the course of generations—and perhaps in very few generations—will cease to take an interest in 'conception' and become equally difficult to persuade to go on breeding. In fact, the directions in which failure can take place are so many that they could only be adequately considered in a very long chapter.

My experience in dealing with nature as I have found it on the farm, both as regards animals, and the living plant, and the living soil, shows that so long as we leave nature very much to herself she usually takes best care of her affairs. It is when man, with his artificialities, begins to interfere in the soil, in the plant, in animals, and in humans, that troubles begin.

Viewing this extending practice of artificial insemination, not from a moral standpoint alone, but from the point of common physiological knowledge, I feel sure we are playing with fire. I am familiar with all the

arguments that are put forward about the grading up of our livestock, and theoretically I am in complete agreement with every well-founded aspiration that will attain this end. I am not, however, in sympathy, or prepared to support, without qualification, practices which are dangerously artificial; we have to look no further than the Thoroughbred breeding stock of our country to see what may happen.

For some three hundred years Thoroughbred breeding has received more attention than has yet been devoted to cattle stock of all kinds put together. One has only to consult the *Annual Stud Book Returns* to learn that something like a third of the mares at stud are reported barren each year. This is unassailable evidence that all is not well with the Thoroughbred industry, and yet this has been conducted by people of the greatest skill using meticulous care to breed the best of animals regardless of expense.

Although there are still to be found in the Thoroughbred Lines a goodly number of individual horses of great racing qualities both as to stamina and speed, 80 per cent of the horses that are bred every year are so utterly worthless that they might as well be shot as sent to a racecourse to try and win races. This deterioration in our Thoroughbred stock is very real and while a few breeders do succeed, thanks to their great knowledge of breeding and rearing, in producing good stock from certain lines of blood, in the greater part of the Thoroughbred population it is very poor stuff indeed.

It will, therefore, be seen that the pitfalls lying ahead of the breeders of pedigree cattle stock are many and that when they begin to restrict the number of blood-lines on the male side, as is the inevitable practice at the artificial insemination centres, they may eventually find, as the Thoroughbred breeders have found, that nearly all their animals are related to one another, some of them carrying as many as seven crosses of the same line of blood. This is definitely not breeding for permanent constitution and cannot be for the good of any breed.

Three hundred years ago there were three hundred different bloodlines in the Thoroughbred breeding stock on the male side alone, with a larger variety of blood-lines on the female side. To-day the whole of the Thoroughbred breeding stock, male and female, has been reduced to three families—Eclipse, Herod, and Matcham—and of these 95 per cent belong to Eclipse and the remaining 5 per cent is divided between Herod and Matcham. This is what intensive selective breeding is bound to develop into.

The value of a dairy cow is based on her ability to produce so many thousand gallons of milk and so much butter fat per annum. All the breeders have got this high-yield-and-high-percentage-of-butter-fat 'bug' in their brains, and in the future they are going to patronize only those bulls—those very few bulls—that are backed by these record breaking figures. This means that the lesser important performers in milk production and butter fat are not going to be bred from on the male line, and we are going to intensify matings with the record-breaking champions.

According to my experience, high milk yields, coupled with mischievous factory-made concentrate feeding, are the present cause of much of the disease to be found in the dairy stock to-day. This weakness is going to be further intensified by inbreeding with the inevitable result that the constitution of the beast will be further depleted.

From every point of view, therefore—moral, physiological and economic—artificial insemination may bring in its train the complete undermining of the health of our livestock—if not its ultimate extinction.

PART II

CHAPTER XVII

GREATEST SCOURGE OF THE FARMING INDUSTRY

The foregoing is the heading of an article which appeared in the *Farmer's Weekly* on 12th November 1943. A famous veterinary surgeon, Mr. H. W. Steele-Bodger, past-president of the H.V.M.A., when addressing the Farmers' Club, is reported to have said:

'Contagious abortion is the greatest scourge that affects the farming community. We have been striving for control of it for years, yet even now there are some gullible farmers who believe that they can find a cure out of a bottle.'

There was no known cure in spite of the many highly coloured advertisements. If half the money spent by the farming community on quack remedies had been spent in urging the vets in trying to find a cure, then they would have been much better off and might have been nearer a remedy.

In a paper read by Mr. J. R. Lawson of the Veterinary Laboratory at Weybridge, at the same meeting, bovine contagious abortion was said to be the cause of an annual loss of 40,000,000 gallons of milk.

Mr. Steele-Bodger said that he knew of no disease that farmers were so loath to admit to in their cattle, as abortion. He will admit to Johne's disease, or to anything else, but never to contagious abortion.

I am giving this subject some degree of pride of place in the pages of this book because I believe that contagious abortion, as well as mastitis, Johne's disease, tuberculosis, foot and mouth and the rest, are all intimately associated with soil fertility and that the land fertility is responsible for life-sustaining food which in turn will build up well-nourished cattle able to resist disease. Once the disease appears, however, the farmer is faced with the problem of building up the fertility of his farm and eliminating the disease at one and the same time.

First and foremost, it is important that the nature of contagious abortion should be understood. The egg from the female's ovaries, after passing down the fallopian tube, locates itself on to the wall of the uterus by some grip-like appointment. This act is technically called nidation. The egg remains *in situ.* When she is served by the male, the spermatozoa find their way through the cervix and into the uterus where they travel round in search of the egg. One sperm only is successful in penetrating that egg and conception takes place.

In the meantime, there are millions of spermatozoa floating about in the uterus but immediately conception is effective the remaining sperms combine together around the egg and help to form the placenta, and in so doing lose their own individuality and existence. Thus nature, as always, takes care of herself and wastes nothing. The embryo develops day by day drawing its sustenance through the walls of the uterus which is in communication with the maternal blood stream.

The germs of contagious abortion live on one food only, and that is the ligament-like structure attaching the growing placenta to the wall of the uterus. When these germs are present, and especially in the early phases of gestation, they are continuously attacking this structure upon which alone they actually live. If the bodily resistance of the female is sufficiently high, whereby she can continuously replace any material that is consumed by the contagious abortion germ, she may succeed in carrying her foetus the full period of time; but if her resistance through insufficient feeding, or lack of life-sustaining foods, causes drooping health, then the germ makes an ascending progress and succeeds in eating through the complete ligatures which hold the placenta to the walls of the uterus. If this severance is successfully accomplished before the complete period of gestation, the embryo falls into the cavity of the uterus and, being detached from the blood stream, quickly dies, and begins to putrefy. Nature in her wisdom expels it from the mother's body—that is abortion.

If, therefore, a cure is sought for a contaminated animal, the obvious thing to do, after isolating the animal, is to prevent her from breeding. The germ of contagious abortion, not having the food that it needs to live upon, will emit itself from the female's body in the course of time. This is one of nature's own methods of eliminating germs of disease, and it more or less applies to every kind of disease in both man and beast.

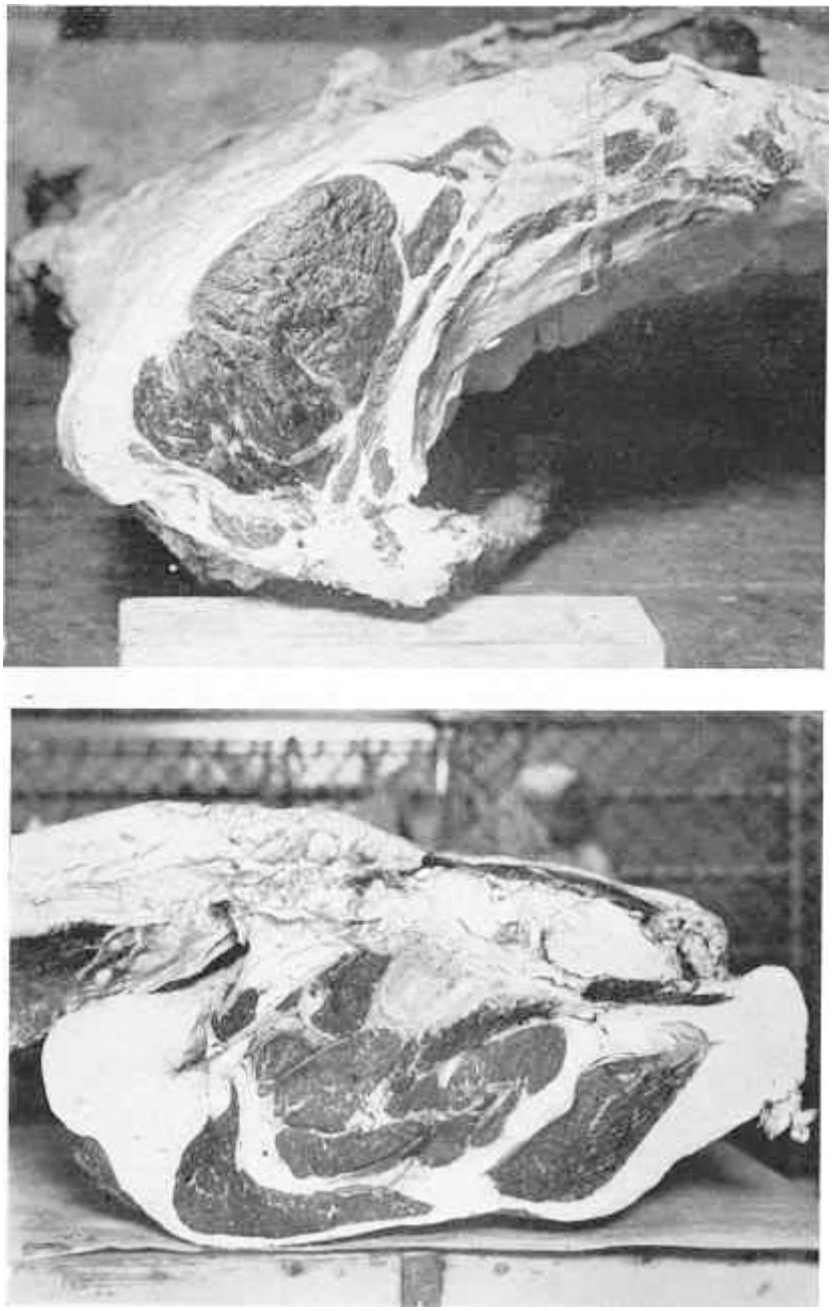
This was the procedure that I followed when I cured my mare Dáil of her attack of contagious abortion. She was isolated and prevented from breeding for a considerable period; during that time her blood stream

became absolutely clean; she built up her own health during this period by eating practically nothing but grass from humus-sufficient land where no artificial fertilizers had ever been used, and when eventually she was put to the stallion she began her breeding life all over again, and in the course of years produced four magnificent foals, living to the age of twenty-one.

When this problem is approached on a very large scale as it must inevitably be if the herd on the farm is a large one, it becomes a matter of considerable skill in management to tackle it effectively. It is by no means easy to cure perhaps a hundred animals which might easily be affected. Isolation is difficult with such a large number and the suspension of breeding interferes with routine management and with income to such an extent as sometimes to bring ruin to the farmer. This, then, is where the skill of modern veterinary science, which has advanced considerably in very recent days, can come to the farmers' assistance.

There are two vaccines at the present time which are recommended by the Ministry of Agriculture. Strain No. 19 is used generally for younger stock and strain 45/20 for adult cattle. I do not pretend to have the necessary scientific knowledge of precisely how these two act and react, but I do suggest to every farmer who has the unpleasant experience of having to deal with this grave disease, that he should place himself in the hands of the most competent veterinary surgeon in his district and take his advice, if necessary having every animal on the place inoculated against further infection. If he will take steps to rid his ground of the contagion and if, at the same time, he will follow a systematic course of feeding, using foods of his own farm growing rather than purchased factory concentrates and if, at all times, he will try to maintain a fair average diet for his animals whereby their bodily health and well-being is maintained at a constant and reasonable level, he will, with the assistance that the modern scientific veterinary surgeon can provide, quickly clear his farm of all the disease. *But he must refertilize with humus—not artificials.*

36. Smithfield Fat Stock Show at Agricultural Hall, Islington Champion Galloway Carcase



37. 'Cuts' from Champion Galloway Carcase, Smithfield

There are many sources of infection, but it is thought that most occurs by the mouth. It might be through drinking water or through foodstuffs which have become contaminated. It is also known that it can take place through abrasions in the skin. The usual way in which a herd becomes infected is by the purchase of an infected cow. It is alleged, too, that infection can come 'over the hedge'. The source of infection is often very obscure and most difficult to trace but it is certain that it comes from an infected source and I for my part am equally certain that the germs only find a habitat in which they can live and develop in the animal whose bodily resistance is below par.

It behoves every farmer to do all he can to rest his pastures when contagious abortion has been discovered; to keep the floors of his buildings clean and disinfected; to take special care about the cleanliness of drinking water and utensils for the carrying of food and also to see that the men who attend on the animals are especially clean and do everything to avoid carrying the infection about the place.

I am not able to say how long the bacteria can retain their viability outside the animal's body but it is certain that they can live for some time. Under these circumstances, everything must be done to help the veterinary practitioner so that he in turn can help the farmer.

With the present development of inoculation, coupled with thorough supervision by the farmer himself, every herd can be cleansed of this scourge providing there is simultaneous care as to foods and as to the humus health of the farm soil. Given these conditions, and when all the recommended measures are meticulously carried through, the disease has been eradicated from a large number of herds in this country and from a still larger number of herds in the United States.

Mastitis

This disease, a farmer said at one of my lectures, was as serious as contagious abortion. With this I do not agree, but I am bound to admit that it is even more widespread and is so serious in its consequences that it can, in the long run, be equally devastating. The methods by which it can be overcome, however, are much easier to put into operation than those for contagious abortion. I am satisfied that the basic cause of this disease is lowered vitality in the cattle themselves, and that lowered vitality comes from the farmer's insistence on the maintenance of high milk yields, notwithstanding a possible reduction in the stamina of the cow, and a too intensive feeding of factory-made concentrates with an insufficiency of the natural rougher foods grown on the farm.

A complete cure of this disease calls for a much more normal and reasonable milk production than the crazy record-breaking which is all the vogue to-day. A reasonable milk production, the use of home-grown food, a raising of the health standard of the cattle, an improvement in humus cultivations and management, as outlined in this book—all these forces, brought together to work one with another, will speedily rid any farm of mastitis.

The same remarks apply to tuberculous cattle. By the same process of elimination by T.T. testing, a herd which is well fed on home-grown produce from humus soil will speedily eradicate the disease of tuberculosis from the farm.

Reduced to very simple language the disease in both man and beast, which is at the present time baffling both the medical profession and the veterinary authorities, unquestionably find their origin in man's abuse of Nature's laws. Until this materialistic world appreciates that biological influences in both the micro-organisms in the soil, and in plant, animal and man, are all important, and man himself abandons his materialistic outlook, there can be little hope that the world will ever be put right.

It is thought by many people to-day that civilization is at the parting of the ways and that we shall either sink deeper into abysmal misery and difficulties, or take hold of this biological situation and restore the balance which Nature calls for. One has only quietly to contemplate man's greed and rapacity in the scandalous way in which he treats his animals, using them as if they were machines instead of creatures of flesh and blood, to begin to understand how, almost without knowing it, he has reached so callous and thoughtless a condition.

Poultry are expected to lay between 200 and 300 eggs a year—this was never intended by Nature. To achieve it, intensive lines of breeding have been studied and much inbreeding has taken place. Feeding experiments have been conducted where heat producing undesirable food ingredients are introduced, all with the one object of stimulating a greater and still greater supply of eggs.

Not content with this we introduce stimulating fertilizers to our soil, kill off the bacteria and the earthworms in millions, upset their natural balance and deprive the plants of a great deal of their lifegiving qualities. This, then, further reacts on the fowl and we have the disease of fowl paralysis and many others with which the poultry of the world are to-day afflicted.

Then we turn to our milking cattle and here again we adopt intensive breeding and stimulating feeding; we at one time thought that a 1,000-gallon cow was a world's wonder, then 2,000 was attained, but now we have got beyond the 3,000-gallon cow and I believe 4,000 gallons has been reached on one or two occasions.

To achieve these ridiculous figures all kinds of trickery have been practised, quite apart from the mischievous inbreeding. We find farmers striving after records, feeding back to the cow its own milk, and thus producing these fictitious results.

We then breed and sell the heifers from this stock and pay high prices for bulls that show these animals in their pedigree. The cow, above all animals, with its four stomachs, is pre-eminently a ruminant and intended to live on the roughages and rough conditions generally out of doors provided by Nature. To-day, many farmers house their cattle for some five months in the year, keeping them more or less closely tied by the neck during the whole of this time, feed them with concentrated foods which the cow's digestion was never intended to deal with, and then expect heavy milk yields, and high butter fats, and, then, in addition,

expect the cow to keep herself free from tuberculosis, mastitis, Johne's disease and contagious abortion. It is indeed difficult to understand why we have not many more diseases, and much more of them than are now recorded; we may be only at the beginning of our diseases, not at the end of them.

Some 80 per cent of our cattle passing through our markets are diseased, and the cost that contagious abortion alone imposes upon the dairy industry is alarming. And the farmer expects to be able to put all these elements right by buying something in a bottle—a chemical compound which some ingenious chemist and a still more unscrupulous company promoting salesman will sell him. He takes all these quick and quack remedies in preference to setting his own house in order by restoring the balance in the soil which Nature calls for.

I wonder if the townsman who consumes the food of the farms has ever stopped to think for one fleeting moment of the effect on his health of the eggs he consumes, produced from disease-ridden poultry. Or the like effect of the milk that is drawn from a cow with tuberculosis, mastitis, contagious abortion and Johne's disease. Is it no concern of the townsman to take an interest in these fundamental matters? Is there any purpose to be served in breeding children, and feeding them with food which comes from contaminated sources? And surely eggs and milk which come from diseased poultry and animals are just as much contaminated as an open drain water supply which runs through a cesspool.

The health of the world is in the hands of the farmer. If he refuses to learn to farm properly and to understand the biological condition of his soil, then there is no hope either for the livestock industry of the world or for the future of mankind.

A continuance of the present lines of chemical farming, and the supplying of alleged deficiencies in the soil by certain remedial chemical prescriptions will take the farmer further down the wrong road to the complete ruining of the earth's surface, and will one day bring the world's soil into the condition we find in the Sahara Desert, the wastes and desolations of Libya, Transjordan, Babylonia and Arabia. All these ancient civilizations succumbed and ceased to exist entirely because their farmers did not know how to farm.

Notwithstanding the alleged advancement of Western civilization, the farmers to-day are carrying on a system of husbandry which is nothing short of the banditry practised by those of earlier civilizations, and can do no other than end in the same result—the complete annihilation of man himself. This is Nature's method of imposing and exacting penalties for the abuse of her laws.

CHAPTER XVIII

REACTIONS—MEDICAL OPINION

The Medical Press and Circular (founded in the year 1839) reproduced an article of mine, 'Will there be a second Black Death?', which originally appeared in the *Veterinary Journal* of an earlier date. This prompted the editors to write a leader, which I am going to reprint here, under the heading, 'The Good Earth'.

'To-day, for the first time in our history (and we believe, for the first time in the history of any medical journal), we publish an article by a farmer on what might appear to be a purely farming problem. But it is, in fact, a problem that raises the most fundamental issues with which we deal. We make no apology for this departure: on the contrary we can only express surprise that we should still have to regard it as an innovation. For if there is one goal on which the eyes of our profession are set to-day, it is health, and the first and indispensable condition of health is that it must be based on adequate nutrition. In common with all other forms of life on land, we depend for our existence on the fruitful interaction of sun and soil, and we are bound up in an inescapable symbiosis that comprehends the humblest of soil bacteria and the proudest of living mammals. The farmer's work is, in fact, an essential prerequisite of our own.

'Soil health, with which our contributor deals, is apt to be taken for granted by the uninstructed. In truth, this assumption is one of the most dangerous that we could make, as history so painfully records. Consider the dustbowls of modern America that have developed with such appalling rapidity within the last few decades. And lastly, let us consider what has been happening in our own country in recent years.

'But first to examine an apparent paradox. It is beyond question true that the public health has enormously improved during the past hundred years. Sanitation and epidemiology have made tremendous strides. The advance in surgery since the discovery of general anaesthesia, and of both medicine and surgery since the epochal discoveries of Pasteur, has been phenomenal. Many of the captains of the forces of death have been subdued or vanquished. We have our asepsis, our vaccines, our sera, our X-rays and insulin, our penicillin and sulphonamides, all of them great and literally vital advances. We have stamped out or brought under control many sources of danger, and we have prolonged human life by a decade or more. 'But is that the full story? As Lord Teviot pointed out recently, in a most revealing debate in the House of Lords, side by side with all this achievement has marched an increasing array of minor, though often crippling, disorders, amounting in the aggregate to an enormous total. Millions of money represented by the work of hundreds of thousands of doctors, nurses, technicians and chemists are constantly engaged in grappling with this problem. Hundreds of thousands of hospital beds have to be provided and maintained—indeed, if we include the employees of drug manufacturers, the personnel of the retail chemists' shops, the health workers and visitors, and other public health employees, the clerical staff of hospitals, the porters and wardmaids, the ambulance drivers, and so on, we must compute an army, engaged in this conflict, many times the size of that mobilized to repel the Spanish Armada!

'How is all this to be changed, if it can be changed at all? This is no easy question to answer, but we may say, in general, that there are two main lines of attack—by pressing forward with preventive medicine, and by pursuing the quest of "positive health". And, of all the factors that go to constitute the latter, diet, as we have stressed already, is the dominant one; perhaps, too, it may play a larger role in the former than we now suspect. Diet, that is, meaning not only the type and quantity of the food we eat, but its essential quality—a question that our investigators take, far too often, for granted.

'About one hundred years ago the great German chemist, Liebig, laid the foundations of a process that has since had an immense effect on the agricultural practice of Europe and America. This was the stimulation of plant growth by the application of chemicals to the soil. This method spread more and more widely until to-day it may be said to be universal in the West. This chemical treatment of our soil seemed at first to do nothing but good, particularly when only used in an auxiliary role. Yields were greatly increased as the technique of application was improved. But in later years, since it has become more and more the method of choice, other factors have thrust themselves on the notice of our agriculturalists. Disease, both of plants and animals, has greatly increased, and more and more pressure has had to be applied to the soil to maintain its yield. Recently, diseases of stock have assumed alarming proportions, and the very existence of our dairy herds seems to be threatened by one of them, contagious abortion, alone.

'The conviction that something is very wrong has grown more and more irresistible, and recent years have seen new researchers taking the field, of whom Sir Albert Howard is the chief apostle and protagonist. He believes that nature's cycle must be restored if the soil, and the animals that derive from it, are to regain

health. That cycle may be epitomized by saying that all that comes from the soil must go back to jt_vegetable waste and animal excretion alike. By special treatment (composting) of these wastes humus is made. Unlike many chemicals, humus does not depress, but stimulates the biological flora of the soil, and especially those fungi—the mycorrhiza—that seem to bridge the gap between soil and rootlet, and whose presence in increasing numbers gives a mounting index of health. Humus, too, it is believed, holds much of the moisture of the soil, preventing alike soil dropsy or dehydration. By means of composted humus, Howard and his co-workers not only claim to restore vigour to the soil, but produce plants of vastly improved quality and flavour that are, moreover, resistant to disease.

'From our point of view this last is a crucial point. If Howard's claim be well founded—and there is much evidence that it is—then by the restoration of its natural pabulum plant resistance can be greatly exalted. If chemically nourished plants be defective in certain vital resistance-conferring factors, then it is but natural to assume that animals fed on such plants will similarly lack resistance, and that human life, parasitic on both plant and animal, will share the same defect. Conversely, human life nourished on the products of a healthy soil should exhibit greatly exalted resistance.

'What evidence is there of this? Again, much that is suggestive, but we must beware of arguing too much by analogy. There are many factors to consider. But apart from McCarrison's classic and, one might add, conclusive experiments, to which Lord Teviot referred in the debate in the Lords, there are many striking phenomena which one cannot overlook. The diet, for example, and the enormous disparity in physique and sickness-rates between the Northern Indians—Sikhs, Pathans, and Hunzas-—and the peoples of the South. Or the Prince Edward Islanders described by Lord Geddes, in his acutely analytical address in the same debate, as "an extraordinarily vigorous and active population, and quite remarkably the only social organization composed of Western Europeans, which has not shown in the last fifty years a really sharp fall-in the birthrate". These islanders lack cities; they carry on mixed farming "using muck and the products of the sea".

'Vigour, fertility and resistance. These are the qualities we seek. Are they to be ensured dietetically? What has modern dietetic research to say? So far, one must admit, very little. Piecemeal research on this or that vitamin complex goes forward, and here and there one or other fragment of the mosaic of knowledge falls into place, mostly from the chemical viewpoint. But the great design still by much eludes us. That is surely because it consists of a fusion of pictures superimposed one on the other. There is a physical picture of the world and a chemical picture of the world, but there are also ecological and biological pictures of the world, and these, for our present purposes, represent the final and dominant synthesis. To base our nutritional policy on our present rudimentary—and mostly chemical—knowledge of dietetics, and in particular, to denature foods, and to claim to restore them by the addition of a few laboratory-made vitamins, has always seemed to us an example of hubris that may yet be fittingly chastised. Lord Teviot's friend, we are told, preferred to take his vitamins with his knife and fork and spoon; we can only add that he has our sympathy. It would be a simple matter, one imagines, to break up and analyse a battery and fail to discover the electricity—suppose one to be ignorant of its existence. The analogy need not be pressed.

'For our part we hasten to associate ourselves with Lord Teviot's demand for a Royal Commission to inquire exhaustively into the whole matter, and we call on the new Ministers of Food and Health to lend their support. In this purse-proud capitalistic age, soil fertility is our own true capital, and soil health the only sure and lasting prop of public health in its widest and truest sense. We place the issue before our readers, not for the first time, to stimulate their interest and enlist their support. They will hear more of it; we can be sure of that. For whatever way we look at it, health begins in the soil.'

CHAPTER XIX

QUESTIONS AT MY LECTURES

In company with Lady Eve Balfour I gave an address to three hundred of the West Sussex Tomato Growers on the advantages of composting for tomato cultivation at Worthing in January 1945. As is well known, tomato growing under glass is a highly scientific branch of horticulture. The tomato plant grown under these artificial conditions is a very sensitive and delicate organism. Forced with artificial heat and the heat of the sun through the glass, it has been subject to a very large variety of pestilential ailments. To combat these the assistance of the chemist and the 'spray merchant' has been called in for many years and the technique usually adopted by all the growers without exception is the sterilization of the soil by formaldehyde or by steam. From this sterilized soil the grower *hopes* that his succeeding crop, by the grace of providence, will be freer from disease than the crops of the previous season. He has quite a variety of sprays and treatments to assist him to combat all these troubles but, notwithstanding all that he does the pests still come, the diseases are uniformly prevalent and tomato growing is recognized as one of the great horticultural gambles.

Speaking as a compost man I confess the anxieties of the tomato grower are beyond my understanding for if he would but prepare compost with a considerable degree of thoroughness and would abandon the use of artificial fertilizers altogether, the sterilization of his soil would be quite unnecessary, and the certainty of a crop without pestilential visitations would be something the tomato grower could depend upon every year.

I frankly told my audience that I was not a tomato grower, but that I felt sure that the technique which I followed for ordinary farm crops could, with slight alterations perhaps, be easily incorporated into their scientific scheme. They would get an even greater weight of crops and of a quality such as they had never known before.

All this, of course, sounded too good to be true and altogether much too simple. It is a curious thing in life that man seems to delight in performing the simplest of Nature's task in the most complicated way. Tomato growing for instance, in my view, presents very few greater difficulties than the growing of the ordinary farm crop. Even allowing that it is growing intensively under glass there is no reason whatsoever that a serious basic departure should be made from ordinary farming technique.

The great capabilities of compost for moisture-retaining qualities alone justify its application to the soil on which the tomato grows in the hothouse. This fact would appear to be almost entirely overlooked.

It is true that the West Sussex growers are very big users of cow dung and all these growers make such a demand on the local supplies that cow dung in the year 1945 costs 37s. 6d. per ton at the farm, after which it may have to be carted as much as ten miles to the growers.

In addition to the dung the tomato grower uses nitrogen and phosphates, with exceptionally heavy dressings of potash. The use of potash is considered necessary for a variety of highly scientific reasons. And then the potash has to be supplied at one time, the phosphates at another, and the nitrogen at another, but even with all this so-called scientific care and 'messing about', the pestilential troubles come and sometimes ruin the tomato grower.

It can be easily appreciated, therefore, that I was speaking to a large audience of doubting Thomases when I told them that the whole of their growing programme could be easily simplified if they would but make and use compost and abandon artificial fertilizers altogether. At question time naturally I was 'for it' and so too was Lady Eve Balfour who had also been recommending the use of compost. When she admitted that she was not a tomato-grower and a doubt was expressed about the efficacy of the claims that she and I were making on behalf of compost, a gentleman from the back of the hall got up and said:

'Mr. Chairman, I would like to say a few words in support of the speaker. During the past few years I have heard a great deal about compost and a year or two ago I bought Sir Albert Howard's book *An Agricultural Testament* and I became impressed with the possibilities of the use of compost. I made the compost according to the prescription set out in his book and this year I have applied that compost to a practical test and I am able to give this meeting the results of my work.

'I had two hothouses of exactly the same size in which I determined to grow the same variety of tomato. In one house I sterilized my soil with formaldehyde and I applied my artificial fertilizers according to the usual custom.

'In the other house I did not sterilize the soil but applied liberal dressings of the compost which I made. The results are these.

'In the compost house I got a 20 per cent bigger crop. I had practically no visitation of pestilential troubles during the season. I had 50 per cent less watering and the tomatoes were of a quality which I have never grown before and so different from the house where the artificial treatment was applied that no one could suspect them of being the same botanical variety of fruit.

'In the artificial house I had my usual visitation of pestilential troubles of the diseases that were prevalent, and now I am determined to apply compost everywhere and abandon sterilization and the use of artificial fertilizers.'

This was not an isolated piece of tomato-growing evidence, for in March, when I gave five lectures in the Isle of Man, and at one meeting in Douglas I was being doubted by one tomato grower, another tomato grower got up in the meeting and supported me in much the same terms as the grower in West Sussex.

It would, therefore, appear that the panacea of all hothouse troubles is to be found in the sole application of compost to the complete exclusion of artificial fertilizers and of sterilization of the soil.

Phosphate Shortages

When I addressed the Nottinghamshire Farmers at Newark, one stood up and said that he thought that under my system of farming, I should eventually suffer from shortage of phosphates as I was sending away milk and wheat and many other crops that were depriving the land of phosphates. He furthermore went on to say that he could not agree that the application of phosphatic fertilizers was inimical to the soil. 'Mr. Sykes', he argued, 'says that lime can be added to the soil and does this by alleging that lime is not an artificial fertilizer—presumably it would come under the word "natural". And since ground rock phosphate is a natural product of the earth I fail to see how the application of phosphate should be different from that of lime, and if phosphates are being taken away from Mr. Sykes's land by the milk and beef and wheat, surely it is only common sense to replace those deficiencies by application of superphosphate.'

My reply to this query, which, incidentally, is raised at almost every lecture I give, is as follows.

'When I apply lime to my land (and this is scarcely necessary with a subsoil of chalk, which is carbonate of lime), I prefer to apply the untreated chalk as it is dug in the pits. I prefer this carbonate of lime to the calcium oxide from the lime works. If the carbonate of lime was not available from my chalk pits I should then prefer to apply the lime in the form of ground limestone. I do not like lime artificially prepared by burning, as this is much too strong and chemically disturbing for application to the ground.'

Furthermore, while calcium oxide is more readily assimilated by any acidity in the soil, such unconsumed calcium oxide as may prove to be not necessary reverts to calcium carbonate. It is a waste of money, therefore, to pay the increased cost for calcium oxide and have 60 per cent or more revert to its original form.

When we come to examine the alleged analogous argument that superphosphate is the equivalent of the natural carbonate of lime, this comparison is quite untenable. Ground rock phosphate when mined in Africa or elsewhere is chemically known as tri-calcic-phosphate. The affinity of all acids for calcium is well known and every acid takes up to saturation point all the lime that may be present.

Tri-calcic-phosphate is in a form that is unavailable to plants being insoluble in water. This mined rock phosphate is brought to England and mixed with its equivalent weight of sulphuric acid and water in the parts of two-thirds sulphuric acid and one-third water. By this process calcium sulphate is made as a by-product and mono-calcic-phosphate is left as a residual.

Mono-calcic-phosphate is soluble in water and this becomes the superphosphate of commerce introduced to the soil as an artificial fertilizer. It quickly dissolves and the solution is available as plant food. This is the process by which superphosphate is made, and owing to the necessary chemical treatment to which the original ground rock phosphate has been submitted, the final product of *superphosphate is anything but a natural product* and is, therefore, not to be compared with ground limestone or carbonate of lime, both of which are natural and untreated products of the earth.

Phosphate Deficiencies

It is generally asserted that my soils are being depleted of the phosphatic content through my sending away milk, wheat and beef, but an important point to remember is the system of farming that is in practice.

Every acre of land is not subject, year after year indefinitely, to a phosphatic depletion. We run an eight-year system of farming, four years of which are devoted to the making of a very complicated ley. During the four-year period by the system of grazing which we incorporate, more phosphates are added to the soil than are taken from it— much more. Then, during the four year of arable period we have some fifty ricks of straw per annum to make into compost with the assistance of farmyard manure and something like a thousand tons

or more of compost per annum is made, which is generally returned to the land either during the arable break or as a top dressing to the ley. I verily do contend that this land at Chantry, which has already been farmed for four thousand years and to-day is in a high state of fertility, can continue to be farmed for another four thousand years on the system I have now established and be in as great or much greater fertility at the end of that time than it is now. If the eight-year system that we have laid down is followed, then, with the assistance of subsoiling, the encouragement of the earthworm, the micro-organism and the fungi of the soil, the mineral content of this land will last indefinitely.

In my view, this 'alleged phosphate deficiency' is a slogan that must have been invented by some ingenious salesman of artificial fertilizers. It has shown itself to be the most effective whip that was ever designed for urging farmers to buy phosphates to replace those which it was alleged were being taken from their land. This has the undoubted effect *of frightening* farmers into buying artificial fertilizers and, as the average farmer is utterly unacquainted with the real technicalities of the subject, he is influenced all the more easily by an unscrupulous salesman's patter. The farming community of this country and of America are being influenced to buy untold millions of pounds sterling worth of artificial fertilizers which they do not need if only they farmed on a well balanced system of husbandry.

At this point, it is just interesting to state the small amount of phosphates that are extracted from the soil by the growing, for instance, of a wheat crop. With the average phosphatic content to be found in the' soil, the first six inches is generally estimated to contain somewhere in the neighbourhood of 20 to 30 cwt. of phosphoric acid per acre. A good crop of wheat, say a dry ton and a dry ton of straw, making two tons in all, requires only 22 lb. of phosphoric acid to grow it. Recalling that the straw is returned under my farming system, it will be seen that with a 30 cwt. phosphoric acid content in the soil some 300 years' supply of phosphoric acid content is theoretically available; but as a matter of fact, with my husbandry and where periodically phosphates are returned to the soil, the probabilities are that in the course of 1,000 years, the phosphoric acid content is not substantially changed. In addition to this, if subsoiling is indulged in, and adequate dressings of compost, dung and urine are returned to the soil during the eight years' rotation, untold millions of earthworms will be continuing to function, and they will bring up from depths as deep as eight feet, phosphates and other minerals. The store of minerals, therefore, that is generally available throughout the world is such that in 99 per cent of the cases no real deficiencies ever exist. But we need knowledgeable farmers who will farm to return humus to the soil.

There may be times I do admit when chemical analyses will show phosphate shortages, but I have already shown elsewhere in this book that there is nothing so misleading and so misdirecting as soil analysis.

How do you deal with wireworm?

At nearly every lecture I am asked this question. The farmer has become so chemically minded over the last thirty years that whenever he has a visitation of some pest he immediately thinks there will be a poison spray or a powder or a salt which he can apply very easily and inexpensively to eradicate it. He fails to read the true meaning of these pests; they are a pointer whereby he might learn, if he would read his calibrations accurately, that when he has a large population of wire-worm, this is evidence of bad farming. If his land enjoyed the periodic breaking up and consequent aeration, the wireworm could not exist. This organism is of the anaerobic species and cannot live in the presence of oxygen. Applications of artificial chemicals will do nothing useful to destroy them and even if a chemical was prescribed which would do the trick, it would have to be so very strong that while it was destroying the wireworm, which is an enemy of the farmer and his crops, it would also destroy millions of other bacteria which the farmer cannot do without. While killing his enemies therefore, any chemical prescription would kill his friends as well.

There is only one treatment that is possible for wireworm, and that is ploughing and ploughing and ploughing again. Aerate the soil by every means in your power, send the cultivator through it time and again; by this means oxygen will be introduced into the soil and the land will not any longer be a suitable habitat in which the wireworm can live.

I gave this explanation to a farmer in the Isle of Man. He listened most attentively and when I had finished stood to his feet and replied, 'Your recommendation, sir, is to fallow the land and cultivate very thoroughly, but in so doing the farmer will lose a crop.'

'That is true, but you will lose a crop anyway because the wireworm will eat the crop that you sow and you will still be left with the wire-worm!'

Nitrogen an element

When I made a tour of the Isle of Man and delivered five very long lectures lasting nearly three hours each in four days, a friend who took me to my last lecture at Ramsey asked sympathetically whether I did not find this continuous lecturing very tiring and exhausting; I replied that I thought it probably was, but perhaps the most exhausting feature of these lectures was the nervous alertness called for to deal with unexpected and difficult technical questions. My friend said he was quite sure that at Ramsey we should not be asked any questions of that class, and to this I rejoined that one never knows whence these questions will arise and they frequently come from the most unexpected places.

And so it happened at Ramsey. A youth, I should estimate not more then eighteen or nineteen, who sat not very far from the front of the hall, got up and asked:

'Would the speaker tell us if nitrogen is an element?'

'Yes.'

'In turning the compost heaps several times as he does, does not the speaker think that he is suffering a considerable loss of nitrogen through the free ammonia thus released?'

'If composting is carelessly done, yes, a certain amount, but no losses if it is done properly.'

'Is this not a serious loss, and how does the speaker replace this loss of nitrogen, for if nitrogen is an element the speaker cannot manufacture nitrogen and how does he make this good? Would it not be well to add artificial nitrogen to make good these losses?'

This very intelligent question coming from a youth caused me surprise and interest, because it is not often that I receive questions so well put as this one was and certainly never from such a junior member of my audience.

My answer was as follows:

'I would like the audience clearly to understand that the refertilizing of the soil is not entirely chemical—it is biological and chemical and those people who belong to my school of thought believe it to be more biological than chemical. There is one substantial difference, apart from many others between the supplying of food for plants by artificial fertilizers on the one hand, and that of supplying food for plants by the introduction of compost on the other.

'In the case of the artificial fertilizers the food is supplied direct by the solutionizing of the chemical salt which the plant absorbs through its root system.

'In the case of compost the method is indirect. The compost, although it contains nitrogen, phosphates and potash, is primarily humus, which is food for the micro-organisms of the soil. Humus too, has all the other physical qualities claimed for it, like the power of retaining moisture and so forth; but, to deal with its food value alone, it is primarily intended to provide food for these organisms and this it does in the very best way. It also provides conditions under which those organisms can reproduce themselves in enormous numbers. These little bodies, which are man's greatest servants, function in a variety of ways. Many of them are nitrogen-forming bacteria extracting their nitrogen not only from the soil and from the compost but from the air as well. The compost feeds these nodules and these nitrogen bacteria, and breeds them, and they provide nitrogen of a quantity in the soil which would far outstrip any dressing of sulphate of ammonia that the most courageous farmer ever dared to apply.

'Losses of nitrogen in compost making can be altogether avoided by supplying a sufficient base (soil, ground limestone or chalk to keep down the acidity) and sufficient vegetable matter. There is no loss because all the nitrogen goes into:

'1. The microbial tissue which break down the vegetable waste, and;

'2. Into the finished humus.

'With all this arranged there is a great deal of nitrogen fixation in the heap, probably an increase of at least 25 per cent.

'The misconception on the part of the average farmer who values farmyard manure and compost according to its strict chemical content is fundamentally a wrong assessment. Farmyard muck and compost are two different things altogether.

'This indirect method of feeding the plants in the soil, which is brought into play by the action of humus, is nature's method of providing every conceivable kind of plant food that is called for—nitrogen, phosphates, potash, and trace elements. Here, indeed, is the fundamental difference of the most important kind between the functions of artificial fertilizers on the one hand and those of humus on the other.'

After I had given my explanation to my Ramsey audience, I went out of my way to congratulate this young man upon asking me such an interesting and deeply intelligent question.

Where shall I get my material for composting?

Without exception this question is asked at every meeting and at both Worthing and the Isle of Man I was happy to be in a position to give a very prompt and easy reply.

On the beach at Worthing and on most of the shores in the Isle of Man, seaweed grows and is deposited in abundance. It is a nuisance to the seaside watering places like Worthing, Douglas, Ramsey, Pool and Castletown, and a great expense is caused every year to the local authorities through having to move this troublesome marine deposit.

Now it happens to be one of the provisions of Nature that seaweed makes an excellent fertilizing material, especially when passed through the compost heap. Its qualities have been well known for centuries. My answer to the Worthing growers provided them immediately with all the raw material, about which they had never thought before, with which to make compost. They are now buying their cow dung in sufficient quantities to enable them to make all the compost they need with the agency of seaweed.

In the Isle of Man the farmers all make a certain amount of farmyard muck. Before I left the island we provisionally organized a scheme for the collecting of seaweed on the higher beaches and the carrying to those beaches of the farmyard muck by the farmer. On the beach the compost will be made and then carted back by lorries to the farms. This should prove a very economic scheme both to the Isle of Man farmers and to the West Sussex growers.

The handling of the seaweed presents some difficulties, however, and the Rapier muck shifter is peculiarly suited to the solving of this problem. Machines for both the Worthing beach and the beaches of the Isle of Man have already been ordered, and by the time that this book gets into print should have been in actual operation for some time.

Does compost eliminate slugs?

At a lecture given to the Isle of Man Scientific Society in March 1945, I was asked, among other things, whether compost would eliminate slugs from gardens and from horticultural glasshouses.

Mr. Watson, a well-known horticulturist in the Isle of Man, supplied the answer. He said that he had been composting for some three years now and one of his reasons for so doing was to see if he could eliminate slugs in his horticultural work. His ground seemed peculiarly afflicted with this pest and after trying, without success, a number of chemical remedies, all of which proved abortive, he eventually decided to give compost a trial. The slug menace has almost entirely disappeared and is in fact so slight that it causes him no anxiety whatsoever, and he is satisfied that with a continuance of composting treatment his gardens will be completely cleared of this trouble.

Quality in garden produce

Another question I am always asked is whether the composting will produce quantities as great as the artificial manures do and whether, also, quality will go hand in hand with this increased production.

I have always been able to assure my audience that whether it is in garden produce, beef, mutton, pork, bacon, chickens, eggs, milk or butter, all these and any produce grown with compost will be greater in quantity and far better in quality than the same produce grown with artificials, or with artificials *plus* farmyard muck.

1 cannot emphasize too strongly the enthusiasm of all those people who have either tried any of our own produce from compost-grown land—and it covers all the varieties named—or have actually produced similar produce from their own composting. They are one and all in agreement that the quality is something the like of which they have never experienced before.

There is no mistaking the health of the individuals who eat this produce ; they are far better and on a much higher plane than those who live on the artificially grown produce. Speaking for myself I never enjoyed such good health as I now do and I attribute this entirely to living on produce which is exclusively grown by composting methods.

Food preferred by cattle

One of my questioners in the Isle of Man stood up to testify to the preference his animals had shown for food grown on land without artificial fertilization. He had run short of sulphate of ammonia to finish a certain clover ley and as it was only a small area he did not trouble to order further supplies. Part of the field was dressed with 1 cwt. of sulphate of ammonia to the acre and the remainder was left without any top dressing.

When the crop was growing his bull one day was in need of some fresh food. He took a scythe and cut a quantity for this animal. The bull mouthed it over and refused to eat it. The farmer was mystified so he gathered up the food and took it to some cows in the yards. They did the same thing and refused to eat it. It then occurred to him to go and cut a piece of the clover and rye grass which had not been top-dressed with sulphate of ammonia. He brought a large armful of this and offered it to the bull who immediately ate it with avidity. He cut another armful for his cows and they ate it likewise.

This is another piece of evidence to show that grass lands dressed with artificial fertilizers produce crops which the cows do not enjoy, and this should be a warning to all farmers that although they may get increased crops by the application of these artificial stimulating fertilizers they are harvesting a produce which the cattle do not like and which may perhaps do them more harm than good.

Chickens and turkeys at Chantry

Every year we rear a flock of turkeys and some two hundred to three hundred cock chickens, as well as a number of geese. These are usually finished for the Christmas market and we have received almost numberless testimonials to the effect that they have never tasted such quality of food as these finished products always provide. There is no reason for this except that the food which they consume is all home grown and produced on humus-filled land. This applies to everything which comes from the soil when it is refertilized with humus.

An Agricultural Policy for the Isle of Man

I was asked to formulate the rough outlines of an agricultural policy to govern the Isle of Man.

The first essential of an agricultural policy is 'good farming'. In the Isle of Man, as well as on the mainland, the vote is controlled by the townsmen. Over there, as in England, the townsmen far outnumber those engaged in agriculture. Unless an agricultural policy is one with which the townsmen can agree it is useless to expect him to give it his practical sympathy and support. There is the widespread feeling in both the Isle of Man and in England that there is considerable inefficiency in current agricultural practice. Sometimes this impression is all too well founded and the first task is to eradicate this from the townsmen's mentality. A proposal, therefore, for any agricultural policy must be based on good farming with a promise that inefficiency everywhere shall be vigorously eliminated.

The next item is to promise the resident in the Isle of Man that if the right composting methods can be universally put into practice, the island will grow much more produce than she now produces and of a quality such as has never been seen before.

One of the most important industries in the Isle of Man is that of catering for visitors. There is a population resident in the island of about 50,000. During the holiday months it rises to some 250,000. The people from the mainland visit the Isle of Man with considerable regularity, finding in its climate health-giving qualities which attract them year after year.

If the island can, in addition, establish a name for food of a quality without equal anywhere in the world, there will be a still further increasing demand for holiday accommodation. It is, therefore, important that a promise of this kind should be held out to the citizens in Douglas and the other towns in order to win their sympathetic and practical business-like support. They must be made to realize that their own interests and those of the agriculturalist are the same.

If all the advantages of a first-rate diet are promised by the agriculturalist to the townsman, it will be only reasonable to ask of the townsmen that fair prices for produce shall be guaranteed to the farmer.

With the increase of production which I foresee in the island, combined with the quality which is undoubted, it appears more than likely that the island will be an exporter of food to the mainland, in which event there will be additional revenue of the greatest importance to the islanders.

Hill Stock

The question why I left the rich deep lands of South Buckinghamshire to farm the poor thin lands 800 feet above sea level on Salisbury Plain is one that crops up regularly. Salisbury Plain is probably one of the finest military training grounds in the world. As a piece of farming country, except for the farmers who know how to farm it well, it has never been in high esteem. Before the war this land could often not be sold at all and much of it has actually changed hands at capital value prices as low as £2 an acre. This is widely known and it is not surprising, therefore, that most of my farming friends thought that I had taken leave of my senses when I gave up some of the richest land in order to take over some of the poorest.

As I have explained elsewhere, this act of presumed madness had some basic common sense behind it. I had made temporary experiments with similar land on Major Morris's estate at Aston Tirrold in Berkshire, and I had found that I produced Thoroughbred horses of a far better quality, stamina and health, than I ever produced on the rich lands in the Thames Valley. My further experience at Chantry has not only confirmed what I found in Berkshire but has led me to the point of seeking to make known the great qualities for stock rearing that the hill-lands of this country undoubtedly provide.

These hill-lands, as I see it, are far superior for the breeding and raising of young stock than any of the vale lands could ever be. They grow herbage from a subsoil, frequently of limestone of a bone-forming character which builds into the beasts a constitution out of all knowledge, and I cannot help feeling that when the Ministry of Agriculture are a little more informed on this matter than they now appear to be, they may one day segregate our hill-lands for the purposes of stock raising with no other object in view than that of raising a standard of health in our livestock such as we certainly do not know to-day.

I would personally go even further than this and I would specially invite the hill farmer to seek 'attestation status', as a result of which he would then be able to sell his livestock to the attested farms in the vales. The Government ought to pay a premium of one, two or three pounds per head for beasts that passed into the vales with a health certificate such as those farms undoubtedly could provide. This would go far to raising the standard of health of the country's livestock and within a very few years would make a marked improvement everywhere. It would become the practice and, let me emphasize, the recognized practice of all intelligent farmers to replenish their livestock from the attested hill farms, whether it was for beef or for milk. And when it came to beef again, the meat should be sold by the butcher with a label stating that it came from an 'attested carcass.'

In this way the public, in the course of time—and not a very long time either—would be educated to a much higher quality in both meat and milk.

It must be remembered that the farmer has not only got to educate himself into better systems of farming in every direction, but has also to set about educating the public who consume his goods into regarding quality as of supreme importance. Up to the present, quality has been practically disregarded. Rothamsted admit that all their experiments have been quantitative and never directed in the direction of quality— this is fundamentally wrong. Quantity can have no virtue if it does not carry quality with it.

Ploughing in a green crop

Farmers often tell me that they have tried the ploughing in of green crops and cannot see much benefit from having done so; and some of them are doubtful whether they have followed the correct technique.

The ploughing in of green crops is the easiest and very often the cheapest method by which to reintroduce humus to the soil, but there is a certain elementary knowledge needed to obtain the best results. The best time for ploughing in a green crop is in July and August; the reasons for this are to be found in Chapter V in which I described the laying down of a ley under a cover of rye, and the reader is recommended to consult that chapter and to examine the accompanying graph.

There are one or two fundamental features of the ploughing in of a green crop which appear to be very little understood—I refer now to the lack of balance in the soil itself. If it is an old pasture which has perhaps not been ploughed for twenty or more years, it is almost certain that the micro-organic balance is thoroughly upset and the soil in consequence is in a very unhealthy condition. If this is so, a crop grown thereon will be similarly affected and will not in itself be complete in balance. If this crop is ploughed back into the soil this lack of balance and any special deficiencies will be accentuated, for instead of introducing humus to the soil which is in perfect order, you are only increasing the ground's defaults and deficiencies. Therefore, on land like this, which has obviously been insufficiently ploughed and cultivated and aerated, the correct thing to do is to pass the crop through the 'innards' of the beast. By so doing highly concentrated organic matter is introduced to the land and this, mixed with the roots of the crop consumed, forms an ideal basis for sheet composting. It is important that the farmers should note this, *because the ploughing in of a green crop on land which is unhealthy may actually do more harm than good.*

In any event, I would prefer to cover the green crop with about ten tons to the acre of compost after I had rolled the green crop, and then to wait for a good rainy day and, as soon after that as the land was ploughable, to plough in that green crop mixed with the compost. This would be giving an ideal mulch back to the land. It is the ideal way of ploughing in a green crop.

It will be seen in Chapter V that I regularly plough in mustard in preparation for my four years' ley, using rye as a cover crop, and in this case I seldom apply compost at the same time. If I had enough available I certainly would do it (but I have never yet been in a position to have such a plethora of compost that I could

afford to use it in this way), and I should put a minimum of five tons of compost on to my mustard crop and plough the mustard and the compost in together.

I must again emphasize the timeliness of the operation—the best months for ploughing in a green crop are July and August. Enormous benefit, if the land is healthy, will be obtained therefrom.

CHAPTER XX

REACTIONS—LANDOWNERS

The growing recognition of the significance of humus matter in agricultural practice, more especially in soil conservation, and the lack of adequate treatment of this important subject in our agricultural text-books, may to some extent account for the very charming letter which I received from a distinguished London publisher some little time ago, and which I reproduce in this chapter.

The subject of humus is a highly complicated one, and although it is my intention to dilate upon the matter from time to time, I am bound to say that whatever I have to say is necessarily very imperfect and incomplete. I am conscious of the limitations of any one farmer's ability to do justice to such an enormous subject. Although the importance of humus in agriculture was recognized by generations of thinkers as far back as the early Greek and Roman philosophers, it is only during the last century or a little more that real attempts have been made to disclose the nature of this group of organic complexes, their forms of deposition and their role in plant nutrition and in life generally. A vast number of problems concerned with the study of humus still await solution, and are likely to remain unsolved for a very long time, but this does not mean that farmers generally should not do their best to try and understand something of the matter. No one has fully covered the subject of humus hitherto, the problem having usually been approached from a purely chemical, physical, agricultural, or technological point of view. Unfortunately, soil micro-biology is still in its infancy and even now little is known concerning the role of the micro-organisms in the form of humus.

Since Sir Albert Howard persuaded me to take an active part in this humus campaign, I have received encouragement from many quarters and none more emphatic than from Scotland where I have been in closest contact with some of the best farmers to be found in Britain. Those who take an interest in the happenings of the world must have been interested to see the attention that land fertility has recently received. In every walk of life, in the daily press, in the House of Commons, in the House of Lords—one can hardly pick up a paper without finding articles on the subject of soil fertility of one kind or another. We are asked to dig for victory in our gardens. We have been asked to farm for victory on our farms, and we have all become land conscious, fertility conscious. As a result, we are beginning to realize that fertility comes from somewhere, and many of us are beginning to understand that it finds its real origin in humus—'a fertile soil is one rich in humus'. To none so much as to the landowner, therefore, is the maintenance of fertility important, for if his land is depleted of its humus fertility, its capital value is fast diminishing. If the farmers' profits are paid away in Excess Profits Taxes, that is surely a capital levy in its worst form, for which not the farmer himself but the landowner is being penalized with a vengeance. All these facts and influences brought me to meet the Bursar of All Souls College at Oxford, Mr. Geoffrey Faber.

All Souls College have a large part of their endowments invested in agricultural land. They own something like 18,000 acres of this class of investment. They are concerned more than any farmer can possibly be in the welfare of their land; for fertility means everything to them—it means the preservation of their capital. They fully realize what is happening to their capital when their land is being cropped year after year in cash crops, like the cereals and milk and other produce which are taking away humus fertility; and they have deliberately set up a farm of their own at Minsted in Sussex under their own management, so that they can keep abreast of agricultural developments. About the middle of June I received a request from Mr. Faber that he might bring his agent, Mr. J. P. C. Done, his farm manager, and his wife, to see the result of compost organic manuring and subsoiling as carried out at Chantry. As a result of their visit I received the following letter from Mr. Geoffrey Faber:

'24 Russell Square,
London, W.C.I.
21st June 1944.'

Dear Mr. Sykes,

'I ought to have written sooner to thank you for our extraordinarily interesting and stimulating time at Chute, a visit which I bracket with my first visit to Stapledon's new Grass Experimental Station near Haford many years ago, as one of the most significant experiences in my so-called farming career. Both Done and I were badly afflicted with hay-fever during our round of your farm, so that I am afraid you may possibly have thought us undemonstrative. If you have never had hay-fever you will not realize what an awful affliction it is, and how it hampers communications between the victim and other human beings. But in fact we were, all

four of us, very greatly impressed, and even McHardy's Scottish scepticism was shaken by the sight of your wheat-lands. We have also decided to put our names down, or rather the name of All Souls College, for a Muck Shifter. Our idea is to try it out at Minsted first and then, if it justifies our hopes, to get one or two more for use on our other estates by hiring to our tenants.

'I am not yet fully convinced that compost has all the virtues claimed for it and artificials none of the virtues claimed for them, and I should like eventually to see controlled experiments carried out on our own land; but up to the present we have had to confine ourselves to ordinary farming practice.

'I was particularly glad to hear you tell McHardy that there was nothing new in the compost idea, at least to Scottish farmers—nor is there, of course, to any good traditional farmer. It was a most tactful thing, to say to a Scot!

'Of course our problems at Minsted are exactly the reverse of yours at Chantry. We took over a lavishly cultivated and manured farm with first-rate equipment and buildings. We have already discovered that the unexhausted artificial manurial values for which we had to pay heavily are in fact almost worthless, and we are writing them off completely at the end of our first two years. So we are potential prey for Sir Albert Howard. But McHardy is Scotch, I am Yorkshire, and Done is Cheshire, and altogether we are an unbelieving lot!

'Although my firm is thought by some to be championing Sir Albert Howard and his school, that is because de la Mare, not himself a practising agriculturist, although a keen gardener, is a convert. Personally I have been rather afraid that we might be allying ourselves, 1 mean my publishing firm, too exclusively with composters. Part of my doubts came from the fact that composting on an ordinary farm requires so much labour to turn and shift and spread, that it is just out of the question. I was most interested to hear this view confirmed by you. Your machine is, no doubt, the answer. It makes compost on a farm practical. But the other parts of my doubts were, and still to some extent are, related to the exceedingly far going and ambitious claims made for this method of farming, and the absolute nature of the accusations brought against the use of artificials. Both the claims and the accusations may be true, but I do not think they have been proved; especially it has not been proved that the judicious combination of artificials and organic manures is not a good thing. Equally, it has not been proved that it is a good thing. We need a long-term experiment, and there must be not simply experiments in organic versus artificial manures, but also experiments in the combination of the two.

'If I may be impertinent, I think your suggested experiments ignore the necessity of combination experiments, but it may have been that you were just talking against time. However all this may be, the out-and-outers do seem to put compost everywhere as the complete solution of all physical and sometimes mental ills. They, therefore, come under the risk of being regarded as the devotees of a new panacea, and of being taken rather less seriously than they should be by the hard-headed man who has to knock a living out of the land. This is a tactical, indeed a strategical error. The whole movement may be easily wrecked by the instinctive distrust which all such claims always excite in most practical men. However, I must not go rambling on like this. I am, if not a full convert, rather more than anxious to get this complex business fully and impartially and clearly worked out. Your performance at Chute is simply astonishing. What is not clear is the part played in it by the use of compost. Would your yields, after the refertilization by the bail system, and after subsoiling and all the subsidiary acts of cultivation, have been less than they are or less valuable than they are if you had not been a composter? I do not know the answer to that question—you may know it, but how can you prove your knowledge?

'Writing hurriedly, as I am doing, after a tiring London day, I cannot really get all I want to say on paper without turning a letter into an essay, so I must make up my mind to break this letter off; but I must not end without obeying my wife's instruction to say that she took as great an interest in what you had to tell us and show us, as did her three male companions, and in particular, your prospective publisher.

'(Signed) GEOFFREY FABER'.

This personal and very charming letter is a treasure which I shall long retain. It is a personal tribute to my work as a farmer, but more than that, it is a very fair comment on this complex subject of humus. It emphasizes, as my book I hope will still further emphasize, the necessity for a long-term experiment and one which shall be impartially conducted, surveyed and controlled. It also shows the interest the world as a whole, and landowners in particular, are taking in the well-being of their land. My All Souls visitors realize better than anyone that their capital is at stake. Continuous war-time cropping is reducing this capital beyond measure. What are their tenants doing to see that the humus, of which the land is being robbed, is, in due course, returned to it? Generally speaking, the tenant is impotent to do anything about it at all. He is compelled by the War Agricultural Executive rulings to do as he is told and to crop according to instructions.

He must apply stimulating artificial fertilizers in order to secure as heavy a crop as he can possibly get. All this, of course, is justified by the emergency of war. I do not suggest for one moment that the War Committees could have done otherwise, but I do seriously think that recourse to other manurial expedients than artificial fertilizers should now equally form part of the instructions of War Committees, and there should be a demand by the War Committees that the manures and the farmyard muck and the straw and all the waste vegetation should be composted and returned to the soil. 1 shall immediately be told, and quite rightly too, that there is no labour available for this. This is an excuse that I cannot accept. We have some fifty ricks of straw every year on this farm, and I believe that we are the only farm in England which has not one single straw rick left unconsumed. If we can find methods by which it can be done, surely other farmers can find methods also. It means a lot of hard work, very hard work, distasteful work, and neither the farmer nor his men like it, but we have done it. It is true that we have now been compelled to invent a muck shifter because our men got so sick of the job that they refused to do it any more. But even so, there are many farmers throughout this country who have made no attempt whatsoever to return their muck back to the soil. I am told by the Ministry of Agriculture that at this moment there are 20,000,000 tons of farmyard muck waiting to be returned to the land and nothing is being done to put it back whence it came. Is this not a disgrace to our farmers? Are we not prostituting the soil and have we not got at our fingers' end the means with which we can return the humus? There it is and it must be returned. If it is not returned—humus which is self-consuming—this invaluable material will eventually prove to be worthless, because its own microbial content will consume itself, and there will be nothing left to return to the land. All over the country I can see to-day ricks of straw being burnt because the farmers do not take the trouble either to compost them, or to put them into the farmyard to be trodden by bullocks in the good old-fashioned way. Surely it is time that all this was stopped? If Mr. Hudson's speech was correctly reported in the daily press, did he not say that when this war was over the land of England would be in a higher state of fertility than it was in 1939? If Mr. Hudson has any measure of the importance of the statements that he makes—and I believe in him to such an extent that I feel sure that he must have some good idea of the gravity of his words —does he really think that a man who had a big credit in 1939 in the form of the humus manurial value which lay under the sod of England cannot be other than gravely impoverished by five years' continuous cash cropping? How at the end of that time can it possibly be in a better state than it was five years previously? Does he seriously ask any thinking man to believe that? Could any statement be wider of the mark? In my view, with the use of stimulating fertilizers, the land of England as it stands to-day as a whole, is far worse than it was five years ago— so far as humus content goes—it cannot be otherwise. There is only one way to restore the fertility of the land since we have depleted it in so wholesale a fashion, and that is to put back the humus. That humus is awaiting its return on every farm in the form of waste vegetation, unconsumed straw ricks, and 20,000,000 tons of farmyard muck. In addition to this, there are all the uncontrolled humus tips around our great cities and towns which would be invaluable to the land. All these should be returned to the soil at once. Again, I shall be told that there is no labour for it. It is true that the new Muck Shifting device will be greatly called upon to fill this labour shortage, but it cannot be made immediately in the numbers that are needed. In the meantime, labour may shortly be a surplus commodity. After the war, therefore, cannot we do a great deal of this work by hand, and so find employment for many thousands of men who may be hard put to it to find jobs? At this point I want to insert my reply to Mr. Geoffrey Faber.

'G. Faber, Esq.,
24 Russell Square,
London, W.C.I. 24th *June 1944.*

'Dear Mr. Faber,

'This letter is in answer to your courteous communication of the 21st, received this morning.

'I am in agreement with you in the necessity for stating our case for "Compost" with moderation and tolerance. I also approve of one of our long-term tests being made with a combination of both compost and artificials. For whatever convictions I may have reached as a result of several years' trial and error I do not ask the world to take my findings without question. I go even further than this, and suggest that every intelligent farmer should conduct experiments on his own. He should try land solely with muck, solely with compost, solely with artificials, and with a mixture of both. I urge, furthermore, that results should not be reached by sending the finished products to a chemist for his analysis, but rather that the foodstuffs produced by all these methods should be tried out on the cattle themselves, over a long period of time, when their health, the milk production, their breeding capabilities should be closely recorded. People like All Souls College should try to carry out these records with great care, and eventually make their findings available for

the world to read. We cannot know too much, and my feelings are, no matter what I may or may not know, that we know just about nothing at all, compared with what is yet to be truly learned.

'A very simple and interesting experiment which McHardy might carry out for his own, and your information, is this:

'Take a field which is newly sown to a three or four year ley. Refertilize half of the field with ten tons of compost per acre, spread over the surface, or ploughed in. Refertilize the other half of the field with 1 cwt. of sulphate of ammonia, 2 cwt. of superphosphate, and 1 cwt. muriate of potash. Observe the behaviour of the cattle when they are turned out to graze this new ley. If your experience is the same as my own I think you will find that the grass and clovers grown with compost will hold the cattle all the time, that they will eat the plants right down to and in danger of damaging the crowns, while you will have to drive them on to the land that is artificially treated. Observe, also, the weights per acre of hay that is recovered over the four years, and note too the readiness with which the cattle eat the one and the other. Note again the ability of the land to carry on through the entire duration of the ley of the one method against the other, and the condition of the swards when you finally plough them under. But this is not all. Carry your observations still further, and without any aid of any kind whatsoever to either section of the land, note the character, quality, and weight of the succeeding cereal crops. Note all these facts in your records, and you will have in this simple experiment alone much that will give you food for serious thought.

'I cannot agree too strongly with what you say about what is proven and what yet remains to be proved in this highly controversial subject, and I do not associate myself at all with the heated deductions and convictions of the "out-and-outers" in either the one school or the other.

'My attitude of mind is, "I do not *really* know. I am very keen to *really* know. Let us have a long-term-controlled-test to see what we can learn".

'This proposal is utterly reasonable, and has never been contested when put forward to any independent authority. It is interesting, however, to note at this juncture, that the only opposition so far resurrected *is from the makers of artificials.*

'As a farmer, with nothing to gain from either way, I simply *want to know.*

'Why should we be refused these long-term tests?

'The health of our people, of our livestock, of the land itself on which we live, all these are at stake. Why should this fair and most reasonable request not be granted?

'Like yours, however, this letter must be brought to an end, for it will not develop into an "essay" as you suggest, but into the very book which you are good enough to think of publishing.

'I confirm my conversation, that with the advent of the new machine, composting and muck shifting becomes a practical and commercial proposition, which will not only, perhaps, lead to better farming, but to more economical farming than ever the *bag* was able to do. Of this I am convinced. Since you were here we "turned" part of the heap of muck, beside which the machine was standing. We did this to demonstrate the usefulness of the muck-shifter to Mr. Reginald Ford, a large market gardener in South Wales, who wanted a machine purely for compost making. He bought a muck shifter and a water pump for composting. The figures we took out would seem to show that we can "turn" a bank of compost for a few pence per ton. This is truly most important. Two or three turns at a cost so negligible is not a matter of concern to any farmer, and the effect of "break-down" shown in this initial turn was more gratifying to me than anything that I have done for a long time.

'On Friday last we demonstrated at the Andover Sewage Works the turning of straw composted with town liquid sewage. The efficiency of the machine was amazing, and its effectiveness was remarked upon by everyone. As a result of what the Andover Corporation are doing it is likely that every Corporation in Hants will take up the making of compost out of sewage, now that the process is mechanized. A great many public bodies were represented there, and the greatest interest shown. What an enormous step forward if the whole of the sewage sludge now destroyed, at great public cost, can be saved and returned to the land in fit condition for use as the valuable fertilizer that it ought to be.

'Returning to the success this farm shows of such acts of husbandry as we practise, I would place them in this order of sequence and importance:

'1. The four years' ley.

'2. Good and most thorough cultivation, including subsoiling.

'3. Organic manuring through the grazing of stock of *all kinds.*

'4. Composting.

'(Signed) FRIEND SYKES'.

In the Ministry of Agriculture News Service, published in October 1940, read these words:

'In the eighteenth century when British farming reached a higher peak of productivity and self-sufficiency than it has ever known since, artificial fertilizers were unknown.'

Can one say more? A further piece of evidence might be given. We are warned by all students of agriculture that one of the most dangerous of all agricultural practices is monoculture. Perhaps there is no greater offender in this particular practice than is the market gardener. One of the machines which we have sold for muck shifting has gone to one of the leading market gardeners in this country. I inquired of him why it was that he was interested in making compost and his remarks were illuminating in the extreme. I visited his farm where he is growing and selling many thousands of pounds worth of produce, and made a very careful examination of all the work he was doing, and the acts of husbandry that he was performing. When I inquired why he was so interested in composting he made this reply:

'I have been a market gardener all my life—my father before me, my grandfather before him. We are, therefore, born market gardeners. Up to a few years ago we were tenant farmers. Now I own practically every acre I have under my control. This gives me a very different outlook from that which I had some time ago, for I realize that my farm capital is my land. I intend that my capital shall remain intact. I am satisfied that the big crops, which the use of artificial manures may give me, may be obtained at the capital expense of the humus fertility of the soil itself. I have proved to my own satisfaction that I must return organic manures to my soil or one day my land will be bankrupt. I can send my mind back to the days when we used to refertilize entirely with stable manure which we bought from the Great Western Railway Company. A mere fraction of that manure is now available, and since that time we have had to farm with artificials, because we had no alternative-—or at all events we made no alternative—but I, looking back, can see now that there is a difference between my farming and the farming of my forefathers. In my grandfather's day we never knew poison sprays. We never knew diseases which are quite commonplace among our market gardeners to-day, and I am satisfied that we are depleting or disorganizing our humus content. As a result, the plants which we are growing are less resistant to disease, and we are having troubles which my forefathers never knew anything about. All this I am determined to stop; I am sure that I can stop it by building a stockyard which will carry a number of bullocks, where I shall provide them with straw and no end of waste vegetation from the market garden.

'I can make on this farm one thousand tons per annum of compost, and that will be returned to the soil every year. In this way I shall maintain the humus content of the soil, and it is my intention, too, to carry out some long-term experiments. I intend to divide up certain acreages where I shall refertilize a section with artificials. A similar section and acreage I shall refertilize entirely with compost and artificials, and over a long period of time, at least ten to fifteen years, these results will be carefully recorded. We shall observe the disease, or freedom from disease, that we get in our plants, and this will be information for the world—information which the world sorely needs. None of us know enough about it, and somebody must set about doing this job, and I for one am going to make a start. I am satisfied that in seeing to it that organic matter is returned to the land I am preserving my capital—my capital to-day is largely invested in my land. My father never owned an acre of land. We were only interested in those days in what we could get out of it. To-day, we are equally interested in what we can put into it.'

So spoke one of the leading market gardeners in this country. Surely the straw shows which way the stream flows? Is not all this convincing evidence that the agricultural world is beginning to think of the humus depletions which our soil is suffering? These are indications which I have met with all over Britain, and it is the most heartening evidence I have had of the sense that all of us who think well of this British land must see that it is saved—saved before it is too late.

CHAPTER XXI

REACTIONS—VOICES FROM NEW SOUTH WALES, CALIFORNIA, WESTERN AUSTRALIA, SOUTH AFRICA

'No. 5 Terry Road, Eastwood,
Sydney, New South Wales,
Australia, 14.7.44.

'Mr. Sykes,
Chute, England.

'Dear Sir,

'Your article "Will there be a Second Black Death" sums up the world position very concisely; unfortunately it is all too true. I am enclosing a recent cutting from the *Sydney Morning Herald and* which may interest you as it has all the portents of your picture of the near future.

'Another pest, which has gradually spread from Queensland into the north coast of New South Wales, is the cattle tick. Some time ago the dairy farmers of this region were up in arms against compulsory dipping of their cows as they contended that it caused a drop in the milk supply. Officialdom won.

'In certain areas of N.S. W. the amount of superphosphate that has to be used to obtain a wheat crop is approaching the point of being uneconomic, and it is being realized that the stage has been reached where the return of organic matter is necessary.

'The weight of tomatoes from a glasshouse operated by the bio-dynamic method was between 2 and 4 lb. per case heavier than those from houses operated by orthodox methods.

'Dr. Minton Connell of King Edward Island, Tasmania, has described your *Black Death* as a classic. He also contends that the *Agricultural Testament* should be in the library of every doctor.

'Wishing you continued success,

'Yours faithfully,

'(*Signed*) E. JEREMY'.

Newspaper cutting from 'Sydney Morning Herald' dated 9.6.44.
'On the land.

'BUFFALO FLY MENACE
'Southward Move

'BRISBANE, Thursday.—All efforts to check the southward movement of the buffalo fly in Queensland had failed, said a veterinary authority in Brisbane to-day.

'It had assumed such proportions that central district cattle authorities described it as "the most rapid insect invasion in Queensland's history".

'Since its appearance north of Cairns about eighteen months ago the fly had traversed hundreds of miles to the south, and had entered the beef cattle districts of central Queensland. At its present rate of progress the fly would enter the dairying districts comparatively soon.

'Experience has shown that when a milking herd is attacked its production goes down by half. The flies look like swarms of bees on every beast and irritate them beyond measure day and night. They live on blood and have a preference for bulls, although they attack all cattle, especially those in poor condition'.

Memorandum from Major E. S. Pillsbury'

Santa Barbara,
California, U.S.A.
30th September 1944.

'To F. Sykes, Esqre.,
Chantry, Chute,
Andover.

'Dear Mr. Sykes,

'I have pleasure in setting out my system of farming in my lemon groves near Santa Barbara, in the State of California.

'This land has a subsoil of Doby Clay, a geological formation with which I believe you have made yourself familiar in your travels through my country. The climatic conditions governing the growth of lemons have an all-important bearing upon the success of intensive lemon culture. Frost is one of our great enemies, and many are the expedients to which we have to resort to keep our trees protected during climatic changes, some of which come quite suddenly. These precautions taken, the next subject is irrigation. In a climate like that of California where we get heavy rains during the rainy season, followed by very hot, long dry periods, and sometimes cold nights, our tasks are many that have to be performed efficiently if we would be a really successful lemon grove farmer. So important are all these several details, that once you have got the right soil, the mechanical appliances to guard against frosts and cold nights, the irrigation schemes made effective, the price of a lemon grove plantation becomes something utterly fantastic to the mind of an Englishman. The freehold value of a first-class lemon grove in my Santa Barbara country is no less than £750 per acre. This price sounds more like what you might expect to pay for a building site, perhaps, in an important thoroughfare like, say, Piccadilly, London. Yet, that is the price that is readily paid for a good lemon grove of fifty-acre extent in my district.

'That brings me to the all-important features that really make the title "a good lemon grove".

'I began some twenty years ago, and I conceived the basic notion, that if I would be really successful, and if I would have my success well-established over a long period of time, I must *refertilize with organic manures* as my basis of plant food.

'In addition to my lemon grove, I own a large ranch some fifty-five miles away from Santa Barbara. There I collect my cattle dung, mixed with adequate quantities of straw, bale it, and transport those bales of farmyard muck, all that distance to my lemon groves. There it arrives, but is not applied as a simple mulch to the soil under the trees. The process is much more scientific than that.

'During our harvests of hay, we gather fairly large quantities of waste grass, vetch, clover and other seeds. These, we sow liberally underneath and round about our lemon trees. These sown we spread a goodly dressing of the baled muck from the ranch.

'All this process is carried out just prior to the beginning of our rainy season. Immediately the rain comes these seeds germinate and grow with tropical luxuriance. When about twelve to eighteen inches high we cut this growth, and allow it to rot where it is.

'Almost immediately through this fallen mass the grasses and clovers grow in abundance again.

'These are again cut, and allowed to rot.

'This process continues for at least three, and sometimes four cuttings during the rainy season.

'This system—which is my own technique—provides me with all the organic manures and soil restoration that my plants could possibly require.

'That the system I have thus carried out is all that I can wish it to be, I am more than satisfied, for I have built up within the period I have been farming in that district a healthy and heavy yielding grove which is without equal.

'It is interesting, furthermore, to note, that I was the pioneer of lemon farming in this valley near Santa Barbara. I was not long alone. Many there were who followed me in this business. They, however, thought they were much more scientific than I was. They ignored and laughed at my laborious technique of *organic* refertilization, and substituted artificial manures for my organics. Their trees, be it noted, came into quicker bearing, and with heavier crops in the early days, than did mine. It is more than interesting too for you to know that in many instances it has been necessary to replant trees, and I believe in every case they have dropped behind in both quality and quantity of production, while mine are in fuller bearing now than ever they were. Moreover, I can look forward to years of continued further growth, full-tree-bearing, and financial prosperity, for my groves are healthy, in grand trim, and produce fruit at all times of the finest grade and quality. I grow and harvest ten crops of lemons a year, in normal times when there is sufficient labour available for picking.

'Since reading your scientific articles descriptive of your own methods of farming in Wiltshire, here in England, I perceive you have given my methods of refertilization, the title of "Sheet Composting".

'And in very truth that is exactly what it is. Underneath my trees, with the methods I have described, I carry out "Compost Making" in its most effective form consistent with the climatic conditions prevailing in my country. You are at liberty to add my humble testimony to the dossier of evidence you are compiling, wherein you seek to show to the world of farmers in every country the urgent necessity to regard the *law of*

return in agriculture as being based upon the return to the soil of all organic wastes in the form of every conceivable leaf, twig, straw and other cellulose of vegetable origin, and that these mixed with the dung and urine of animals, acting as bacterial and chemical activators, mixed with a sufficiency of moisture, make for the provision of humus, the true plant food of all crops for both man and beast. Without humus all land must sooner or later revert to desert conditions—as we well know in the United States.

'Yours faithfully,
'(Signed) EVANS S. PILLSBURY'.

THE TRUSTEES OF THE WHEAT POOL OF WESTERN AUSTRALIA

'569 Wellington Street,
Perth, Western Australia.
8th September1944.

'Mr. F. Sykes,
Chantry, Chute,
Wiltshire, England.

'Dear Mr. Sykes,

'My attention has been drawn to your article published in the *Medical and Press Circular* of the 22nd December 1943, under the title "Will there be a Second Black Death?" I was greatly interested as I have been thinking along rather similar lines for many years, without arriving at a definite conclusion. I had already read Sir Albert Howard's *An Agricultural Testament.*

'In this State, most of our soils are deficient in phosphoric acid and consequently phosphatic manures—principally in the shape of superphosphate—are used very extensively—perhaps more so than anywhere else in the world. This applies to the growing of all crops and the top dressing of pastures. Nitrogenous manures are used mainly in the production of potatoes and by horticulturists but many fruitgrowers and vignerons use superphosphate and legumes—peas, beans, lupins, etc., instead of sulphate of ammonia. In pastures it is extremely difficult to establish clovers or in fact, any plants belonging to the legume family without first top-dressing with superphosphate and in some cases infecting the seed with the specific bacteria associated with the particular species.

'I am sending you an article from *The Agricultural Journal of Western Australia,* which will show you we have our troubles even with this type of pasture feeding. In some parts, mostly small, there is insufficient copper or boron or cobalt in soils. Stock depastured on these soils suffer from deficiency diseases but if the missing chemical is added, immediate improvement takes place. I think that even our very ingenious machinery manufacturers would find difficulty in inventing a suitable subsoiling instrument as most of our implements have to be of the stump-jump variety and it is difficult to imagine an effective stump-jump subsoiler.

'I noted that your article "Will there be a Second Black Death?" was the second you had written on the subject. I would esteem it a favour if you could let me have a copy of your earlier article.

'Yours sincerely,
'(Signed) H. E. BRAINE'.

'Chantry, Chute ,
Andover,
England,
24th December 1944.

'Dear Mr. Braine,

'Your most welcome letter dated 8th September 1944, has only just reached me. I am greatly interested in your description of refertilization difficulties in Western Australia; where you emphasize the serious phosphate deficiency. I perceive that you attempt to rectify this shortcoming by the supply of superphosphate. This, of course, gives you a crop for the moment, but in our experience of it, we regard it as no other than a palliative, requiring increasing applications to secure crops as the years go by. The reasons for the diminishing efforts of superphosphate are due —we feel sure—to the lethal effect that chemical has upon the living organisms of the soil, the earthworm, the fungi, bacteria and everything else.

'Refertilization is not only a chemical and mineral problem, it is the act of growing an increasing number of earthworms, fungi, etc., who are "soil and mineral conditioners", and whose habitat in the soil is justified solely on account of their functioning in preparing plant foods into such a form and concentration, that heavy crops can be grown, and crops, moreover, which, through their own health, produce healthy livestock and healthy humans.

'Wheat, milk and meat grown on your mineral-deficient soils will not sustain life. They will simply procreate animals and humans with a corresponding deficiency in their make-up.

'The problem, therefore, which confronts you is one which can only be solved by the recognition of one simple basic fact—that the earth's fertility everywhere can only be maintained where the life cycle is kept in steady torque free from artificial interruption in every way.

'This life cycle consists of:

'1. A living soil which produces

'2. A living plant—which feeds

'3. A living animal—which sustains

'4. A living man.

'The living, organic residues during life, and their residues at death (decay) should all be returned to the soil.

' "When plant and animal substances decay, the ultimate products are just those which are required by the green plant. Bacteria in the soil thus play an essential part in the *cycle of Nature,* and by their activity the effete matters of one generation are brought into general circulation for the use of the next."

'When I have forced this subject upon some of my audiences during my lectures, I have seen, sometimes, impatience, and an occasional exclamation, "Oh, yes, we understand all that—that is elementary."

'Elementary it is, but what the average agriculturist simply does not appreciate is that this *inexorable law* is immutable. It will not tolerate any change or alteration in its system of working, and when man in his wisdom wishes to substitute inorganic phosphates for the organic triturated phosphates found in the worm casts—*Nature simply won't play ball!* And that is all there is to it. The organic mineral residues to be found in the ten to fifteen tons of earthworm casts per acre are a much more perfect plant food than the inorganic artificial substitute which the chemist prescribes in its place. The analysis of the worm casts shows them to contain five times the nitrogen, seven times the phosphates, and eleven times the potash of the surrounding soils. The chemist, with his analytical materialistic outlook, may tell you that there is no difference between the two. But there is an enormous difference, but this is not disclosed by analysis. It does show itself, however, in the produce from the garden and the farm. The humus produce is superlative in flavour and life-giving qualities, the other lacks taste and flavour and produces deficiency diseases. I know it through my own farming experience, and I have proved it over the years to be true. But the world will not accept my "knowledge", neither will it take my evidence as unassailable proof. Very well, let us have a long term test, under the severest independent control. We have asked for this twice in the House of Lords and we have been refused. The opposition comes from those who are interested in manufacturing artificials. However, I am able to report to you that a wealthy "Trust"—having seen the tremendous publicity we got through these efforts—came forward and have agreed to find us with all the funds that may be needed to carry through this long-term test, and presently results of an unimpeachable character will be available for the world to see.

'But, in the meantime, if I was consulted as to the best way to deal with your serious difficulties in Western Australia, what would I do? This would be my advice. I would use superphosphate once—and once only —to establish the following four years' ley:

12 lb.	Cocksfoot	10 lb.	Common milled Sainfoin
3	Timothy	4	Lucerne
3	Italian Ryegrass	4	Melilotus alba
1	Rough Stalked Meadow Grass	3	Hants broad loaf clover
2	Crested Dogstail	2	Alsike clover
2	Meadow Fescues	2	S.100 clover
-----.		3	Kidney Vetch
23	of grass seeds	4	Burnet
—		2	Chicory

		34	

'When this was sufficiently well established—six to eight weeks in England—I should graze it with beef stock. Graze heavily with a large herd of stock; reduce the growth quickly; then take the stock off; and so let

the sward recover. Then follow the process again; and again; and again; for four years. If you can graze alternately with sheep, so much the better.

'At the end of four years, plough up, and on the upturned sod sow wheat of a variety possessed of a strong short straw. Follow the wheat with Rape and Italian Ryegrass and as soon as tall enough, graze on the "on and off" principle. Next season put down to the four years' ley again, and you will find that this time you will not need to apply "superphosphates", or any other artificial.

'Carry on this system for twenty years, and you will build up a store of humus fertility that will surprise you. This is farming as it really should be done. The fault with the average farmer (is he a farmer or merely a land exploiter?) is that he is always trying to take out of the land so many cash crops. Your banker will not allow you to overdraw your account unless you first inspire him with years of confidence by the sustained deposits you are regularly leaving in his care. The land is just the same. Put plenty in—of the humus kind—and eventually Nature will return you a thousandfold. As to subsoiling in your rocky strewn land—mechanically this is impossible. Your deep-rooting plants, however— chicory, lucerne, burnet, melilotus alba, sainfoin, cocksfoot—are your subsoilers, and you will find them amazingly efficient.

'Yours sincerely,
'(*Signed*) FRIEND SYKES.'

'"Steenbras", Gilbert Street,
Grahamstown.
12th May 1944.

'Dear Mr. Sykes,

'My own work on nutrition has led me to doubt whether South Africa can produce sufficient dairy products to supply every citizen with a natural, health-giving diet. We have had considerable success with our nutritional experiments, but realize that ultimately health depends on soil fertility.

'If only a few more people who "can" would "teach", the world would regain some measure of sanity. There are probably more people to-day than you realize who will find in your writings something for which they have been waiting. In every country there are signs of a "back to Nature" movement for real health.

'With every good wish for the universal acceptance of your ideas,

'Yours sincerely,
'(Signed) MRS. M. M. SMITH.'

CHAPTER XXII

REACTIONS—THE RAPE OF THE EARTH

In writing their excellent work in connection with a world survey of soil erosion, *The Rape of the Earth,* Messrs. Jacks and Whyte say that 'to gain control over the soil is the greatest achievement of which man is capable. The organization of civilized society is founded upon the measures to wrest control of the soil from wild nature and not until complete control passes into human hands can a staple superstructure of what we call civilization be erected on the land. Great advances in science, particularly in transport during the last hundred years, has enabled civilized men to penetrate into every corner of the earth carrying with them the mixed blessings and curses of civilization. They have planted the tree of European civilization over four continents, and in some places it has appeared to thrive.

'Scarcely anywhere has it taken a firm root in the soil for European men, despite their skill and power over nature, have learnt only how to cultivate the soil in European climates. Modern civilization, outside Europe, is more like a plant that will burst into bud and blossom for a short time, rather than like a tree that will grow indefinitely and make its own fertile soil. All goes well with the plant while it continues to blossom, but the flower soon fades and the plant on which it blossoms dies.

'All seemed well with civilization in the century of expansion which followed the industrial revolution. It was a beneficent growth, destined to take possession of the world, and to receive a new lease of life in the new world as it grew old and declined in Europe; but for some years before the Great War dangerous, faint, and usually unnoticed signs were appearing. The early promises of the new countries were not fulfilled, the economic depreciation of the late 1920's brought these matters to a head. The Depression made the peoples of the world take stock of their position. They felt that the structure of civilization was tottering and those who lived on the ground floor near to the earth began to investigate the suitability of the foundations of the soil. Those in the upper stories were too interested in politics and science and were nearer to the light and sun. They were fully occupied in propping up their tottering dwelling places and gave no thought to the foundations without which all their efforts would be in vain. Only within the last few years have some of the shakings of the upper stories been traced to the crumpling foundations, for as a result solely of human mismanagement the soils upon which men have attempted to found new civilizations are disappearing—washed away by water, blown away by wind. To-day, the destruction of the earth's thin living covering is proceeding at a rate and on a scale unparalleled in history; without this thin covering the soil is gone, the fertile regions where it formerly lay will be uninhabitable deserts. Already indeed probably nearly a million square miles of desert have been formed—a far larger area is approaching desert conditions and throughout the New World erosion is taking its relentless toll of soil fertility with incredible and ever-increasing impetus.

'Science with its new aids to agriculture, new machines that aid the work of a score of men, new crop varieties that thrive in climates formerly considered too hard for agriculture, new fertilizers at double and treble strength, makes the world move. There is a limit to the extent to which applied science can temporarily force up soil productivity—there is no limit except zero to which erosion can permanently reduce it. A nation cannot survive in a desert nor enjoy more than a hollow and short lease of prosperity by consuming its soil; that is what all the new lands of promise have been doing for the last 100 years, though few as yet have felt the full consequences. Soil erosion is altering the course of the world more radically than in any war or revolution. Erosion is humbling mighty nations, reshaping their domestic and external policies, and once and for all it has barred the way to the Eldorado which a few years ago seemed almost within reach. Erosion in nature is a beneficent process without which the world would have died long ago. The same process accelerated by human mismanagement becomes one of the most vicious and destructive forces that have ever been released by man. What is usually known as 'geological erosion' or 'denudation' is a universal phenomenon, which through thousands of years has carved the earth into its present shape. Denudation is an early and important process of soil formation, whereby the original rock material is continuously broken down and sorted out by wind and water and becomes suitable for the colonization of plants. On the desert fringe of the Persian and Carthaginian Empires, soil exhaustion, crop failures and land abandonment allowed the desert sands to encroach relentlessly, the people, weakened at the source of their strength, to fall a prey to human conquerors, and were first doomed to be overwhelmed by the drifting sands now covering the precious fields where Darius ruled and the North African plains where Hannibal defended the rich lands of Carthage against the Romans. But as the soils upon which these ancient civilizations were founded were being washed away or covered over with sand and mud, other civilizations possessing new knowledge and

powers were growing up along the eastern and northern shores of the Mediterranean. The might of Greece and Rome had its origin in the mastery of the art of continuous cultivation on forest land—a notable advance on the shifting cultivation whereby the forest re-occupied the land after a few years and compelled the cultivators to adopt, at best, a nomadic tribal existence.'

This brief extract from *The Rape of the Earth* is sufficient to introduce the voice from the United States of America which comes to me from Dr. Hugh Hammond Bennett, the chief of the Soil Conservation Service, United States Department of Agriculture at Washington, D.C. I am honoured to have had correspondence with Dr. Bennett and I have permission to reproduce, as I now do, extracts from broadcasts which he made to the Union of South Africa in June of 1943. These refer to the work that has been done in America to combat the many forms of soil exploitation there, exploitation which originated in the bad farming of the early settlers. It has resulted in millions of acres being left derelict, to be followed by every conceivable kind of land erosion. It is interesting to note that as a result of the fourteen years' work which the United States Government have given to this subject, they are in a position now to say that they can save much of their land from permanent erosion, and that they may be able to maintain their enormous population from the products of their own soil. It is especially interesting also, to learn that the data which Dr. Bennett was able to put before the United Nations Food Conference at Hot Springs, Virginia in May 1943, did much to influence many of the decisions which were taken by the delegates. All this evidence points to the fact that the farming of the past hundred years has not been a farming which put the land first. The land must be first and must remain first all the time.

I will now quote from a talk by Hugh Hammond Bennett, Chief Soil Conservation Service, United States Department of Agriculture, which was transcribed by the U.S. Office of War Information Overseas Branch in Washington, D.C, for broadcasting to South Africa (24th June, 1943).

'No. 1—World Erosion and Productive Soil.

'In the devastating war now enveloping the globe, the people of South Africa and of the United States, together with those of the other United Nations, have found a powerful ally in the productive land that we possess. This ally is as powerful as the bullets and tanks and submarines of the enemy.

'The United Nations control by far the largest and best portion of the earth's supply of agricultural land. And good farm land, in the final analysis, is the source of man's strength. From productive soil we get food and fibre for our armies and factory workers—for everybody.

'But we should not be misled in evaluating this asset. Many people believe the world's supply of productive soil is practically endless. Nothing could be further from the truth. Actually, the available supply of productive land for all mankind is severely limited. Only about 11 per cent of the earth's total land area is capable of cultivation now or in the immediate future. This relatively small fragment of the earth is all the human family can draw upon immediately—and the other areas that eventually may be brought into use are neither abundant nor conveniently distributed. At present the other 89 per cent of the land of the world cannot furnish man with the necessities of life.

'Thus, the world to-day faces a scarcity of productive soil. Some two billion people depend for sustenance on only four billion acres. Moreover, the supply, already so limited, is steadily shrinking. Erosion is constantly damaging productive soil by stripping away the topsoil and by cutting ravines across the fields, thus undermining the productivity of the land.

'All over the globe, erosion, like a plague, has made much of the once-productive earth less productive or barren. South African farmers understand this, just as do the farmers of America, China, and Australia.

'When the soil loses its capacity to produce, a farmer cannot remain on that land. He retreats before the drive of erosion—as wind and rain strip off the topsoil. Whole civilizations have fallen before the attack of this aggressive enemy. And the tragedy is the greater, because it need never have happened. Man brought it on himself by abusing the land. Much of the abuse came about unintentionally or unconsciously; but some of it—too much of it—was the result of carelessness and exploitation.

'There are two kinds of erosion—natural erosion and man-made erosion. Wind and rain are part of eternal nature. They always beat against the surface of the earth, gradually changing its appearance and its structure. Geology shows us that this kind of erosion has worn down high mountain ranges and turned them into mere hills. This *natural* erosion, however, is not harmful as a rule. It goes on very slowly; soil is built up from the materials beneath at the same time topsoil is being removed from the surface. The process involves centuries; it's a continuing activity. Man at first had little conception of the delicate soil balance maintained under a protective cover of vegetation. Only recently have we come to understand the full building and sustaining effect vegetation has on land.

'Rains falling on trees and grass do not strike the bare land to loosen the soil particles. Instead, the tangle of plant life catches and dissipates the beating, gouging effect of raindrops, and otherwise protects the soil

and allows the ground to drink up and store the rainfall for crop use. And wind cannot blow away soil that is tied down by grass or other dense vegetative cover.

'Under natural conditions a good depth of rich topsoil is slowly developed. Plants live and die in the same place and, so, contribute their decaying materials to enrichment of the soil.

'But man upsets this balance of Nature. With his axes and ploughs he clears away the protective cover and turns the soil upside down. His cattle graze the grass down to the very roots. Wherever agriculture spreads, the earth has been exposed to rain and wind. On flat lands and steep lands, on both dry and wet areas, agriculture has paved the way for man-made erosion. Water pouring down hillsides with nothing to obstruct its flow, tears away the topsoil, finally exposing the subsoil. And subsoil, as farmers everywhere know only too well, is not real soil. Usually, it is difficult to handle and crop yields are low. Often, with the topsoil gone, with slopes deeply dissected by gullying, farmers have to look for new land.

'Our best estimates of the land situation indicate that from two-thirds to three-fourths of the world's available supply is subject to erosion. Of this, at least one-third already has been seriously damaged, because of such wasteful practices as up-and-down-hill farming, continuous use of soil for a single exhausting crop, or cultivation of steep land that should be used only for grass or trees.

'We in the United States have done our part in this costly wastage of priceless soil. Because the country was large and had an abundance of new land to replace fields that wore out, early settlers had little regard for any such thing as soil conservation. And so, finally, we fell heir to great areas of impoverished and wasted cropland, together with other evils of soil erosion, such as dust storms, increasing flood hazards, and the filling of ditches and reservoirs with eroded soil.

'In South Africa, parts of the country are similar to parts of the United States. You, too, know that one of the penalties for overgrazing in low rainfall country is less forage on the range and increasing erosion damage to the land. Erosion of the veld has been due, I am informed, chiefly to mismanagement of stock and burning of brush, just as we have worn out grazing lands on our western ranches.

'Erosion must and can be halted, both as a measure of war efficiency and as the soundest kind of economic safeguard. Fortunately, the needs of man and the needs of Nature can be harmonized, under a policy of wise land use. Land hunger and population pressures probably were factors that helped bring on this war. At any rate, freedom from want is the promised goal of our ultimate victory. Erosion and security are completely incompatible. Through a sound programme of soil and water conservation, already tested and proved, we can check further damage to the world's limited supply of agricultural land, so that there may be more food for more people everywhere. 'No. 2—World Conservation.

'War and peace in our time will be decided not only on the battlefields and around conference tables, but on the farmlands of the world. Production and distribution of food are a vital part of our war programme. We of the United Nations are determined to win not only the war, but the peace to follow. How well we shall succeed, how stable and enduring a peace we shall build out of the flaming horror of war, will depend largely on how wisely we use our croplands and grazing lands in Africa and America and the rest of the United Nations.

'As never before, wise use of productive soil is a duty of the individual farmer and of each of our co-operating nations. We have learned that when the soil is mistreated and unprotected, it deteriorates and wears out, losing its capacity to produce. We need every foot of productive soil that we have. To allow the producing capacity of land to decline is worse than extravagance. It is international suicide. Impoverished soil produces less food and inferior food. And worn-out soil means worn-out people.

'Erosion has left its mark everywhere, and many countries have been forced to consider the food problems of their people. The total cropland now available to the world is barely enough to supply a minimum diet. It is *not* enough to provide an *adequate* diet. Continued carelessness in the use of land will mean still further decline of our limited store of agricultural land—and this will mean less food for a world that promises to be terribly hungry some time in the near future.

'Not far from my office in the Department of Agriculture here in Washington, a remarkable meeting has just come to an end.

'It was not a meeting on military matters. This was a gathering of delegates from forty-four nations—including the Union of South Africa —to talk about food. Food production and food distribution.

'I think this was one of the most significant meetings of the United Nations, because food happens to be an item of vital importance. The side that has more and better food for its soldiers, and for the factory workers who make planes and tanks and bullets, and for the people on the home front, is the side that will win the war and decide the peace terms.

'All the food talks in the world would be a waste of time without soil to grow the food. A lot of people take food for granted, as if it were something you get simply by dropping some seed into the soil—any kind of soil—and then waiting for the sun and the rain to bring forth a crop. It doesn't work as simply as that.

'Continued production of food depends on good productive soil. There used to be an abundance of productive soil. That was before man cut down the trees, ploughed up the grasslands, and exploited the land. Fields were ravaged by wind and rain. You won't have to look far back in history to find out what happened to countries that allowed such wastage. Much of the deserts and denuded hills of China once were covered with forests and grass. The Garden of Eden, that was Mesopotamia, is now largely a great waste area. The once fertile lands of Babylon and Assyria have reached a stage of agricultural decadence. The list could be extended indefinitely to include other places that have declined because the soil was allowed to decline.

'Erosion of the soil has been going on at such a rapid rate that we no longer have an abundance of productive soil anywhere in the world. What we do have we must protect with utmost vigilance, not only for our own salvation, but for those who will come after us.

'This war that the United Nations did not start, did not want, and tried to avoid, is costing these nations billions in money and uncountable values in human lives.

'All these human and material resources are being spent to preserve security, decency, and freedom in the world—to guarantee as nearly as possible that basic provision implicit in the Atlantic Charter, "freedom from want", together with its other warranties for mankind. In other words, this stupendous cost is to safeguard ourselves and the better things of the world—the rights of human beings everywhere to the fundamentals of life, including enough food to eat.

'But we may as well understand—all the world may as well understand now—that there is no way to guarantee an adequate supply for all the people of the world just with written documents, with laws or international agreements, or by any other possible way except by having enough good soil to produce the food. That is an undebatable physical fact; and the fact cannot be altered. Recognizing this we can, if we exert ourselves, really do something about the food needs of the world.

'Enough food for everybody on earth is an almost inconceivable quantity of food, the production of which would require almost superhuman effort on the farms of the world. It's a tremendous task, and great tasks are never easy.

'This undertaking of producing enough food for the world is difficult for *more* than one reason. The problems of labour, equipment, and capital beset many farmers, everywhere; they are familiar problems, but they are not the only ones involved with the food supply.

'Given modern equipment in good condition, adequate labour, and enough capital to buy seed and fertilizer—if they are available—you still will need two things, two *essential* things; you must have productive soil and you must have moisture.

'We don't have any too much good soil left in the world—and *that* is another problem—and a very critical one.

'As I have said in previous broadcasts, there are, as a matter of sober fact, only about four billion acres of cropland in the world, to feed the two billion human beings who live on the earth. That's only two acres per person—and two and a half acres of reasonably productive land per person are required to produce what we North Americans have come to consider even an adequate diet.

'And that isn't all: by no means all of this four billion acres of land is *good* land. Millions of acres have been practically exhausted by centuries of continuous cultivation and erosion. Other millions of acres have been damaged in varying degrees by the erosive action of wind and water. The part that has not been damaged and isn't subject to erosion is pitifully small—far under the two and a half acre minimum.

'This is vitally important—we've got to use that land we have *wisely.* There is no more land to lose through unnecessary neglect and erosion; every acre should go to work—in the most efficient possible way.

'The world needs more food to-day than it has *ever produced.* The need is urgent, immediate, continuing, for the world must have food after the flames of war have died down. Even before the war, some parts of the world, with shortages of productive land, suffered most of the time from hunger, and famine was of frequent occurrence.

'We can meet this need through *wise* use of our soil and water resources—that is by employing scientific farming methods that will give larger crop yields per unit of land, while at the same time maintaining the productivity of the soil.

'This can be done—very largely—through the use of soil conservation farming methods. That's the answer to our problem, as simply as I can put it. But first we must understand what conservation farming is—how it works, how really simple it is, after all.

'Soil conservation, first of all, is not magic. It's just common sense, pretty much. It's using your land so as to get all that can safely be gotten from it while still keeping it up—in producing condition.

'Use of land for the things it is best fitted to produce is the basic precept of soil conservation farming. That means growing the erosion-inducing crops—like corn, cotton, and tobacco—on land that is not subject to violent erosion, or on land that has been protected against erosion. It means, for example, not growing these clean-tilled crops on steeply sloping land that should be in hay or timber because of its ready susceptibility to washing.

'To put it another way, conservation farming involves planning the use of land according to the capability and needs of the particular land in question. If economic conditions, habits or cultures, or other man-made situations or circumstances interfere, ways and means for altering such difficulties or adjusting them, must be found, else the hazard of hunger will remain. The physical facts, we cannot write off or overlook.

'No farmer with his wits about him would take a map of his farm, shut his eyes, and place his finger on a field and say, "I'll grow corn here". But far too many farmers in the past have done almost that— they've planted corn and other erosion-inducing crops without regard to soil type, slope, or natural adaptability of the land. Now, the days of such hit-or-miss farming methods are ending—*to-day* and from now one *must* arrange for our farm operations to meet the conditions and limitations imposed by the land itself.

'Soil conservation increases crop yields per unit of land and protects the land for future production.

'The world's farmlands are its most vital, most precious resources. In their proper use and maintenance, lies not only the future of the land itself, but the future of all nations, great and small—even the future of mankind. For people will need food to-day, to-morrow, and for ever.

'The increasing tendency of our farmers to use their lands wisely and to protect them must spread across the earth, if we hope to produce the food that will bring the people of the world nearer to international understanding, security, and peace.'

In concluding Dr. Bennett's broadcast to South Africa, it is of more than ordinary interest to examine how the United States themselves are placed. Here vast areas of one-time virgin land were made into farms, and recently a careful appraisal has been carried out on the present conditions of the agricultural land. The figures are staggering. No less than 253,000,000 acres, or 61 per cent of the total area under crops, has suffered from soil erosion to such an extent that it had either been completely destroyed, or had lost most of its value. Only 161,000,000 acres, or 39 per cent of the cultivated area could safely be farmed by present methods. In less than a century the United States has lost nearly three-fifths of its agricultural capital. The root of this soil erosion trouble is the misuse of the land—the disappearance of humus—Nature's great stabilizer of the soil. Had American agriculturalists farmed to conserve her humus, America would never have had a soil erosion problem, which now threatens her extinction.

Sir Albert Howard says:

'In dealing with erosion the root cause must be emphasized, viz. the destruction of the humic cement of the compound soil particles. These have to be repaired all the time. The cement needed is provided by the specks of glue of the right size left by the dead bodies of the soil bacteria which in turn depend on the supply of humus.'

CHAPTER XXIII

MIXED FARMING AND RE-AFFORESTATION

When we advocate 'Mixed Farming' what do we mean? That every farmer ought to have a mixture of every kind of farming? Or does it mean that it is 'mixture' only to a certain extent?

Do the words 'mixed farming' immediately bring to mind the possibility that we might on a mixed farm be dealing with a new grass ley which would be grazed, first of all by the milking cattle, who walk about the field and take the best of everything and leave the worst for the sheep, which would succeed them and which again are somewhat selective in their choice of grasses and clovers; and do we infer that those sheep would then be followed by Galloway Beef Cattle which come along and make a clean sweep of what the other stock have left behind? All this, of course, with a four years' ley, and four years arable.

If that is what 'mixed farming' means, then perhaps there is something in it; but it seems necessary to carry the process one stage further. Should the first grazing be followed by a movable system of keeping poultry, so that they are steadily worked right across the field?

We shall then be left with a mineral, humus and biological content, entirely different from what is effected either by the sheep or by the bullock, or by the poultry.

If we look into other realms of Nature, where she—the supreme farmer—in her own state carries on her own system of farming, we find that monoculture is nowhere in evidence. Mixed farming is the order of the day, in the woods, in the sea, and in every place where Nature farms on her own. We find a mixture of every kind of animal and microorganism, and this is precisely what is needed on the farm for the fertility of our new grass ley.

When we talk of the toxic condition of our grass land, and examine that land carefully, shall we not find that in far too many cases the pasture has been grazed more or less by one class of stock, or at all events by too few species of stock?

The chemist will tell us that all dung is more or less the same, stating it all contains phosphates, potash, lime, nitrogen, and a few trace elements—which he used to say were not important—so that it doesn't matter which class of stock we use. But this is not the practice in Nature's own farming. Discriminating farmers regard one sheep as the greatest enemy of another sheep, and if a sheep can poison a sheep, is it not a fair inference that one milking cow can poison another milking cow, or that one beef beast can poison another, or that one fowl can poison another? It is one of the fixed orders of Nature that if we get all these animals succeeding one another in the grazing of a field, the humus and biological contents of their various excrements and urine will counter-balance one another, and that all the millions of micro-organisms fostered by this variety, have a great diversity of uses.

The laws of good husbandry, as they may one day be laid down, will prescribe that every farmer shall carry at least four varieties of livestock on the farm, perhaps more. In the list which I have so far provided, I have given no place to the pig. It may be a matter of opinion whether the pig should be regarded as a grazing animal, or an animal purely and simply to be kept in styes for using up the waste of the farm; but even so, his urine and his excrement will find its way on to the compost heap.

May it not also be prescribed in the future that all our animal wastes shall be composted, and that none of them may be put on to the farm in their green or fresh state? For if an animal is diseased, and known to be diseased, is it not against common sense to put the fresh dung and urine of that animal on to the pastures, where another animal of the same species can come and eat and so become infected?

All these may be thoughts for the future, but they are such as would lead to the efficiency of our farms now, and unless we give attention to them, give to our farming more forethought and less afterthought, we shall drift on as aimlessly as we have been doing during the past hundred years.

At a meeting of grassland experts of this country, when a paper was read called 'Pasture Improvement of Alternate Husbandry in relation to Animal Health', some anxiety was expressed as a result of Sir George Stapledon and his colleagues wanting to be informed by the veterinary people about each of the specific organisms which occasion animal disease, and which pass through part of their life cycle on or about the sward and the rest of it in and on the animal. They wanted to know what would be the correct 'off' period in grazing management, and how long a period should be devoted to tillage crops between one ley and the next, in order to scotch disease and botch the life cycle of the organism.

Then, in regard to field grazing, Sir George wanted to know whether disease organisms, worms and the like, kept body and soul together better on rough vegetation and peaty soils or on improved patches. Although, so it was stated, sheep concentrate on and over-graze palatable improved areas with a high content

of protein they do not totally neglect the rougher pieces. They invariably go into the rougher areas in the early morning and late evening; sheep evidently like the change in diet, and during or immediately after periods of rain they show a strong preference for southerly aspects.

Another interesting point was that although sheep will graze in improved areas to the last blade of grass where they must necessarily, even by day, urinate and dung comparatively heavily, they never graze their night camps at all heavily although these have been greatly improved by extra heavy night urination and dunging.

These facts mean that every sheep walk is a patchwork of areas of highly concentrated grazing, and presumably of relatively highly concentrated dunging and urination and of areas relatively neglected; that sheep wander over the whole walk, and to some extent scatter over the walk such germs and organisms as they excrete; and, finally, that they have the opportunity of picking up those organisms as lurk anywhere and everywhere in the walk. However, the major point on which to insist is that the opportunities for mass infection from organisms living on the vegetation are extremely localized.

Now as this source of infection has been weakened by manuring and reseeding, it was argued that, since there is excessive localized concentration of grazing on every natural walk, the improving of large areas reduces excessive concentration.

Sir George emphasized two further points. The improved areas must be large enough thoroughly to eliminate over-concentration. He suggested that not less than 15 to 20 per cent of the walk should be improved and should be well orientated with a favourable aspect. It was a fatal mistake to concentrate too much on southern aspects because blizzards can sweep in from any direction and a sheep must never be encouraged to face violent weather for the sake of succulent food.

Not all blizzards came from the north-east nor all from the southwest. One must have improved patches on both avenues. Another fact to note was that the improved patch made for better soil conditions, eliminating the mat, stopping the formation of peat and, apart altogether from the addition of lime and phosphates, making for greater mineral efficiency.

The question was raised whether, quite independently of the concentration of sheep manure, disease organisms thrive better on rough vegetation than on improved and more highly mineral efficient soil, also, whether the concentration of sheep manure was as effective from a disease point of view on improved and heavily grazed patches as the agronomists thought perhaps it was. The sheep's parlour manners being such that they excreted mostly at night, Sir George suspected that it emptied itself most effectively at night, and he supposed this might have some relation to the excretion of disease germs. The emptying place was the night camp; it might be therefore that if cattle and ponies acted as vacuum cleaners for such disease organisms affecting sheep one of their chief values on the sheep walk was that they would graze down the sheep's night camps.

Another point was that some types of natural hill vegetation harboured specific organisms more than others, ticks, for example. If so, what type of vegetation? and what organisms?

Dr. E. L. Taylor, of the Veterinary Laboratories of the Ministry of Agriculture, said that to avoid overcrowding was a well-worn recommendation for the prevention of disease among animals, yet farmers would persist in crowding stock on their pastures and it was a long time since they had been so effectively aided and abetted as they had been in recent years by Sir George Stapledon.

Within his own particular sphere of interest were some of the larger parasites. Parasites of such diseases as red worm, husk and parasitic gastritis were always there. They only awaited suitable conditions, of herbage, management, the concentration of young animals, or a lower nutritional standard for disease to result. While a number of factors entered in such as the nature of herbage, ploughing, seeding, folding, mowing, movement of stock, was the question of overcrowding and nutrition was still more important. The whole crux of the understanding of the development of disease lay in the definition of the term 'overcrowding'.

Mr. A. J. Hosier, the inventor of the outdoor milking bail, claimed that for twenty years he had been advocating and practising the policy of ploughing-up. He said that he had no doubt that this was laying the foundation of breeding healthy stock. How, he asked, could we keep our cattle free from disease under the old method of not ploughing-up and of letting our cattle run over the same field, year in and year out? He said he could not understand why our grass should be expected to produce optimum crops on the same land year after year, when we would not dream of growing, say, wheat continuously.

The system that he had adopted over twenty years was to rotate practically everything on the farm, that is, stock, crops and grass, the faraway field getting almost the same chance as those around the buildings. After the last war he determined to decentralize as much as possible and for this purpose he evolved the movable milking shed, the poultry folding system, and the portable pig hut. He wanted to get a large output,

to prevent disease, and to save transport. Hay and silage were made and stacked in the fields where he intended to winter his dairy herds.

In 1928 it was all new ley, and, with crops kept and milked under healthy conditions, he decided to produce T.T. Milk. The reactors were removed and put into another herd, and in order to find out the effect of the open-air life they were tuberculin tested again in two six-monthly periods. At the first period 20 per cent were passed, and on the next period a further 5 per cent passed. This seemed to confirm his opinion that the conditions under which the cows were being kept were conducive to good health.

Concluding, Mr. Hosier said it would be futile to try to work the temporary ley system with cattle, until all fields were fenced and watered with pipe supply. Green pastures and pure water were the surest foundation for healthy stock.

Others, it will be seen, are in agreement with me that the way to consume all leys is not to have the same stock grazing those pastures day after day, year in and year out, but to see that the same class of stock are not allowed to revisit a pasture for some considerable period after their first grazing, and that in the interim it is grazed by three other species at least, so as to counteract any of the parasitic organisms that may grow out of the fallen excrement and urine. In this way, we let Nature exercise her own balanced influence which keeps everything healthy, from the grass and clovers which feed the animals, to the animals themselves which consume them.

CHAPTER XXIV

A BRIEF SURVEY OF BRITISH AGRICULTURE

In another chapter I referred to the widespread impression among industrialists that there is a marked degree of inefficiency throughout British agriculture. Such a statement needs examination and it is part of the purpose of this chapter to see how far this widely held opinion is well founded.

We have to go back to the year 1846 when Sir Robert Peel repealed the Corn Laws and made it possible for foreign grain to find its way without interference into the English market. This produced cheaper food for the people, but from the time of that Act there has been a steady falling off in the standard of agriculture generally. It is true there have been periods when agriculture has ebbed and flowed, but nevertheless the general trend has been downward. Industry, on the other hand, has been on the upgrade until the year 1914, and offered some engaging prizes for those who cared to give their attention to it, so that the best brains, at one time engaged in agriculture, left the land for the greater possibilities that might be had by following a life in the towns and cities. Only those remained on the land who either had a love for it which nothing could sway, or felt that they had not the necessary competitive ability to win a princely livelihood in the towns. Many changes took place in the occupations of our farms, and to my regret I think it can be said with some degree of truth that a lower average standard of intelligence is to be found among farmers throughout the country than among the employers in the industrial world. This does not mean that there is no fine intelligence anywhere in agriculture. On the contrary, there are farmers who are following their calling because they prefer farming to any other mode of life, and they are of a high standard of mentality and great natural intelligence. Many of them have an education that will compare with that of any man to be found in any walk of life, agricultural or other. These outstanding examples, however, are much too few, and if agriculture is to take its place in the world of to-morrow, as it ought to do, and to become an efficient instrument in the economic life of the Britain of the future, we shall have to lure back into farming the type of brain that left it years ago, and invite the young men of our Universities to return and apply their minds to the tilling of the soil. I say this with the fullest sense of responsibility.

I am pleased to be able to record that as a result of the publicity my own farming operations have received, I am at this moment in receipt of many applications from University students of good families who are determined to return to the land. This is one of the warmest and most heartening signs of a change. Needless to say, I am doing my best to make it possible for these young men to start life on the land, and, in approved cases, I am recommending that they should come to me and learn husbandry and general humus farming practices for a period of two years. After that I advise them to go to some Scottish border sheep farm, and learn sheep farming for about eighteen months. That done, they should go, perhaps, for one year to a poultry farm, and finally, for a further year either to some well-known Lincolnshire farm, or some other Scottish farm in the East Lothian, Kincardineshire-Aberdeenshire area, where they can learn some other system of husbandry. By this means they can look forward to their farming experiences of the future with a good deal of practical knowledge and a fair assurance that they will stand as well equipped as most men for the ordeals that a farming life imposes.

I further advise that the young student should include in his education the taking of an Agricultural Degree at Wye College in the University of London. Equipped in this way, I see no reason why any young man should not make a great success of farming life during the next twenty-five or thirty years; be a credit to himself and a real asset to the country.

At this point I should like to refer back to the decline in farming which occurred between the year 1846 when the Corn Laws were repealed and the present day. Up to that time England was self-supporting in foodstuffs—very little was imported into this country to feed her population, and in almost every particular she succeeded in supporting herself. In fact, I believe that she actually was an exporter of certain foods: but from that time her farming steadily began to decline and the records of tillage show that the area under arable crop gradually fell and grass land increased. With the increase in the acreage of grass and the falling off in arable tillage areas, there came a decline in the efficiency in husbandry. This, of course, was not marked for a good many years, but in the course of sixty or seventy years it began to make itself felt. As the technique and knowledge which were necessary to make a good farmer of arable land were handed down from father to son, and as the area under tillage diminished, so the necessity for learning how to till land became less and less. In consequence, we probably went to war in 1939 with less knowledge of real farming operations than at any time in our history. A very large proportion of our farmers' general knowledge of true farming practices and of general acts of husbandry was appallingly low; and when the farmers of Britain were called

upon, as they were on the outbreak of war to begin to till their land and to do their best to make this island self-supporting, they were in the fullest sense ill-equipped for the task. Their general knowledge, as I have already said, was appallingly low. Hastily created committees, called War Agricultural Executive Committees, were formed, and these were usually composed of our best farmers. They improvised demonstrations and lecture classes of all kinds so as to help those farmers who were ignorant of ploughing and cultivation and arable tillage generally. It is surprising to look back over the last five years and to realize what an immense improvement has been made by the farmers throughout the country and what a fund of knowledge they have acquired as a result of the conditions which war-time farming has imposed upon them. Some of them have, indeed, to thank this war for practically all they know about their job. Before the war, many were cow-keepers or smallholders, or grassland farmers, of one type or another. The number of farmers who were experts in tillage was very low. Out of some three hundred and sixty thousand farmers to be found in this country perhaps not more than three thousand were first-class farmers, and even they, in fairness to themselves, and in fairness to agriculture generally, will admit that there has been no period of their life when they have learnt so much, and when they found they had so much to learn, as the last five years. Every farmer in this country has learnt much from the years between 1939 and 1945 at which time I find myself writing this book.

After the repeal of the Corn Laws in 1846, there was permanently lost to agriculture much of the knowledge that our forefathers enjoyed. So commonplace had been the general knowledge of agriculture in the days before 1846 and so infrequent the ability to write down ideas, that nobody then thought books on agricultural practice were ever likely to be needed. Good agricultural husbandry was the order of the day. Everybody practised it—everybody knew it. But with the passing of succeeding generations, each one of whom had to farm arable to a less and less degree, there came about a decline in technical knowledge which at this distance from the scene of events it is difficult to appreciate. Nevertheless, this lack of knowledge was profound, and I shall never forget some of the questions which used to be asked at the War Committees' demonstrations by people who, unashamed of their ignorance were, as true Britishers, determined to learn what they could and to ask any question, however simple. It is not surprising, therefore, that the downhill trend of agricultural practices in every branch produced a fall in the general knowledge of the industry; and when we look back upon the course that agriculture has taken during the past century and upon the hardships through which the industry has been called upon to pass, it is surprising to me that any land was left in cultivation at all, that there were any farmers to be found on the land, or any agricultural labour available to begin the task of producing war-time food in 1939. The neglect of agriculture had been a national crime. Politically it was lunacy in its worst form.

Almost simultaneously with the Repeal of the Corn Laws there was first heard a name very famous in the history of chemical agriculture— Baron von Liebig—a great German chemist who has left his mark on agriculture, for all time, and perhaps to its eternal detriment. The propaganda which went with the establishment of the use of artificial manure was considerably helped by the decline in agricultural technique; by the necessity to reduce agricultural costs; and by the influences, everywhere in evidence, which were compelling the farmer to get more out of the land, to put less into it, and to diminish costs at every turn. With the shrinking demand for home-produced food, owing to imports of cheap foreign food, with food values at home becoming less remunerative, with influences such as these the artificial manure industry was enabled to create for its own betterment, it is not difficult to understand what a bad period the land of our country was in for. If, out of a total of thirty-five million acres available for agriculture throughout the country millions fell, in the course of a hundred years, into a state of dereliction; if millions more fell into a condition of semi-usefulness; if further millions were reduced below the point of first-class usefulness, it is easy for any examiner of agricultural conditions to account for the state of affairs in which the country found itself in 1939. Both land and people were ill-equipped for the burden they had to carry. That picture is dismal enough, and it is difficult to realize how such reckless neglect of the land was ever allowed in an island country which could at any time have been threatened with starvation by an aggressive enemy. But no matter how threatening were international relationships the people of our country would take no heed. The townsman was determined to have his cheap food, and he cared not whence it came. As a result, our agriculture was not able to rise to the occasion as it might have done, had it been properly and consistently supported during the last hundred years. There are proofs of dereliction which are even more striking than the lack of talent to cultivate the land—the lack of fertility in the land itself. Many of our farms were useless. Few farm buildings had been erected or adequately repaired for fifty years. What a picture to contemplate as we realize how great has been the national neglect of this, our major industry. Even that does not complete the story, for the actual implements that were available in 1939 were almost antediluvian and looked as if they had come out of the Ark. Ploughs that had been thrown into the hedge bottom twenty,

thirty, or even forty years ago were dug up; the ploughmakers were utterly unable to execute the rush of orders for new ploughs. The agricultural implement-makers throughout the country, and throughout the world, were unable to execute hundreds of million pounds' worth of orders which they were suddenly asked to deal with. So we were woefully short of skilled labour and of skilled farmers; the land was infertile and derelict, buildings and cottages were either neglected or completely lacking, and finally there was the complete absence of tools and of implements of every kind. Let the reader review for himself this sad state of affairs, and let him resolve that never again shall the major industry of this country be so neglected as it has been in the period from 1846 to 1945.

This then brings me to the next part of my task, where I must try to set out the programme of planning which would put agriculture again on the map of the world, enable it to hold its own and win the respect of the townsman, the industrialist, and all those sensibly minded persons who wish to see their nation's agriculture properly developed.

Before the war, Britain produced approximately one-third of the total food needed by her people, and imported the remaining two-thirds from many countries. In order to produce the whole of her food requirements she would therefore require to increase her output by three times, and to make exceptionally good use of all her available agricultural land. To accomplish such a task, having regard to the disability from which she was suffering, might appear impossible. It is not impossible.

It calls for the bringing into cultivation all the land we possess; and farming it with much better farmers than we have yet seen; perhaps better than the best farmers on the land to-day, even after five years of wartime striving for efficiency. It calls for all ploughable land being brought into an arable rotation. It requires that the land shall carry more than double the head of livestock we now possess. It may call for trebling the number of men now working on the land; for the provision of new roads; for considerably increased water supplies; for abundant supplies of cheap electricity; for good drainage; for cottages, farmhouses and buildings without end; for new implements and equipment; for a better system of husbandry; for organic farming everywhere. By such an improvement in husbandry and refertilization, the average crop yield of to-day can be greatly increased, in some cases to as much as double, and in other cases it can be trebled. But let us put aside all thoughts of such high yields, for I propose to approach this issue with care and with the safety of common sense. Many farms, including farms like our own, are already yielding considerable quantities of produce, and in any calculation I shall have to make allowances for that standard of farming. But against this, it can be shown that there are many farms yielding low returns, and they will have to be brought up, both in the quality and in the quantity of their food production, to the level of those which already enjoy a much better reputation.

On my own particular farm we began with a raw material in the form of third-class land, poor in the extreme. We have succeeded in raising the yield per acre to an amazing extent. If this can be done on land over 800 feet above sea level, I am satisfied that if the whole of the land on this island were properly farmed, it could more than supply all the food that is needed to feed our present population.

If it is asked whether the dietary which would be obtained, if we were entirely self-supporting, would be equal either to our wartime dietary or that which was our lot in pre-war days, I feel satisfied that there need be no alarm in this regard; for the quality of food that can be grown on English land humus fertilized is superior, for both man and beast, to that obtained in any country in the world. It is an admitted fact, among agriculturists of knowledge, that there is no land in the world superior to Britain and no climate in the world where crops are more easily grown. But against all these advantages we have very bad periods of harvesting weather, when harvesting conditions are very trying indeed. Even so, as I hope I have shown in other pages of this book, there are ways of dealing with difficult harvesting, and with science advancing I believe these will be successfully overcome. In the meantime, it is well to remember that in order to raise this country's output of food so as to feed her population entirely on produce from her own land, there will have to be a great improvement both in technique of husbandry, and in methods of humus refertilizing, without which such a result cannot be achieved.

If the plan outlined in this book were followed, I believe it could all be attained in from five to ten years.

RE-AFFORESTATION

In these days when every opportunity is taken by the hypercritical to criticize and blame the Government for everything, it may be at least refreshing for the Ministry of Agriculture to find a kindly word recorded in praise of the wisdom of their recent action in taking the office of woods and forestry under their benevolent eye. This is an act of the greatest wisdom.

For far too long in every country in the world, forestry has been looked upon as a crop divorced from every other sphere of agricultural activity, whereas its real importance should give it a position right in the forefront of any comprehensive conception.

Timber is a crop just as much as wheat although it may take a hundred years to come to maturity. Having regard to the fact that in its widest interpretation agriculture demands a long-term policy, timber should be considered in the basic scheme of programmes and should be treated as a primary crop.

The part that timber-growing plays in the health and well-being of the universe is very little appreciated. It not only supplies a thousand needs in the way of carpentry, building material, and other uses, but it also contributes to the well-being of the world by way of inducing a rainfall, arresting soil erosion, providing the finest of Nature's own subsoilers, refertilizing the land with humus as no other crop can possibly do, providing shelter for exposed stretches of agricultural land, to say nothing of all the glorious ornamentation that woodlands, forestry, and hedgerow timber contribute to our landscape's beauties and charm. Of all the glorious creations of the Almighty perhaps trees can claim pride of place. They are Nature's handiwork seen at her best and in the provision of an immense variety of species ranging from the giant Californian pine woods down to the common hedgerow blackthorn, Nature has been profuse. Each has its own function and every type of tree some inherent merit.

The present conception of re-afforestation is to make use of those wild inaccessible stretches of mountain and other lands which cannot find any other useful purpose. Here vast areas are being replanted and, in the course of generations, an inestimable benefit will be available for the mankind of those days. But the legislators of the future may see in reafforestation something much wider and more valuable than the lands which they at present have in mind. In my own view, as well as in that of many eminent people much better qualified than I, the timber crop should slowly travel over the whole of the farmlands of the world, and these farmlands should be subjected to a period of a hundred years of forest treatment. The purpose of this would be to rest and to subsoil the land, to provide some of Nature's re-invigoration, and at the same time to produce a crop of the utmost commercial value for the good of mankind, and for the benefit of the world as a whole. In all these manifold contributions towards farming as a comprehensive act of husbandry the tree has its part to play.

I appeal, therefore, for more enlightenment everywhere throughout the world, and I ask for more generous treatment of the tree. I hope that every farmer will make up his mind to do a little planting himself so that he can make his own contribution towards the benefit of the generations who will one day succeed him.

So far as our own property is concerned it is my intention to try to plant in my lifetime something like a hundred acres of our present estate, and this I hope to succeed in doing during the next few years. If a like determination can be made by every farmer, what a grand thing it will be for the climate of England and for the benefit of our land as a whole.

I would here like to put in a plea for the rehabilitation of deserted countries like the western highlands of Scotland—a country with which I am very familiar—and I have in mind as I write the devastated and neglected windswept hills of the island of Skye. This island at one time carried an enormous acreage of timber and it was so disposed in planning and shelterage that the intervening lands were covered with useful deep soil with grassland and carried a large population of beef cattle. Through the exploitation and scandalous ravages of man, the whole of the forests of Skye have practically disappeared and with them the whole of those gracious farmlands have gone also. Naturally, the cattle are nowhere to be found, for there is no food to-day for them to live upon and only a few sheep—a very few sheep—remain as practically the sole farming livestock of that wide expanse of country.

This story can be repeated more or less throughout the whole of the western highlands. There ought to be steps taken immediately for the restoration of this country in a comprehensive scheme of reafforestation. Forests should be planted in such a way as to provide belts of agricultural land where, through weathering and denudation, more soil can be geologically accumulated and these highlands can go back to the agricultural prosperity which was once theirs.

PART III

CHAPTER XXV

AGRICULTURAL RECONSTRUCTION

How to reconstruct the agriculture of the country so as to meet the conditions which are likely to prevail after the war, to provide the farmer with a reasonable livelihood, and at the same time to add so much to his efficiency that he might be freed from all Government subsidies whatever—this is one of our greatest problems, and to see it in its true perspective, one has to contemplate the farming of Britain as a whole.

Roughly, there are something like 360,000 farmers in Britain, and of these 300,000 farm less than 100 acres. There are 135,000 with twenty to fifty acres, and only 1,000 with 700 acres or more. There are 359,000 'small farmers'. One realizes what a tremendous problem confronts the would-be reformer trying to create such conditions as will make it impossible for the least efficient of all this multitude to earn a livelihood.

It may be that much of what I have said in public lectures, and of what I will write herein, will not meet with the approval of many an agriculturalist. It will, as the saying goes, catch him in the small of the back, and I shall be his friend no longer.

After the war is over, our outlook in all industries—agriculture included—will have to be a less selfish one than it has been hitherto. We may all be called upon to remember that society, which includes everybody from the meanest to the highest, has a right to live. That both industry and agriculture must be so ordered that everybody has a decent chance of living, if he is prepared to work. This may call not only for considerable reorganization of our own industry of agriculture itself, but a complete reorganization of all our manufacturing industries of every kind. On the assumption that some such reorganization may be inevitable, I say to farmers, quite seriously, that much interference with their farming is almost bound to take place.

I would suggest that there may be a limitation of the number of acres to the largest farm. On such land as I now farm I think it is quite likely that no farmer will be allowed to farm more than 1,000 acres, and that at the other end of the scale, in order to ensure every holding being sufficiently self-supporting within itself, no smallholding shall be, as in Denmark, less than twenty-five acres.

At the present time we have ridiculously small holdings of one, two, three and five acres. How anyone, unless he covers the whole of that ground with market garden or glasshouses, can make a living, is beyond the wit of myself to understand, I cannot see how he can make a living at all. If we are to expect some degree of efficiency in everyone then there must be an irreducible minimum.

Similarly, in order that many more people can be brought back on to the land, I think that there may be a maximum of both ownership and farming activities, and that I think might be fixed at 1,000 acres. This suggests that the 35,000 acre farmer will have to yield up 34,000 acres for others to farm and the 20,000 acre farmer to yield up 19,000 acres. If it is argued that by so doing efficiency will be enormously interfered with and output will go down per acre, opinions differ. Many competent minds believe most emphatically that inefficiency in farming is not always the special prerogative of the small farmer, and it is thought by an increasing number of people that many of our big farmers would farm much better if they had less land to farm.

Similarly, I hold that many of our small farmers, with increased knowledge and greater facilities placed at their disposal, would also farm much better and would have a better standard of living if they had more land to till. Many think that the carefully designed Danish scheme of farm practice and farm planning, which has been in vogue so long and proved during a number of years, is the basis on which this country could well plan her future agriculture.

There are no very big farmers in Denmark, such as we find in this country, but their small farms, which reflect efficiency, industry and a high standard of living, are undoubtedly a model to work upon. It must be remembered that in the future farming will not be solely an economic existence. It will not be merely a way of life. It may well prove that the land itself will be the solution of many or most of our social difficulties. We should bear this possibility in mind and we should realize that the land of this country is all held in 'fee simple' from the King and is, therefore, not our own property at all—whether we are the freeholder or the

leaseholder. All of us are only tenants for life. It may be our duty to fall in with legislation designed for the good of the whole community.

This, my dear townsman, will have to apply to you just as it does to my fellow farmer. You, with your factories, your industries, no matter what they may be, whether they are engaged in making toothbrushes or face cream, or whatnot, or whether they are engaged in the more lordly pursuit of manufacturing millions of yards of woollen or cotton cloth or linen, all these industries may either have to become State owned or be conducted in such a way that the workers throughout the land are allowed some participation in your activities—in order that you may be led to know that you are working for them, and they for you, and each for all. Only if we can view the future in an unselfish frame of mind, can we hope eventually to find a solution for the curing of the world ills in every country. To the land, I believe, millions of people will have to return, and they must learn to have a love for that land, whether they are farm workers, or smallholders, or a 1,000-acre farmer. Be its precise form what it may, is this change not coming? It will come upon us, and we shall have to accept it, whether we like it or not. This revolutionary change, it is widely predicted, may come about within ten or twenty years.

How then would the country be organized so that the newly created holdings could work with a fair degree of efficiency and a reasonable chance of survival?

Reforms will proceed cautiously at first. There will probably be experiments of grouping farms in blocks of 20,000 or, it might be, not more than 10,000 acres.

A number of these, perhaps ten or twenty, throughout the whole of Britain, might be assembled so as to try out the experiment of farm grouping in a comparatively small way, before proceeding to divide the whole country into similar groups. These farms would be chosen so as to form compact geographical units—so that if a unit was roughly in the shape of a square or a circle, the distance from the centre would be perhaps three or four miles. There might then be an overhead organization which could control the whole of such a block of farms. It would not be the master organization, for each farmer would still be his own master, but the central organization would be very much in the nature of the farmer's servant. Its staff would contain highly skilled and well-educated men—an agronomist, a botanist, perhaps a full-time veterinary expert, perhaps a full-time highly qualified engineer and, no doubt, an accountant. The staff could be added to as circumstances justified their appointment. They would be chosen for their expert knowledge, and their ability would be at the disposal of all, and any, of the farmers.

The activities of this organization could be widened or restricted as circumstances showed to be necessary. If the experiment was a success then the development might include the ownership of a larger equipment of agricultural machinery that could be individually owned by one farm. For instance, on a farm like this at Chute, we carry something of almost every kind of implement from a threshing machine and Clover Huller, a mechanical Muck Shifter, down to a hand muck fork. But on a farm of twenty-five acres you could not expect them to have a threshing machine, but there might be several threshing machines available for the use of a group of ten or 20,000 acres, in addition to those which were privately owned by some of the thousand-acre farmers. It is the ownership of this machinery which makes for increased efficiency, and the small men here are obviously at a disadvantage.

I know it will be argued by some people that everybody wants the same machine at the same time. That is quite true of certain classes of machinery, but it certainly does not apply always to tractors in general, nor to such things as ploughs and cultivators and many other types of machinery. Such implements can be more or less used all the year round, but when it comes to dealing with the combine harvesters, or the binders, then, owing to the weather conditions which prevail in this island of ours, there would have to be a sufficiency to enable everybody's harvest to be gathered with expedition.

This machinery pool would be an enormous boon and blessing. It would not be exactly in the nature of an untried experiment, for during the war several Agricultural Committees have run their machinery pools in this way, and they have worked very successfully, notwithstanding that much of the work was in the nature of an experiment. Furthermore this central organization could be responsible for a great deal of the transport work. At the present time the long transport on my own farm always has to be done through hiring, and my hiring costs run to a considerable figure in the year. If there was a central organization doubtless either I should get this hiring done, either at a cheaper rate, or I might benefit by the profit which the central organization might make and which would become available to all the participants in the scheme. Then, again, there is another advantage that the central organization might have: it isn't every farmer who can afford to own a high-class bull. A number of these animals could be kept and made available to the individual farmers. Those who like this scheme might immediately say, 'That's a good idea, but how can a block of 20,000 acres like that be made?' Only by definite Government control. An Act of Parliament would be required which would enable county organizations to determine the district and to compel every farmer

within the selected 10,000 or 20,000 acres to join in the scheme whether he liked it or not. If he didn't like it he could then sell his farm to the central organization.

You certainly would not get the farmer voluntarily to join such a scheme. One of the difficulties that I and others who have been associated with an agricultural organization for over thirty years have had to contend with is that the farmer is a 'non-co-operator'. He didn't want the Milk Marketing Board, which has proved the greatest boon and blessing that was ever bestowed upon the British agriculturalist, and he doesn't want anything else that is good for him. He is just a contentious, difficult fellow for whom to work. It is for the best brains in our country to evolve these schemes, and once they have evolved them to determine that a trial shall be made. This trial would have to be made by Government authority, and the farmers would just have to put up with it and await the results of some twenty such experiments being carried out over a period shall we say of five years.

In my view the cost would be a very small amount indeed—perhaps a few shillings an acre which could be added to the rent. At the most I should estimate 5s. an acre and in all probability it might be as low as 3s. or 2s. or even 1s. In fact, I could conceive that it might be nothing at all because the services that were rendered could be professionally charged for or there could be a levy of so much per acre which would pay for any reasonable service that was needed. This is purely and simply a matter of detail and presents no difficulties. The main point at issue is that this central organization could be made wellnigh self-supporting, or in any event would be such a small burden that not one farmer in the whole group would be aware of its existence as far as the financial cost to him was concerned.

If such a grouping of farms were inaugurated it would attract a much higher average level of brain to the land; for in the central organization many an aspiring young man would be encouraged to go and educate himself especially for one or another of the appointments. The Agricultural Colleges would make it a feature of their curriculum, and we should have a very fine type of man introduced to the land, who at the present moment is wandering wearily and discontentedly in the mazes of industrialism, whereas his heart and soul might be found in the land if there were a wage good enough to attract him.

In pre-war days, the salary offered to men of considerable scholastic knowledge, with an agricultural degree, was abominably low, and so our industry has not had the benefit of the good class of student that we might have had. It is important to remember that these central organizations governing 10,000 or 20,000 acre blocks would have behind them, in the course of time, a very fine type of young man and it is one of its best features of the scheme that such a class could be attracted back to the land. In the course of a few years these men, as a result of the wide experience they would be able to draw upon, would indeed become —and be worthy of the name—*experts*. They would be genuine counsellors and advisers to all the farmers; they would be the farmers' friends; the farmer too would learn to be more scientific, and the scientist would become a better farmer.

Note by Sir Albert Howard

'In dealing with the size of farms we must look at this point from the plant's point of view. The area used by the crop is not the acre but the total internal surface of the leaf spaces. Compost multiplies these by three or four, so that as the land goes up in fertility so does the area from the plant's point of view.'

CHAPTER XXVI

CO-OPERATIVE BUYING AND SELLING

When urging that the farmer must increase his efficiency, I do not simply mean that he should be a more efficient and a more scientific farmer—all that is important—I mean also that he must enormously increase his efficiency as a commercial man in his use of markets both as a seller and as a buyer.

It fell to my pleasant lot in 1917 and 1918, to be associated with Mr. John Foster, one of the present Secretaries of the National Farmers' Union at headquarters. About that time he and I were members of a semi-governmental organization known as the Agricultural Organization Society. He was my senior colleague. We occupied premises in Salisbury, and our work was of a very interesting character. There is no man in either this country or any other who understands the economic side of the farmer's life so thoroughly as Mr. Foster. He has put forward schemes which merit the consideration of all who are interested in agriculture, and both he and 1 know, through our own experience, how difficult it is to do anything for farmers. They are suspicious of their real friends and yet they are often the prey to any City man who comes to talk nicely to them. Look at the speculation in land to see how farmers have helped to make enormous profits for speculators all over the country. These hucksters are legion, and the farmers have submitted to them at every turn. The farmer has to set his house in order, not merely on the farm, where he must determine to be a more efficient farmer, but he must see to it that he has the equivalent of the Milk Marketing Board for everything he produces. Everything the farmer buys should be bought through his own organization; and everything the farmer sells again should be sold through some well-established and well-thought-out scheme of co-operative salesmanship.

This was the work of the Agricultural Organization Society nearly thirty years ago; the opposition that we had was appalling, and most of that opposition came from the farmers themselves. Farmers always fancy that they could do better for themselves individually. But they have now had one magnificent lesson in the benefits that can accrue to them by the success of the Milk Marketing Board. This should be taken as an example. I am not suggesting for one moment that perfection is anywhere near being achieved in that organization, but it is an unqualified success as far as it has gone, and its efficiency and general usefulness are increasing every day.

The Milk Marketing Board does not exist purely and simply for the benefit of the farmers, for undoubtedly the consumers themselves have benefited, and by the time still further improvements are made in milk buying and in milk selling in a number of ways, the public will benefit still more as well as the producer.

We have only to consider the figures that were published some time ago in showing the cost of distribution in order to realize that wide discrepancies exist. For instance, it was shown by Lord Woolton in the House of Lords that the growers received for foodstuffs consumed something like £600,000,000 but that the cost of distribution was no less a figure than £850,000,000. This disparity is appalling. There is no good reason for it.

When we were farming in Richings Park, we were dissatisfied with the current system of commission and salesmanship, and we determined to have our own organization in Covent Garden. This we established and ran for some twelve years most successfully, and we have our own records of the profits that are taken. We have seen cabbages loaded at our farm at Richings Park realizing only 30s. or 40s. for something like a three-ton load—such a low price that it was more profitable to plough them into the ground. Nevertheless these were taken to the wholesale market where they realized a ruinous figure; and yet they were as much as 6d. and 9d. apiece in the London shops. This shows that the big market simply exists to take advantages of gluts and shortages, and that the farmer is outside the profit all the time.

This sort of thing must cease if the farmer is going to get anywhere, and it isn't any use his seeking further Government subsidies until he has taken a firm grip of these matters himself and made up his mind that he will both buy and sell everything through his own organization and through no other. Seedsmen, seed merchants, millers, and many others, all these people are very largely living on the back of the farmer. I am not saying that they are not performing any useful function, but I am suggesting that for the services they render both to the farmer and to the consumer they are being far too handsomely paid in receiving £850 million for distribution, while the producer with all his risks of growing crops and producing produce receives only £600 million. The disparity cannot be reconciled, and it is high time that farmers tackled this fundamental problem.

CHAPTER XXVII

WATER SUPPLY

Of all the many features of farming which are calling for the most urgent reform none is more important than that of supplying the farms and villages, in fact, the whole of our countryside, with adequate supplies of good clean water.

In recent days, a Bill was passed by Parliament which makes it possible for farmers to get new water supplies provided they are prepared to bear a certain percentage of the cost themselves.

This is helpful but I personally feel that it will only be really effective when the Government go so far as to find the *whole* of the capital cost of such water installation. This may seem to be asking too much, but the whole of our countryside is seriously short of water and thousands of farmers are not able to assume the responsibilities of even half the initial cost.

Second only in importance to water supplies is the supply of power from electricity. Our grid system has been traversing a very large area of our countryside in connection with wartime power production and national security and it is a pressing need that this power should be made available for the farms and villages everywhere, at a price which will encourage a very liberal use of electricity both by peasant and farmer.

At the present time these grids frequently pass through the countryside, but no transformers are provided anywhere with which to tap them. Furthermore, such supplies as are available in country districts are so hemmed in by appalling charges, imposed by the electricity company for connecting the power to the farm, which make it a serious question whether a farmer should have it at all.

I have had quotations given by the local electricity company who came to the village of Chute a year or two before the war and the cost of laying the cable to the various farms and cottages under our care is great that we have not been able to contemplate its use. We could make very extended use of electric power, but we simply cannot face the capital cost of laying *the company's* cable to supply us with *their* electricity and then, in addition to that, have to guarantee a minimum consumption perhaps greater than we can take.

The price at which they sell the electricity is beyond reason, and we have found it more economical to install our own electrical supply. This is surely ridiculous. The power should be laid on to the farm, and there should be such capital arrangements made by Government authority, with money at a low rate of interest, as would allow both farmers and cottagers and all the inhabitants of our villages, to have the same amenities as are enjoyed by the town so easily, and at the same cost.

The third reform that our general scheme requires is the erection of new buildings on every farm throughout the country. For a hundred years our farming has been steadily going downhill. Landowners and farmers alike have been unable to keep pace with the requirements of modern conditions. Farming became less and less profitable till it was a case of make-do, make-do, and make-do all the time. This was equally true of equipment, water supply, cottages and building maintenance.

So much neglected have our buildings become that many of them are completely derelict and practically none of them are designed to meet modern conditions. It can be fairly said, and without exaggeration, that it would be better for the whole country if 99 per cent of the existing farm buildings were razed to the ground, new sites chosen, and complete new designs made.

I have before me an estimate prepared by Colonel Pollitt, in his very interesting book *Britain Can Feed Herself ,* where he sets out the costs of new capital required for additional farm buildings, reconstruction of existing buildings, water, roads and electricity supply, and I give in the following table a list of all these amounts:

'Cowhouses	£91,000,000
Byres and Cattle Yards	55,000,000
Liquid Manure Tanks and Manure Sheds	76,000,000
Pig Houses	67,000,000
Dutch Barns	60,000,000
Granaries	7,000,000
Grass Dryers	56,000,000
Implements, Tractor Sheds and Repair Shops	25,000,000
Fertilizer Sheds	2,000,000
Potato and Root Stores	18,000,000
Machinery Rooms, Fitters' Shops and Stores	10,000,000
Water Supply	105,000,000

Roads	35,000,000
Electricity	70,000,000
Drainage	30,000,000

Total: £707,000,000 (new fixed capital required).'

This, the Colonel goes on to say, amounts to £20 7s. per acre of all the cultivated land in this country, which will show the townsman and the country reader alike, the extent of neglect that British farming has suffered at the hands of those people who have managed the politics of this country.

One of the most important items that is needed to make our agriculture as efficient as it will have to be is the provision of new housing. It has never been contested that the agricultural worker was paid too low a wage and was asked to live in an unmentionable hovel. The townsman could be provided with new cottages, and of a variety of kinds, but very little was ever done for the agricultural worker. I believe that between the two wars only 34,000 new village and farm cottages were built. Then, in addition to that, such cottages as are still occupied ought to be immediately condemned if other accommodation could be made available. It is estimated that of the number of people employed on the land, 700,000 of them were inadequately housed.

There will be a further 800,000 workers probably brought on to the land as a minimum when this war is over and if this is so, a further 1½ million houses will be needed to supply the agricultural industry. Assuming that each house costs £600 (£1,000 is the price in December 1944), this represents a capital outlay of £720,000,000. The provision of houses is, I think we are all agreed, now a national responsibility. It is not the responsibility of either the landlord or the farmer.

Another thing that our countryside needs very much indeed is increased facility for transport to local towns. Although this has improved during the last twenty years by the enterprise of many transport and bus companies, it is still far from being as good as it ought to be, and the isolation that some of our farm workers have to endure is beyond belief. This is an agricultural reform that is long overdue and must be seen to as one of the urgent necessities when the war is over.

Colonel Pollitt says elsewhere that if Britain is called upon to feed herself, and she is quite likely to be called upon to perform that task, the farmers themselves will have to provide more working capital of their own to cover the cost of additional cattle, pigs, poultry, horses, machinery and implements, and he estimates that in cattle alone £182,000,000 more will be required.

Details of the new working capital which would be required to be provided by the *farmers themselves* would be as follows:

Cattle	£182,000,000
Sheep (no additional capital would here be required)	
Pigs	70,000,000
Poultry	6,500,000
Machinery and Implements	230,000,000

Total additional capital which the farmers themselves will be called upon to provide	£488,500,000

Further capital responsibilities:	
New Houses and Cottages	£720,000,000
New Buildings	707,000,000

	£1,915,500,000'

To rehabilitate agriculture and to bring it into approximate comparison with modern industry, some two thousand million pounds sterling expenditure is called for. This figure indicates the cumulative national neglect that our greatest industry has sustained.

PART IV

CHAPTER XXVIII

WHOLE-WHEAT GRAIN; HEALTH PORRIDGE; MEDICAL OPINION; BRITISH WHEAT THE BEST IN THE WORLD

My management of livestock, which differs from accepted practice in various ways, is a direct consequence of the fact that at one time I was myself in a very unsatisfactory state of health. My return to normal health and to a high degree of enjoyment of life is entirely due to the attention I have given to diet, and in particular to the use of whole-grain bread, and whole-grain porridge. This bread should be made from wheat which is grown on compost land and, in particular, on land that has not been fertilized by artificial manures. The bread that we eat at my home is better than anything I have tasted anywhere in the world and every visitor to the house remarks upon it.

I can think of nothing which is so important to the race of man at the present time than that he should speedily return to the consumption of whole-wheat bread, rather than the 80 or 85 per cent loaf to which he is now condemned. There are many reasons for this.

It is at least an interesting coincidence that sterility, or barrenness, in women coincides with the introduction of the white loaf. I have found too, that when any of my animals have refused to breed, or become barren, I can invariably get them to recommence breeding by feeding wheat-germ meal into their diet, for about two months—this introduces vitamin E into their blood stream and within a couple of months I find that they start breeding. Similarly; if a woman fails to have children, if she eats whole-wheat bread she generally finds that she is able to have a family. Why this information is not more widely known both to the ordinary man in the street and to farmers in particular, I cannot understand. The knowledge is available to our doctors and to our veterinary surgeons, but for some reason or other they do not seem to pass it on, either to the farmer or to the community.

This is an omission which lies at the door of both those two eminent professions. There are many doctors, be it said, who have agitated for years for a return to the whole-grain loaf, and in this particular few have shown more energy than the Member of Parliament for London University, Sir Ernest Graham-Little, M.D., F.R.C.P.

I should very much like to dilate at considerable length upon the work that Sir Ernest Graham-Little has done in connection with 'The Great Bread Mystery'. Space in this book, however, precludes my doing other than make the shortest possible reference thereto. He has dealt with this subject so ably in a brochure issued under the title *The Great Bread Mystery* that I feel it my duty to refer readers to that record.

That influential journal *The Medical Press and Circular* is continuously drawing the attention of the medical fraternity, and of the public alike, to the national need of the whole-grain loaf, and in their article 'Unsolved Enigma', which is reproduced here, it will be seen what severe criticisms they have to bestow upon the former Minister of Food, Lord Woolton.

They have returned to this onslaught again and again but up to the present the milling interests and the Government take no notice of either Sir Ernest Graham Little or the *Medical Press.*

It is sometimes argued that British wheat is not good milling wheat. In a bad season like 1944, when so much rain fell during harvest time, there can be no doubt about it that the British wheat suffered most terribly. At the same time, when we can find a better method of harvesting (such as the intra-molecular respiration of the enzymes system referred to in another chapter) there is no reason why British wheat should not be regularly harvested in good condition, and there is no wheat in the the world with the quality that is produced from British humus-filled soil.

UNSOLVED ENIGMA

'The recent debate in the House of Commons gave the new Minister of Food an opportunity to review our food situation in the light of nearly five years of war. The Minister's speech was not untinged with complacency. "Things", he declared at the outset, "are going well on the food front"; and in his peroration he

concluded: "The Ministry of Food is jealous of the reputation it has built up. Its staff has a strong and deep desire to serve the people well, to maintain their fighting strength and their fitness in factory and field. The remarkable health record of the nation during the war and, above all, the health of the children, has been their chief reward. It is my aim so to lead the great team I have that the reward will still be theirs."

'Perhaps a certain amount of complacency on the Minister's part might well be pardoned. His ministry has certainly done its most difficult work with good will, with zeal and, for the most part, with commendable sagacity. As he justly claimed, infant mortality has touched a new low level, and mercifully we have been spared a major epidemic. But to suppose that the general standard of well-being marches with the figures is, in our view, absurd. The figures for maternal and neonatal mortality, for example, are for persons for whom special provision has been made, nor are they uninfluenced by the availability of our powerful new bactericidal drugs. The same applies to the figures for infectious diseases, with the addition of immunization as a preventive of diphtheria. But there are no figures for minor ailments, such as dyspepsia or sporadic entero-colitis, and none for gastritis, duodenitis, or peptic ulceration. The figures for pulmonary tuberculosis give little grounds for satisfaction. On the whole, however, considering the circumstances, we may forgive and even applaud the Minister's satisfaction with his ministry. With one exception.

'That is our bread. The Minister hurried past bread. "We eat", he stated, "some four million tons of bread a year. The bread is better than it was. The oats, rye and barley have gone, and now the only cereal left is wheat." But as to the other ingredients he preserved a discreet silence. How much potato flour is there, for instance? And how much bran and how little wheat germ—if any? And of the four million tons of bread consumed annually, how many thousands of tons of chalk pass through our alimentary canals with results hitherto undetermined? To these questions, so often asked, the Minister and his advisers remain obstinately silent.

'In a written answer to a recent question the Minister stated that the addition of calcium to the 85 per cent extraction loaf was made on the recommendation of the Medical Research Council and approved by the Chief Medical Officer's Standing Committee of the Ministry of Health. It is a little difficult to see why the former body, which was founded for quite different purposes, and none of whose then members (with one exception) had evinced any particular interest in dietetics, should have been consulted at all. But, indeed, the source of the recommendation is well known. It is one thing to hold and maintain an opinion—that is every man's right, and often his duty—but to thrust it down the throats of his fellow citizens, in the form of chalk, against their will, and in defiance of the findings of such bodies as the Dietetic Committee of the American Medical Association—argues either a compelling obsession or an egotism of no ordinary intensity and stature.

'This recommendation was fiercely attacked in the pages of the medical journals at the time it was adopted and, for our own part, we have never yet met a doctor who had a good word to say for it. The defence appears to be that the calcium will do no harm, and that it *may* prevent rickets, osteomalacia and dental decay. As to the harmlessness of calcium, we know that it tends to cause constipation; whether it will produce long-term effects, such as the arterio-sclerosis and increased incidence of stone formation, prophesied by some, time alone will show. Meantime the experiment goes forward.

'But that is not our main point. What troubles us is the support that this mischievous recommendation has given to the enemies of good nutrition. The curse of our pre-war "can and carton" domestic economy was denatured food, and the greatest single offender, our white flour, deprived of the wheat germ and the germ oil, and "improved" with alum and other dubious chemicals. Under the tea, white bread and margarine regime, malnutrition was rife. So, too, were rickets and dental decay, the first until the role of vitamin D was demonstrated, and the second until the ante- and post-natal clinics and the school medical and dental services combined to reduce it to reasonable proportions. But dental decay is common to-day despite their efforts, despite extra rations for expectant and nursing mothers and young children, and despite the chalk; it is rife in the United States, the home of denatured, phytin-free cereals. Recent work in that country, in fact, strongly suggests that a deficiency in fluorine plays a cardinal part in its causation, so much so that a vast experiment is reported to be under way to verify this hypothesis.

'After the war no doubt we shall return to our peace-time practices. The merry racket by which the germ is removed from the wheat and sold to us in chemists' shops as an essential nerve food at six times its normal price, will begin again; the public, in its snobbery and ignorance, will demand and receive its white bread, and the vendors of ready-cooked worthless breakfast cereals will continue to sell them at a highly satisfactory profit. But now they have a new weapon. They will be able to say: "Mothers! we are saving your children from rickets and safeguarding their teeth!" and if necessary they can quote the Medical Research Council on their claims. May those who are responsible for this monstrous perversion of the truth be suitably rewarded.'

From the point of view of the health of the people and the health of our livestock whole-wheat bread is important, and it is especially interesting to farmers in so far as they ought to be encouraged here in Britain to produce our own wheat. It has been alleged time and again that other countries are more suitable to wheat production than Britain. I maintain that there is no country in the world where better wheat can be produced than in England, and if only we find out the best methods of harvesting, I believe that the special difficulties and disadvantages of our weather can be overcome. And overcome they must be; for it must never be said that any other country can produce better wheat than we can, and certainly not better wheat than our peculiar climate demands. For I believe it is one of the provisions of Nature, that each country can grow food peculiarly suited to sustain life within its own area and, if for that reason alone, so far as foodstuffs are concerned, be as nearly as possible self-supporting. Wheat growing, therefore, must be an essential part of our industry of farming, and I ask that propaganda against its inclusion from our system of husbandry should be stamped out with all the vigour of which we are capable.

In his *Farming Memoirs* S. G. Kendall says, 'Providing English grown wheat is of good quality it is still sought by all first-class mills, since a little of it gives that excellent flavour which few foreign grown wheats can produce.'

I am prepared to go further than this and state with emphasis that in these days, when every country has been exploited to grow wheat to export to England at less than the cost of its production, all that wheat, without exception, is grown on land which has been reduced to a very low standard of fertility. Deficiency diseases in wheat crops are reported from all the wheat producing countries of the world. These are entirely due to exhaustive cropping and to the failure, on the part of the farmers, to restore humus to the soil through animal dung and urine, the ingredients which they have taken out through heavy and persistent wheat cropping. This, obviously, must produce a wheat which lacks both flavour and life-giving properties.

We have had a political and economic policy which demanded 'cheap food', and we have certainly been provided with 'cheap food'. After all, whether one is a farmer or the maker of rouge and lipstick, one cannot get anywhere in the world 'ninepence for fourpence', and 'cheap anything' generally means a commodity which is both 'nasty' as well as 'cheap'.

It is of the utmost importance, therefore, that wheat-growing, no matter what kind of international trading policy is eventually decided upon, should remain one of the staple lines of British farming husbandry.

As a life-giving force to our people our wheat was second to none in the world, even when other countries were working for the first time on their virgin prairies. Many of them have only kept going with wheat production through the fact that they have regularly bought much of the seed-wheat they used from this country. The Salisbury Plain area, where I now live, is world-famous for the seed-wheat grown here. Every year a large quantity is exported throughout the world. And yet the amateur economists would tell us that England is not a wheat-growing country.

This brings me to one of the most important themes of this book—the Health of our People. There is no other purpose in life more important than that of procreating and building up a virile human population.

The very unsatisfactory state of my own health when I was twenty-two years old led me into a deeper study of diet than falls to the lot of those who are blessed and fortified with a constitution that can eat anything and defy everything. 1 was not one of them, and all my life food has had to be a close study with me.

Not until the doctor says, 'I can do nothing for you', does the average citizen take the slightest interest in the kind of food he eats, when he eats it, whence it came, or how it was produced. When, however, he receives a 'death warrant' in the foregoing terms, he instantly feels, perhaps for the first time, that health is more important than anything else in the world, and will listen to the possibilities that food, and quality in food, has something to do with both good and bad health.

To-day, nearly forty years after my doctors told my father that I had but six months more to live, I am grateful to be able to say that I now enjoy a degree of health, a standard of strength, fitness and endurance as good as anyone could wish to possess.

This has been achieved mainly, and basically, because I have long ago discovered that of all human foods there is nothing we consume so important as 'our daily bread'. This should be made from home-grown wheat, grown on humus-filled land, and milled so as to preserve the *whole-grain* which includes the life-giving germ. A man can eat almost anything and be healthy, provided he starts the day right with his first meal consisting of:

Health Porridge and Whole-Grain Bread made from home-grown wheat.

Home-grown, and humus-grown, wheat contains everything that the body needs. *It is a perfect* and complete food. In its coarsely ground flour it possesses all that is required to secure perfect peristaltic action and efficient elimination.

Every disease known—from the common cold to cancer—finds its origin in constipation. A dirty, disease-ridden bowel produces those toxic conditions out of which all disease originates and develops. Cure this set of conditions and you must inevitably be healthy. Whole-grain health porridge and whole-meal bread effectively accomplish this.

The eminent medical testimony in this chapter proves how the whole world is exploited by the misuse of the wheat cereal.

I go even further, and say that if you would really know rude health, that feeling of fitness every day, with scarcely ever an experience either of headache or a common cold, and with a complete indifference to weather, however severe—even when you live on a mountain top 829 feet above sea level and exposed to the north-east—you can have all this. It can be obtained if only you will insist on being supplied with a sack of humus-grown wheat for your household.

Mill your own flour in a small power mill, and grind each supply of your own home-milled flour, in 4 lb. lots, just as you need it for your own baking.

Here I would emphasize the use of the whole-wheat grain by way of a substitute for the ordinary oat porridge—and especially for the factory-made breakfast cereals in packets, which lazy housewives put on to the breakfast tables.

There is a *health porridge* from whole-wheat grain, made by Mrs. Horsfield, Dean Water Mill, Lindfield, Sussex, which is, *par excellence,* the finest cure for constipation known anywhere. Farmers who have an ordinary Bamford Roller Mill can make this for themselves. The townsman can get it by post from Mrs. Horsfield, or from any of the health centre shops to be found in all our large towns. I recommend this Horsfield porridge to everyone. It is easy to prepare, and excellent to eat.

Where can wheat grown on humus-filled land be bought? If there had been no war, and if there were no restrictions, it could be bought from me—I doubt very much whether wheat quite like mine can be bought anywhere, for if there are any farmers to-day who do not use artificials I do not know of them.

Unless he is prepared to write to his Member of Parliament and demand that these restrictions should be raised or waived—under suitable conditions, such as an undertaking that the wheat shall not be used to feed backyard chickens—the townsman will have to submit to a lifeless deficient white bread, because of the Ministry, who make and administer our laws.

While extracts from wheat are sold in tins in large quantities and at high prices over the chemists' counter, when all this extracting is, perhaps, far more profit-making than selling the whole-grain to the consumer, you cannot expect vested interests to yield easily their profit-making industries to such reorganization as this chapter shows to be desirable. Vitamins taken with a spoon may be convenient and, when a patient is 'down and out', may be useful; but to deprive our most life-giving cereal—wheat—of all its elementary life-sustaining forces—the wheat germ—for no other good reason than private profit, is a crime.

Perhaps, some day, when our apathetic population is a little more exploited for gain, a little more downtrodden and further deprived of the essentials of life, we may have a revolution against this monopoly.

Until then, the Ministry of Food will tell you to eat more and more white bread.

Remember the old Scottish saw:

The whiter your bread,
The sooner you're dead.

AUTHOR'S NOTE

Leslie Forbes, Cottage Mill, Chute, Andover, is another maker of Wholemeal Flour and a Wholemeal Porridge.

PART V

CHAPTER XXIX

THE EARTHWORM – MAN'S GREAT BENEFACTOR

On 1st November 1837, Charles Darwin read a paper before the Geological Society of London on the formation of moulds in which it was shown that small fragments of burnt marl, cinders, etc., which had been thickly strewn over the surface of several meadows, were found after a few years lying at the depth of some inches below the turf, but still forming a layer. This apparent sinking of superficial bodies is due to the large quantity of fine earth continually brought up to the surface by worms in the form of castings. These castings are sooner or later spread out and cover up any object left on the surface. Charles Darwin was thus led to conclude that all the vegetable mould all over the country had passed many times through, and will again pass many times through, the intestinal canals of worms. Hence the term 'animal mould' would be in some respects more appropriate than that commonly used term 'vegetable mould'. Ten years after the publication of Darwin's paper, a Frenchman named M. D'Archiac, evidently influenced by the doctrines of Beaumont, wrote about Darwin's theory and described it as the 'singulière theorie', and objected that it could only apply to 'les prairies basses et humides'; and that 'les terres labourées, les bois, les prairies élevées, n'apportent aucune preuve à l'appui de cette manière de voir.' But D'Archiac must have thus argued from inner consciousness and not from observation, for worms abound to an extraordinary degree in kitchen gardens where the soil is continually worked, though in such loose soil they generally deposit their castings in any open cavities or within their old burrows instead of on the surface of the soil. Hensen estimates that there are about twice as many worms in gardens as in cornfields. In woods, again, if the loose leaves in autumn are removed, the whole surface is generally found filled with worm casts. Dr. King, Superintendent of the Botanical Gardens in Calcutta, to whose kindness Darwin was indebted for many observations on earthworms, informed Darwin that he found, near Nancy in France, the bottom of the State forests covered over many acres with a spongy layer, composed of dead leaves and innumerable worm-castings. I write in the year 1944, which is 107 years after Darwin read his first paper to the Geological Society in London, but I wonder how many farmers there are, of the 360,000 farmers in Britain, who have read Darwin's book on the 'formation of vegetable mould' through the action of worms with his observations on the happenings. I wonder if one in 5,000 of those farmers have read that valuable work, and yet I doubt very much if there is any contribution to agricultural literature that is so important to the farmer as these investigations of Darwin's. For the part which worms have taken in the formation of the layer of vegetable moulds which covers the whole surface of the land in every country, is an important one.

'Means by which Worms Excavate their Burrows. This is effected in two ways; by pushing away the earth on all sides, and by swallowing it. In the former case, the worm inserts the stretched out and attenuated anterior extremity of its body into any little crevice, or hole; and then, as Perrier remarks, the pharynx is pushed forwards into this part, which consequently swells and pushes away the earth on all sides. The anterior extremity thus serves as a wedge. It also serves, as we have before seen, for prehension and suction, and as a tactile organ. A worm was placed on loose mould, and it buried itself in between two and three minutes. On another occasion four worms disappeared in fifteen minutes between the sides of the pot and the earth, which had been moderately pressed down. On a third occasion three large worms and a small one were placed on loose mould well mixed with fine sand and firmly pressed down, and they all disappeared, except the tail of one, in thirty-five minutes. On a fourth occasion six large worms were placed on argillaceous mud mixed with sand firmly pressed down, and they disappeared, except the extreme tips of the tails of two of them, in forty minutes. In none of these cases did the worms swallow, as far as could be seen, any earth. They generally entered the ground close to the sides of the pot.

'A pot was next filled with very fine ferruginous sand, which was pressed down, well watered, and thus rendered extremely compact. A large worm left on the surface did not succeed in penetrating it for some hours, and did not bury itself completely until 25 hr. 40 min. had elapsed. This was effected by the sand being swallowed, as was evident by the large quantity ejected from the vent, long before the whole body had

disappeared. Castings of a similar nature continued to be ejected from the burrow during the whole of the following day.

'As doubts have been expressed by some writers whether worms ever swallow earth solely for the sake of making their burrows, some additional cases may be given. A mass of fine reddish sand, twenty-three inches in thickness, left on the ground for nearly two years, had been penetrated in many places by worms; and their castings consisted partly of the reddish sand and partly of black earth brought up from beneath the mass. This sand had been dug up from a considerable depth, and was of so poor a nature that weeds could not grow on it. It is therefore highly improbable that it should have been swallowed by the worms as food. Again, in a field near my house the castings frequently consist of almost pure chalk, which lies at only a little depth beneath the surface; and here again it is very improbable that the chalk should have been swallowed for the sake of the very little organic matter which could have percolated into it from the poor overlying pasture. Lastly, a casting thrown up through the concrete and decayed mortar between the tiles, with which the now ruined aisle of Beaulieu Abbey had formerly been paved, was washed, so that the coarser matter alone was left. This consisted of grains of quartz, micaceous slate, other rocks, and bricks or tiles, many of them from one-twentieth to one-tenth inch in diameter. No one will suppose that these grains were swallowed as food, yet they weighed 19 grains, the whole casting having weighed 33 grains. Whenever a worm burrows to a depth of some feet in undisturbed compact ground, it must form its passage by swallowing the earth; for it is incredible that the ground could yield on all sides to the pressure of the pharynx when pushed forwards within the worm's body.

'That worms swallow a larger quantity of earth for the sake of extracting any nutritious matter which it may contain than for making their burrows, appears to me certain. But as this old belief has been doubted by so high an authority as Claparède, evidence in its favour must be given in some detail. There is no *a priori* improbability in such a belief, for besides other annelids, especially the Arenicola marina, which throws up such a profusion of castings on our tidal sands, and which it is believed thus subsists, there are animals belonging to the most distinct classes, which do not burrow, but habitually swallow large quantities of sand; namely, the molluscan Onchidium and many Echinoderms.

'If earth were swallowed only when worms deepened their burrows or made new ones, castings would be thrown up only occasionally; but in many places fresh castings may be seen every morning, and the amount of earth ejected from the same burrow on successive days is large. Yet worms do not burrow to a great depth, except when the weather is very dry or intensely cold. On my lawn the black vegetable mould or humus is only about five inches in thickness, and overlies light-coloured or reddish clayey soil; now when castings are thrown up in the greatest profusion, only a small proportion are light coloured, and it is incredible that the worms should daily make fresh burrows in every direction in the thin superficial layer of dark-coloured mould, unless they obtain nutriment of some kind from it. I have observed a strictly analogous case in a field near my house where bright red clay lay close beneath the surface. Again on one part of the Downs near Winchester the vegetable mould overlying the chalk was found to be only from three to four inches in thickness; and the many castings here ejected were as black as ink and did not effervesce with acids; so that the worms must have confined themselves to this thin superficial layer of mould, of which large quantities were daily swallowed. In another place at no great distance the castings were white; and why the worms should have burrowed into the chalk in some places and not in others, I am unable to conjecture.

'Two great piles of leaves had been left to decay in my grounds, and months after their removal, the bare surface, several yards in diameter, was so thickly covered during several months with castings that they formed an almost continuous layer; and the large number of worms which lived here must have subsisted during these months on nutritious matter contained in the black earth....

'From the several foregoing cases, it can hardly be doubted that worms swallow earth, not only for the sake of making their burrows, but for obtaining food. Hensen, however, concludes from his analyses of mould that worms probably could not live on ordinary vegetable mould, though he admits that they might be nourished to some extent by leaf-mould. But we have seen that worms eagerly devour raw meat, fat, and dead worms; and ordinary mould can hardly fail to contain many ova, larvae, and small living or dead creatures, spores of cryptogamic plants, and micrococci, such as those which give rise to saltpetre. These various organisms, together with some cellulose from any leaves and roots not utterly decayed, might well account for such large quantities of mould being swallowed by worms. It may be worth while here to recall the fact that certain species of Utricularia, which grow in damp places in the tropics, possess bladders beautifully constructed for catching minute subterranean animals; and these traps would not have been developed unless many small animals inhabited such soil.

'The Depth to which Worms Penetrate, and the Construction of their Burrows. Although worms usually live near the surface, yet they burrow to a considerable depth during long-continued dry weather and severe

cold. In Scandinavia, according to Eisen, and in Scotland, according to Mr. Lindsay Carnegie, the burrows run down to a depth of from 7 to 8 feet; in northern Germany, according to Hoffmeister, from 6 to 8 feet, but Hensen says from 3 to 6 feet. This latter observer has seen worms frozen at a depth of 1½ feet beneath the surface. I have not myself had many opportunities for observation, but I have often met with worms at depths of 3 to 4 feet. In a bed of fine sand overlying the chalk, which had never been disturbed, a worm was cut into two at 55 inches, and another was found here at Down in December at the bottom of its burrow, at 61 inches beneath the surface. Lastly, in earth near an old Roman villa, which had not been disturbed for many centuries, a worm was met with at a depth of 66 inches; and this was in the middle of August.

'The burrows run down perpendicularly, or more commonly a little obliquely. They are said sometimes to branch, but as far as I have seen this does not occur, except in recently dug ground and near the surface. They are generally, or as I believe invariably, lined with a thin layer of fine, dark-coloured earth voided by the worms; so that they must at first be made a little wider than their ultimate diameter. I have seen several burrows in undisturbed sand thus lined at a depth of 4 ft. 6 in.; and others close to the surface thus lined in recently dug ground. The walls of fresh burrows are often dotted with little globular pellets of voided earth, still soft and viscid; and these, as it appears, are spread out on all sides by the worm as it travels up or down its burrow. The lining thus formed becomes very compact and smooth when nearly dry, and closely fits the worm's body. The minute reflexed bristles which project in rows on all sides from the body, thus have excellent points of support; and the burrow is rendered well adapted for the rapid movement of the animal. The lining appears also to strengthen the walls, and perhaps saves the worm's body from being scratched. I think so because several burrows which passed through a layer of sifted coal-cinders, spread over turf to a thickness of 1½ inches, had been thus lined to an unusual thickness. In this case the worms, judging from the castings, had pushed the cinders away on all sides and had not swallowed any of them. In another place, burrows similarly lined, passed through a layer of coarse coal-cinders, 3½ inches in thickness. We thus see that the burrows are not mere excavations, but may rather be compared with tunnels lined with cement. . . .

'A worm after swallowing earth, whether for making its burrow or for food, soon comes to the surface to empty its body. The ejected earth is thoroughly mingled with the intestinal secretions, and is thus rendered viscid. After being dried it sets hard. I have watched worms during the act of ejection, and when the earth was in a very liquid state it was ejected in little spurts, and by a slow peristaltic movement when not so liquid. It is not cast indifferently on any side, but with some care, first on one and then on another side; the tail being used almost like a trowel. When a worm comes to the surface to eject earth, the tail protrudes, but when it collects leaves its head must protrude. Worms therefore must have the power of turning round in their closely fitting burrows; and this, as it appears to us, would be a difficult feat. As soon as a little heap has been formed, the worm apparently avoids, for the sake of safety, protruding its tail; and the earthy matter is forced up through the previously deposited soft mass....

'Worms do not always eject their castings on the surface of the ground. When they can find any cavity, as when burrowing in newly turned-up earth, or between the stems of banked-up plants, they deposit their castings in such places. So again any hollow beneath a large stone lying on the surface of the ground is soon filled up with their castings.. . .

'It is certain that old burrows collapse in the course of time; for the fine earth voided by worms, if spread out uniformly, would form in many places in the course of a year a layer one-fifth of an inch in thickness ; so that at any rate this large amount is not deposited within the old unused burrows. If the burrows did not collapse, the whole ground would be first thickly riddled with holes to a depth of about ten inches, and in fifty years a hollow unsupported space, ten inches in depth, would be left. The holes left by the decay of successively formed roots of trees and plants must likewise collapse in the course of time.'

The study of Darwin's investigation into the habits of the earthworm leads one to the conclusion that he proved that the amount of earth brought up by worms every year throughout the ages is enormous, and one is compelled to admit that the earth's covering of mould has largely been put there, in its present form, in the course of countless centuries by the activities of this perfectly wonderful little animal.

I can imagine the average farmer, reading these words for the first time and perhaps not having given much thought to the work which the earthworm performs on the farm, may say, 'Well, this is very interesting, I wonder when we shall know exactly how many worms we ought to have to the acre in order to make certain that all this manufacturing by the worm is going on to maximum capacity.'

Sir Albert Howard puts the matter in a very practical way when he says that if you take an ordinary garden spade and dig with it and if one or two healthy, pink, active worms come up with every spadeful of earth, you can assume that all is well with the land, and that the quality and quantity of the next season's crops is assured; but if the worms are few or if they are coiled up in balls, or pale in colour and sluggish in their movements, then Sir Albert says, the next crop will be poor, and trouble with pests will almost certainly

be inevitable. In Britain, old and experienced gardeners pay great attention to the earthworms and often make their manuring largely on the indications they furnish. In return for what the earthworms do for the gardener, all that is needed is to supply these animals with the right kind of food and to avoid the use of unnatural nourishment. Earthworms thrive on farmyard manure, or better still on compost, manufactured from vegetable and animal waste. On a diet of artificial manure and poison sprays they either perish outright or abandon the garden and farm to their fate.

Sir Albert tells us that a few years ago in south Lincolnshire, while investigating the root developments of a crop of potatoes he noticed that the fine roots of the potato plant in passing downwards into the subsoil always made full use of the tunnels that were created and made by the earthworm. In these galleries fresh worm casts were constantly being deposited. Whenever the fine roots passed one of these deposits it at once formed a web-like network of new roots which closely invested the cast and penetrated it in all directions. Then the root continued its downward passage into the subsoil. Obviously the potato was receiving something from the cast, or this network of new roots would not have been developed.

Feeding the crop is not the last service performed by the earthworm, they are the ideal soil analyst, and furnish the gardener and the farmer with a report on the state of his land. All that is necessary is for the gardener or farmer himself to make a rough count of the earthworms in the top spit of soil and to notice their colour, their general condition and, above all, their liveliness.

According to a large number of experiments and observations which Darwin made, it would appear that the tonnage of earthworm casts to the acre would vary from eight to sixteen tons per acre per annum.

How much do we owe to the earthworm?

If, as a practical farmer, I was asked to set out the scientific and practical deduction that I learned from my own study of the activity of the worm and from what Darwin and other scientists have told us, I would say this: The worm provides me with all the mineral content of my soil that I can possibly need. He provides me with no end of subsoiling and underground drainage needed for water and for other purposes connected with the growth of the plants. He creates a system for the circulation of oxygen without which the soil cannot be healthy or even live. He keeps down the population of the malignant anaerobic bacteria, and of pests such as wireworm and leather-jacket, all enemies of my plants.

Perhaps more important than all he is a conditioner of all the mineral requirements of my soil—he is Soil Conditioner No. 1—concentrating them and bringing them to the surface where I need them most; these include the essential ingredients—phosphates, potash, nitrogen and lime —and the trace elements as well.

Since the earthworm provides me with all these it is my duty to carry on such a system of husbandry and refertilization as will encourage him to live and multiply in increasing numbers; to make his activities more and more lively. Any act of farming which threatens the life of the earthworm is one of which 1 ought not to be guilty.

In other words, the one thing that I must do with my soil is to keep it a living entity—to see that it is frequently and adequately cultivated; to secure that it is fed with living organic matter, so that the earthworm can live and do his part, and the rest of Nature can perform hers.

Without the earthworm, I, as a farmer, believe that I cannot live. And I am not referring to my lifetime only, for I am simply an occupier for the period of my life only of the land which I farm. At the end of my time of occupation, I have to hand this heritage over to my successors, and it is my duty to see that the land is in better condition than when I assumed my tenancy. To give Darwin the final word, he says the plough is one of the most ancient and most valuable of man's inventions and that long before he existed the land was, in fact, regularly ploughed by earthworms. It may be doubted whether there are any other animals that have played so important a part in the history of the world as these low-organized creatures.

A visit to almost any orchard in Kent during the spring immediately after the trees are sprayed with tar oils or lime sulphur will be sufficient to prove how harmful this spraying is to the earthworm population. The ground soon afterwards is covered with a carpet of dead worms.

It is in the United States of America that Darwin's studies of the earthworm have of recent years attracted most attention, and have also been carried further in a number of useful directions. The reader interested in these developments should begin with the work of Dr. Oliver who, in 1937, published *Our Friend the Earthworm,* which contains a detailed account of his studies. Starting life as a doctor, quite by chance be read Darwin's account of the work of the earthworm and at once began to investigate the relation of these animals to crop production. Soon he obtained evidence which fully confirmed Darwin's findings. Thus was started a series of experiments on the culture of earthworms, on the production of new types of hybridization, and the distribution of egg capsules for the purpose of restocking and improving derelict land almost devoid of these creatures. His success was immediate and in two years he sold his medical practice and set up as a landscape engineer, his main work being to improve private estates and public parks. By 1920 he had

become independent and was able to move to Los Angeles, where he pursued his investigations on a ten-acre experimental farm. In 1937 he published his results in the above-mentioned work of three volumes, which has helped hundreds of farmers all over the United States to restore fertility to barren land where the earthworm population had been destroyed by artificial manures and poison sprays.

One factor in Oliver's career must be emphasized. His mind was prepared for the message contained in *Vegetable Mould and Earthworms* by his early connection with farming, a detailed account of which will be found in the issue of *Organic Gardening* (The Rodale Press, Emmaus, Pa., U.S.A.) of June 1943. As a small boy, he went to live with his grandfather in Huron County, Ohio, on a 160-acre family holding which had been farmed continuously for sixty years on organic lines. This farm was divided into four blocks of forty acres, one of which was taken up by the homestead, garden, orchard, and park, the other three blocks being used for mixed farming. In the centre of the whole 160 acres was the farmyard of two acres, which communicated directly with each of the four forty-acre blocks by large swinging gates. In the centre of the farmyard, in which the livestock were kept during the winter, was the compost pit, 50 feet wide and 100 feet long, which had been excavated to a depth of 2 feet. Down the middle line of this compost pit about 20 feet from each end were two heavy posts about 12 feet high, each connected with the barn by a cable furnished with large travelling baskets, by which the manure from the great barn was transported each morning to the compost pit, where it was evenly spread. When necessary the contents of the compost pit could be flooded by gravity flow from a neighbouring stream, which also supplied the drinking troughs of the livestock. The heart of this farm, on which crop failures were unknown, was the compost pit and its vast earthworm population of several millions.

An essential item of the daily work of the farm was the care of this compost pit. Every morning the barn was cleared of the droppings of the livestock, which were evenly spread, together with all the available soiled litter, on the compost heap. When about a foot deep, several tons of red clay from the floor of a pond were distributed all over the compost pit. In this way the vast earthworm population was supplied with organic and mineral food. After the spring thaw, the upper layer of the compost pit was removed and the rich dark crumbling layer of sweet-smelling worm casts was removed by shovels into waggons and spread on the fields just in front of the ploughs. Thus an effective addition to the food materials needed by the new crop, as well as a copious supply of earthworms and egg capsules, was given to the land. Care was always taken to leave behind in the compost pit an adequate supply of earthworm castings, which acted as a 'mother substance' for the composting of the surplus top material when that was returned to the pit and composting was restarted.

This early experience naturally influenced Oliver in his later work. He had observed in his boyhood that earthworms will thrive and that a concentration of many thousands to the cubic yard is possible, provided a suitable environment, sufficient moisture, and above all ample food are supplied.

On this Ohio farm a regular rotation was practised—two straw crops (wheat and maize)—followed by a temporary ley of mixed timothy and clover. Every year some forty acres of this ley were turned under. These areas always contained an unbelievable earthworm population.

A further detail must be mentioned. Four acres were in orchard, while other fruit trees were planted in the hedgerows. Oliver's grandfather never allowed these trees to be cultivated. His motto was: 'Never disturb the soil under a tree. The earthworms are the best people for taking care of a tree and I don't want them disturbed.'

Oliver concludes the autobiographical fragment, from which the above account of his grandfather's farm is taken, with the following words:

'In this example of my grandfather's earthworm farm, we have the technique of utilizing the earthworm in general farming operations either on a large or on a small scale. From my experience as a small boy growing up on this farm with much friendly and loving instruction from my grandfather on the subject of earthworms, and in my own work covering a period of more than forty years, I am fully convinced that the eventual salvation of the soil of our country will include the harnessing of the earthworm as one of the major measures. And from my experience I know that the soil can be made to produce several times as much food as the present average through the proper harnessing and utilization of the earthworm under control.' (Sir Albert Howard)

The preceding paragraph will help to explain the origin of the present-day interest in the place of the earthworm in farming, which is rapidly growing in the United States of America and which is re-enforcing the campaign against artificial manures and poison sprays.

There is a growing volume of evidence from all over the world that agriculture took the wrong road when artificial manures were introduced to stimulate crop production and when poison sprays became common to check insect and fungous pests. Both these agencies destroy the earthworm and thus deprive the

farmer of an important member of his unpaid labour force. There is also a strong case for believing that one of the roots of present-day disease in crops, livestock, and mankind can be traced to an impoverished soil and that these troubles are aggravated by the use of chemical manures.

CHAPTER XXX

COMPOST MAKING BY MECHANIZATION

Compost in one form or another was a process in nature before the beginning of man's occupation of the earth. Decomposition of the rock which now makes the soil covering of the earth which we use to live upon was the first agency by which compost was made. During the last forty centuries, China has been the foremost country in the world in the manufacture of man-made compost, and she alone, of all civilization, has maintained an increasing population, and yet never diminished the fertility of the soil; and her population continues to increase as at the same time her land fertility rises.

When Sir Albert Howard went to India some forty or so years ago, he left these shores with such training—largely of a chemical character— as he had obtained from Cambridge University, and he regarded the experiments of Rothamsted as the accepted basis of all calculations. When, however, he journeyed out into the Orient and studied the methods that had been in vogue for so long, he began to retrain his ideas and to experiment on new planes to seek new evidence.

He sets out the whole of this story in his most interesting book which every reader should possess, *An Agricultural Testament,* and in his more recent contribution, *Farming and Gardening for Health or Disease.*

In these books he details the system of compost making which he has described as the Indore Process. I cannot do better here than quote his own description of it. I have been a student of his methods for many years, and although I have modified his system to suit my own requirements in many particulars, which will be detailed in this chapter, I am, nevertheless, broadly following the Indore Process.

THE RAW MATERIALS NEEDED

1. Vegetable Wastes

'In temperate countries like Great Britain these include straw, chaff, damaged hay and clover, hedge and bank trimmings, weeds including sea and water weeds, prunings, hop-bine and hop-string, potato haulm, market-garden residues including those of the greenhouse, bracken, fallen leaves, sawdust, and wood shavings. A limited amount of other vegetable material like the husks of cotton seed, cacao, and ground nuts as well as banana stalks are also available near some of the large cities.

In the tropics and sub-tropics the vegetable wastes consist of very similar materials including the vegetation of waste areas, grass, plants grown for shade and green-manure, sugar-cane leaves and stumps, all crop residues not consumed by livestock, cotton stalks, weeds, sawdust and wood shavings, and plants grown for providing compostable material on the borders of fields, roadsides, and any vacant corners available.

'A continuous supply of mixed dry vegetable wastes throughout the year, in a proper state of division, is the chief factor in the process. The ideal chemical composition of these materials should be such that, after being used as bedding for livestock, the carbon-nitrogen ratio is in the neighbourhood of 33:1. The material should also be in such a physical condition that the fungi and bacteria can obtain ready access to and break down the tissues without delay. The bark, which is the natural protection of the celluloses and lignins against the inroads of fungi, must first be destroyed. This is the reason why all woody materials—such as cotton and pigeon-pea stalks—were always laid on the roads at Indore and crushed by the traffic into a fine state of division before composting.

'All over the world one of the first objections to the adoption of the Indore Process is that there is nothing worth composting or only small supplies of such material. In practically all such cases any shortage of wastes has soon been met by a more effective use of the land and by actually growing plants for composting on every possible square foot of soil. If Nature's way of using sunlight to the full in the virgin forest is compared with that on the average farm or on the average tea and rubber estate, it will be seen what leeway can be made up in growing suitable material for making humus. Sometimes the objection is heard that all this will cost too much. The answer is provided by the dust bowls of North America. The soil must have its manurial rights or farming dies.

2. Animal Residues

'The animal residues ordinarily available all over the world are much the same—the urine and dung of livestock, the droppings of poultry, kitchen waste including bones. Where no livestock is kept and animal residues are not available, substitutes such as dried blood, slaughterhouse refuse, powdered hoof and horn,

fish manure, and so forth can be employed. The waste products of the animal in some form or another are essential if real humus is to be made for the two following reasons.

'(*a*) The verdict given by mother earth between humus made with animal residues and humus made with chemical activators like calcium cyanamide and the various salts of ammonia has always been in favour of the former. One has only to feel and smell a handful of compost made by these two methods to understand the plant's preference for humus made with animal residues. The one is soft to the feel with the smell of rich woodland earth: the other is often harsh to the touch with a sour odour. Sometimes when the two samples of humus made from similar vegetable wastes are analysed, the better report is obtained by the compost made with chemical activators. When, however, they are applied to the soil the plant speedily reverses the verdict of the laboratory. Dr. Rayner refers to this conflict between mother earth and the analyst, in the case of some composts suitable for forestry nurseries, in the following words:

"Full chemical analyses are now available for a number of these composts, and it is not without interest to recall that in the initial stages of the work a competent critic reported on one of them—since proved to be among the most effective—on a basis of comparative analysis, as 'an organic manure of comparatively little value'; while another—since proved least successful of all those tested—was approved as a 'first-class organic manure'."

'The activator used in the first case was dried blood, in the second case an ammonium salt.

'(*b*) No permanent or effective system of agriculture has ever been devised without the animal. Many attempts have been made, but sooner or later they break down. The replacement of livestock by artificials is always followed by disease the moment the original store of soil fertility is exhausted.

'Where livestock is maintained the collection of their waste products— urine and dung—in the most effective manner is important.

'At Indore the work-cattle were kept in well-ventilated sheds with earthen floors and were bedded down daily with mixed vegetable wastes including about 5 per cent by volume of hard resistant material such as wood shavings and sawdust. The cattle slept on this bedding during the night when it was still further broken up and impregnated with urine. Next morning the soiled bedding and cattle dung were removed to the pits for composting; the earthen floor was then swept clean and all wet places were covered with new earth, after scraping out the very wet patches. In this way all the urine of the animals was absorbed; all smell in the cattle sheds was avoided, and the breeding of flies in the earth underneath the animals was entirely prevented. A new layer of bedding for the next day was then laid.

'Every three months the earth under the cattle was changed, the urine-impregnated soil was broken up in a mortar mill and stored under cover near the compost pits. This urine earth, mixed with any wood ashes available, served as a combined activator and base in composting.

'In the. tropics, where there is abundance of labour, no difficulty will be experienced in copying the Indore plan. All the urine can be absorbed: all the soiled bedding can be used in the compost pits every morning.

'In countries like Great Britain and North America, where labour is both scarce and dear, objection will at once be raised to the Indore plan. Concrete or pitched floors are here the rule. The valuable urine and dung are often removed to the drains by a water spray. In such cases, however, the indispensable urine would either be absorbed on the floors themselves by the addition of the bedding of substances like peat and sawdust mixed with a little earth, or the urine could be directed into small bricked pits just outside the building, filled with any suitable absorbent which is periodically removed and renewed. In this way liquid manure tanks can be avoided. At all costs the urine must be used for composting.

3. Bases for Neutralizing Excessive Acidity

'In the manufacture of humus the fermenting mixture soon becomes acid in reaction. This acidity must be neutralized, otherwise the work of the micro-organisms cannot proceed at the requisite speed. A base is therefore necessary Where the carbonates of calcium or potassium are available in the form of powdered chalk or limestone, or wood ashes, these materials either alone, together, or mixed with earth, provide a convenient base for maintaining the general reaction within the optimum range (pH 7.0 to 8.0) needed by the micro-organisms which break down cellulose. Where wood ashes, limestone, or chalk are not available, earth can be used by itself. Slaked lime can also be employed, but it is not so suitable as the carbonate. Quicklime is much too fierce a base.

4. Water and Air

'Water is needed during the whole of the period during which humus is being made. Abundant aeration is also essential during the early stages. If too much water is used the aeration of the mass is impeded, the fermentation stops and may become anaerobic too soon. If too little wafer is employed the activities of the micro-organisms slow down and then cease. The ideal condition is for the moisture content of the mass to be maintained at about half saturation during the early stages, as near as possible to the condition of a pressed-out sponge. Simple as all this sounds, it is by no means easy in practice simultaneously to maintain the moisture content and the aeration of a compost heap so that the micro-organisms can carry out their work effectively. The tendency almost everywhere is to get the mass too sodden.

'The simplest and most effective method of providing water and oxygen together is whenever possible to use the rainfall—which is a saturated solution of oxygen—and always to keep the fermenting mass open at the beginning so that atmospheric air can enter and the carbon dioxide produced can escape.

'After the preliminary fungous stage is completed and the vegetable wastes have broken down sufficiently to be dealt with by bacteria, the synthesis of humus proceeds under anaerobic conditions when no special measures for the aeration of the dense mass are either possible or necessary.

PITS VERSUS HEAPS

'Two methods of converting the above wastes into humus are in common use. Pits or heaps can be employed.

'Where the fermenting mass is liable to dry out or to cool very rapidly, the manufacture should take place in shallow pits. A considerable saving of water then results. The temperature of the mass tends to remain high and uniform. Sometimes however, composting in pits is disadvantageous on account of waterlogging by storm water, by heavy rain, and by the rise of the ground water from below. All these result in a wet sodden mass in which an adequate supply of air is out of the question. To obviate such waterlogging the composting pits are: (1) surrounded, by a catch-drain to cut off surface water; (2) protected by a thatched roof where the rainfall is high and heavy bursts of monsoon rain are the rule; or (3) provided with soakaways at suitable points combined with a slight slope of the floors of the pit towards the drainage corner. Where there is a pronounced rise in the water-table during the rainy season, care must be taken, in siting the pits, that they are so placed that there is no invasion of water from below.

'To save the expense of digging pits and to use up sites where excavation is out of the question, composting in heaps is practised. A great deal can be done to increase the efficiency of the heap by protecting the composting area from storm water by means of catch-drains and by suitable shelter from wind, which often prevents all fermentation on the more exposed sides of the heap. In temperate climates heaps should always face the south, and wherever possible should be made in front of a south wall and be protected from wind on the east and west. The effect of heavy rain in slowing down fermentation can be reduced by increasing the size of the heap as much as possible. Large heaps always do better than small ones.

'In localities of high monsoon rainfall like Assam and Ceylon, there is a definite tendency to provide the heap or the pit with a grass roof so that the fermentation can proceed at an even rate and so that the annual output is not interfered with by temporary waterlogging. After a year or two of service the roof itself is composted. In Great Britain thatched hurdles can be used.

CHARGING THE HEAPS OR PITS

'A convenient size for the compost pits (where the annual output is in the neighbourhood of 1,000 tons) is 30 feet by 14 feet and 3 feet deep with sloping sides. The depth is the most important dimension on account of the aeration factor. Air percolates the fermenting mass to a depth of about 18 to 24 inches only, so for a height of 36 inches extra aeration must be provided. This is arranged by means of vertical vents, every 4 feet, made by a light crowbar as each section of the pit is charged.

'Charging a pit 30 feet long takes place in six sections each 5 feet wide. The first section, however, is left vacant to allow of the contents being turned. The second section is first charged. A layer of vegetable wastes about 6 inches deep is laid across the pit to a width of 5 feet. This is followed by a layer of soiled bedding or farmyard manure 2 inches in thickness. The layer of manure is then well sprinkled with a mixture of urine earth and wood ashes or with earth alone, care being taken not to add more than a thin film of about one-eighth of an inch in thickness. If too much is added aeration will be impeded. The sandwich is then watered where necessary with a hose fitted with a rose for breaking up the spray. The charging and watering process is then continued as before until the total height of the section reaches 5 feet. Three vertical aeration vents, about 4 inches in diameter, are then made in the mass by working a crowbar from side to side. The first vent

is in the centre, the other two midway between the centre and the sides. As the pit is 14 feet wide and there are three vents, these will be 3 feet 6 inches apart. The next section of the pit (5 feet wide) is then built up close to the first and watered as before. When five sections are completed the pit is filled. The advantages of filling a pit or making a heap in sections to the full height of 5 feet are: (1) fermentation begins at once in each section and no time is lost; (2) no trampling of the mass takes place: (3) aeration vents can be made in each completed section without standing on the mixture.

'In dry climates each day's contribution to the pit should again be lightly watered in the evening and the watering repeated the next morning. In this way the first watering at the time of charge is added in three portions—one at the actual time of charging, in the evening after charging is completed and again the next morning after an interval of twelve hours. The object of this procedure is to give the mass the necessary time to absorb the water.

'The total amount of water that should be added at the beginning of fermentation depends on the nature of the material, on the climate and on the rainfall. Watering as a rule is unnecessary in Great Britain. If the material contains about a quarter by volume of fresh greenstuff the amount of water needed can be considerably reduced. In rainy weather when everything is on the damp side no water at all is needed. Correct watering is a matter of local circumstances and of individual judgement. At no period should the mass be wet: at no period should the pit be allowed to dry out completely. At the Iceni Nurseries in south Lincolnshire in Great Britain, where the annual rainfall is about 24 inches and a good deal of fresh green market-garden refuse is composted, watering the heaps at all stages is unnecessary. At Indore in Central India where the rainfall was about 50 inches, which fell in about four months, watering was always essential except during the actual rainy season. These two examples prove that no general rule can ever be laid down as to the amount of water to be added in composting. The amount depends on circumstances. The water needed at Indore was from 200 to 300 gallons for each cubic yard of finished humus.

'As each section of the pit is completed, everything is ready for the development of an active fungous growth, the first stage in the manufacture of humus. It is essential to initiate this growth as quickly as possible and then to maintain it. As a rule it is well established by the second or third day after charging. Soon after the first appearance of fungous growth the mass begins to shrink and in a few days will just fill the pit, the depth being reduced to about 36 inches.

'Two things must be carefully watched for and prevented during the first phase: (1) the establishment of anaerobic conditions caused generally by over-watering or by want of attention to the details of charging; it is at once indicated by smell and by the appearance of flies attempting to breed in the mass; when this occurs the pit should be turned at once; (2) fermentation may slow down for want of water. In such cases the mass should be watered. Experience will soon teach what amount of water is needed at the time of charge.

TURNING THE COMPOST

'To ensure uniform mixture and decay and to provide the necessary amount of water and air for the completion of the aerobic phase it is necessary to turn the material twice.

First Turn

'The first turn should take place between two and three weeks after charging. The vacant space, about 5 feet wide, at the end of the pit allows the mass to be conveniently turned from one end by means of a pitchfork. The fermenting material is piled up loosely against the vacant end of the pit, care being taken to turn the unaltered layer in contact with the air into the middle of the new heap. As the turning takes place, the mass is watered, if necessary, as at the time of charging, care being taken to make the material moist but not sodden with water. The aim should be to provide the mass with sufficient moisture to carry on the fermentation to the second turn. To achieve this sufficient time must be given for the absorption of water. The best way is to proceed as at the time of charging and add any water needed in two stages—as the turning is being done and again next morning. Another series of vertical air vents 3 feet 6 inches apart should be made with a crowbar as the new heap is being made.

Second Turn

'About five weeks after charge the material is turned a second time but in the reverse direction. By this time the fungous stage will be almost over, the mass will be darkening in colour and the material will be showing marked signs of breaking down. From now onwards bacteria take an increasing share in humus manufacture and the process becomes anaerobic. The second turn is a convenient opportunity for supplying sufficient water for completing the fermentation. This should be added during the actual turning and again

the next morning to bring the moisture content to the ideal condition—that of a pressed-out sponge. It will be observed as manufacture proceeds that the mass crumbles and that less and less difficulty occurs in keeping the material moist. This is due to two things: (1) less water is needed in the fermentation; (2) the absorptive and water-holding power of the mass rapidly increase as the stage of finished humus is approached.

'Soon after the second turn the ripening process begins. It is during this period that the fixation of atmospheric nitrogen takes place. Under favourable circumstances as much as 25 per cent of additional free nitrogen may be secured from the atmosphere.

'The activity of the various micro-organisms which synthesize humus can most easily be followed from the temperature records. A very high temperature, about 65° C. (149° F.), is established at the outset, which continues with a moderate downward gradient to 30° C. (86° F.) at the end of ninety days. This range fits in well with the optimum temperature conditions required for the micro-organisms which break down cellulose. The aerobic thermophyllic bacteria thrive best between 40° C (104° F.) and 55° C. (131° F.). Before each turn, a definite slowing down in the fermentation takes place: this is accompanied by a fall in temperature. As soon as the mass is re-made, when more thorough admixture with copious aeration occurs, there is a renewal of activity during which the undecomposed portion of the vegetable matter from the outside of the heap or pit is attacked. This activity is followed by a distinct rise in temperature.

THE STORAGE OF HUMUS

'Three months after charge the micro-organisms will have fulfilled their task and humus will have been completely synthesized. It is now ready for the land. If kept in heaps after ripening is completed, a loss in efficiency must be faced. The oxidation processes will continue. Nitrification will begin, resulting in the formation of soluble nitrates. These may be lost either by leaching during heavy rain or they will furnish the anaerobic organisms with just the material they need for their oxygen supply. Such losses do not occur to anything like the same extent when the humus is banked by adding it to the soil. Freshly prepared humus is perhaps the farmer's chief asset and must therefore be looked after as if it were actual money. It is also an important section of the livestock of the farm. Although this livestock can only be seen under the microscope, it requires just as much thought and care as the pigs which can be seen with the naked eye. If humus must be stored it should be kept under cover and turned from time to time.

OUTPUT

'The output of compost per annum obviously depends on circumstances. At the Institute of Plant Industry, Indore, where the supply of urine and dung was always greater than that of vegetable waste, fifty cartloads (each 27 cubic feet) of ripe compost, i.e. 1,350 cubic feet or 50 cubic yards, could be prepared from one pair of oxen. Had sufficient vegetable wastes been available the quantity could have been at least doubled. The work-cattle at Indore were of the Malvi breed, about three-quarters the size of the average milking cow of countries like Great Britain. The urine and dung of an average English cow or bullock, therefore, if properly composted with ample wastes would produce about sixty cartloads of humus a year, equivalent to about 1,600 cubic feet or 60 cubic yards.

'As the moisture content of humus varies from 30 to 60 percent during the year, it is impossible to record the output in tons unless the percentage of water is determined. The difficulty can be overcome by expressing the output in cubic feet or cubic yards. The rate of application per acre should also be stated as so many cubic feet or cubic yards.

'In devising the Indore Process the fullest use was made of agricultural experience including that of the past. After the methods of Nature, as seen in the forest, the practices which throw most light on the preparation of humus are those of the Orient, which have been described by King in *Farmers of Forty Centuries*. In China a nation of observant peasants has worked out for itself simple methods of returning to the soil all the vegetable, animal, and human wastes that are available: a dense population has been maintained without any falling off in fertility.

'Coming to the more purely laboratory investigations on the production of humus, two proved of great value in perfecting the Indore Process : (1) the papers of Waksman in which the supreme importance of micro-organisms in the formation of humus was consistently stressed, and (2) the work of H. B. Hutchinson and E. H. Richards on artificial farmyard manure. Waksman's insistence on the role of micro-organisms in the formation of humus as well as on the paramount importance of the correct composition of the wastes to be converted has done much to lift the subject from a morass of chemical detail and empiricism on to the broad plane of biology to which it rightly belongs. Once it was realized that composting depended on the work of fungi and bacteria, the reform of the various composting systems which are to be found all over the

world could be taken in hand. The essence of humus manufacture is first to provide the organisms with the correct raw material and then to ensure that they have suitable working conditions. Hutchinson and Richards come nearest to the Indore Process but two fatal mistakes were made: (1) the use of chemicals instead of urine as an activator in breaking down vegetable wastes, and (2) the patenting of the ADCO process. Urine consists of the drainage of every cell and every gland of the animal body and contains not only the nitrogen and minerals needed by the fungi and bacteria which break down cellulose, but all the accessory growth substances as well. The ADCO powders merely supply factory-made chemicals as well as lime—a far inferior base to the wood ashes and soil used in the Indore process. It focuses attention on yield rather than on quality. It introduces into composting the same fundamental mistake that is being made in farming, namely the use of chemicals instead of natural manure. Further, the patenting of a process (even when, as in this case, the patentees derive no personal profit) always places the investigator in bondage; he becomes the slave to his own scheme; rigidity takes the place of flexibility; progress then becomes difficult, or even impossible. The ADCO process was patented in 1916: in 1940 the method to all intents and purposes remains unchanged.

'The test of any process for converting the waste products of agriculture into humus is flexibility and adaptability to every possible set of conditions. It should also develop and be capable of absorbing new knowledge and fresh points of view as they arise. Finally, it should be suggestive and indicate new and promising lines of research. If the Indore process can pass these severe tests it will soon become woven into the fabric of agricultural practice. It will then have achieved permanence and will have fulfilled its purpose—the restitution of their manurial rights to the soils of this planet.'

In view of the lucid explanation Sir Albert gives, and of the great authority and experience behind it, I have nothing to add; but the reader of this book, especially if he is a practical farmer, will quickly agree with me that when such a method as Sir Albert outlines is incorporated in one of the processes of a farm, the cost of manufacturing this compost becomes a serious item. Although I carried out the hand-making of compost faithfully according to the instructions Sir Albert lays down, there came a time in my farming operations when my men refused to dig another forkful of muck.

I was then face to face with the necessity of mechanizing the process. The time has now arrived to refer to this subject in practical detail. I am doing so with the assistance of the illustrations which are to be found as part of this chapter, and to which I would refer.

As a piece of practical farm management, we now arrange the assembly of our corn stacks in such a way that they are disposed in groups over the whole of the farm; and these centres of concentration are always located close to a water supply. This is essential for reasons which will follow.

When threshing takes place the straw, chaff and cavings are blown into a large mountain of material in the centre of a wired-in stockyard.

The stockyard has been chosen, in addition to water requirements, also because of some physical location where there is protection against the weather such as a dip of the hills, or the shelter of some hedges or trees or woodland. This protection is useful to give a cover for the cattle during the winter time and to give them a degree of protection against winds, since there is little or no actual covering otherwise provided.

When all this straw and waste is assembled, the cattle are turned into the stockyard, and are fed, not only with the straw, the cavings, chaff and wasted corn in the rick, but also with food taken to them from other parts of the farm, such as kale, swedes, mangolds, silage, hay.

They remain in that yard for some two or three months during which time they level off the straw to the ground, eat some of it, dung and urinate on the rest of it.

In this way, they succeed in bringing about a mixture of organic manures and urine, with the wastes of the yard, and refuse from the threshing, and thus we have the beginning of the 'compost process'.

MUCK! MORE MUCK; BETTER AND CHEAPER MUCK!

Every farmer believes in muck. After five years of war-time soil-depletion resulting from heavy cropping, he believes in muck now more than ever he did. Though artificial fertilizers *may* have their place every farmer knows that he cannot farm without muck. But there has been one fault with muck; the cost of handling it.

This problem is now solved by the invention of the Muck Shifter. On my own farm I have moved, loaded, carted and spread 400 tons of muck in two days at a cost of 1s. 8d. per ton. The previous equivalent cost of muck has been not less than 12s. 6d. per ton. Muck farming can therefore now be cheaper than any other form of refertilization.

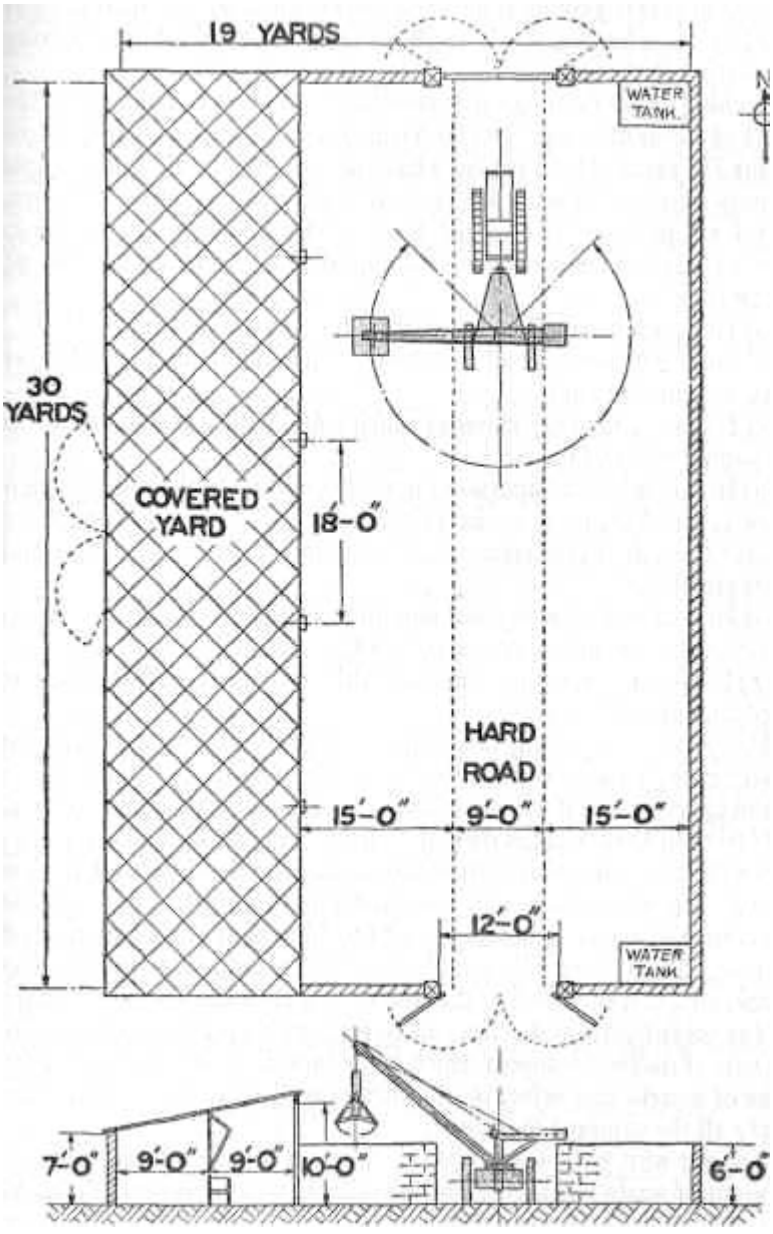
For this reason I am, to-day, a muck farmer, using no artificial fertilizers whatever.

Not content with muck in the ordinary sense of the word I *improve* my farmyard muck, increasing its volume fivefold by the addition of four times its weight of vegetable rubbish, the fertilizing value of the product rising to as high as ten times that of the original muck, through composting with a Muck Shifter.

The muck in an open stockyard, which the cattle have been treading for, possibly, several months is watered, if it is not already sufficiently wet, and piled into a long heap with the Muck Shifter.

This machine, I have found, will lift and load or turn something like 200 tons in an eight-hour day. This can be done with one man on the crane and a second to work the water pump. The purpose of turning is to aerate the muck and, by so doing, to increase the bacterial breeding and activity and accelerate decomposition.

To promote the quickest decomposition both water and air are alternately necessary. Lifting the muck lets in air which stimulates and breeds aerobic bacteria—those which need air to live; the water



SYKES STANDARD STOCKYARD

encourages breeding of anaerobic bacteria until the whole heap becomes a living mass, and composting is further quickened.

In two or three weeks' time this turning process is repeated—more water is added if necessary and more air is introduced: and in a further two or three weeks the process is once more carried out. On this third

occasion it is finally assembled into a tidy heap and left to decompose until a date ninety days from the first turning. During this latter period of decomposition aerobic bacteria are consumed by anaerobic microorganisms which increase rapidly and permeate the whole mass of compost.

Care should be taken to see that the material is sufficiently wet, though not too wet—the consistency of a squeezed-out sponge. At the end of ninety days 'compost' is produced, all of which is humus and will revivify any soil to which it is introduced. Properly made compost is estimated to be equal in usefulness to twice the amount of fresh farmyard manure and is much easier and more pleasant to handle. In the process of making compost *all weed seeds are destroyed* and *all* the material becomes humus, and is available as immediate food for the living population in the soil.

Nothing in my farming experience has been more dramatic than the effect of a coat of compost on land which is to grow a heavy crop. Most of our 750 acres of land at Chute have now been refertilized by organic manure during the past seven years and it is not surprising, therefore, that I am now an 'all-organic' farmer. The following are my main reasons which, I am confident, will appeal to the common sense of all fellow farmers.

(*a*) Humus is essential to soil fertility for it is the source of all life.

(*b*) Humus is the only *real food for* the soil and its denizens as distinct from a mere stimulant.

(c) Humus is the only material which *adds* fertility and so maintains the capital value of the land.

(*d*) Humus adds an important physical condition to the soil making it more crumb-like, more moisture-retaining and physically capable of greater oxidation, that essential contribution to living organisms and plant growth.

(e) Humus creates a physical condition in which wireworm, leather-jackets, eelworm and other pests cannot live.

(*f*) In every respect humus means health and dispels the fear of disease to plant, animal and man.

Many farmers reading this will immediately say, 'But I have not nearly enough muck to refertilize the whole of my farm.' This is rarely found to be the case if the possibilities of compost-making are examined.

If farmyard muck taken from the yard has any fault—and it certainly is not faultless—it is that there is too much animal residue in it and not enough vegetable waste. This is a most important fact. A cow voids in the course of a year something like 14 to 16 tons of muck and urine. A further 55 to 65 tons of vegetable waste, i.e. a ratio of 4 waste to 1 of muck, etc., can be added so that the cow, with waste vegetation added to her voided dung and urine, can be responsible for no less than 70 to 80 tons of finished compost which is far superior to the equivalent 160 tons of excreta and urine. It will thus be realized that most farms can make all the compost they need.

Anyone who goes in for making compost will be astonished at the amount of waste vegetation that is available on almost every farm. All the ditch cleanings, hedge cuttings, useless vegetation, weeds in the farmyard, docks, thistles, nettles, old sacks, ropes, everything that is of waste of vegetable origin can be put into the compost heap. Furthermore, on the public highways there are unlimited supplies of hedge and grass cuttings available for compost making in June and September, most of which are at present burnt or otherwise wasted. Contracts can be entered into with the Local District Council for all these hedgerow cleanings and cuttings. These are ideal for compost making, especially if introduced green.

When one appreciates all the waste that is taking place in this and other ways throughout the country, one begins to understand that Nature in her own way, without artificial aid, provides all the material that the land needs for refertilization, if only man has the intelligence to make good use of her bounty. There is the material: go and collect it; mix it properly; mechanize the work and you then have the cheapest and most perfect system of refertilizing known and the only one which all the time is adding capital value to your land.

There is one further process which is important—that of muck spreading. This operation must be speeded up if that of loading is improved. Spreading can now be done effectively by mechanical means. A simple inexpensive mechanism for this purpose can be obtained for trailing from the back of any cart, motor trailer or tractor trailer; so that the complete mechanization of mucking is now possible—from the farmyard to the compost heap and from the compost heap rapidly on to the land.

Now that the process of spreading as well as making humus by composting has at last been efficiently mechanized, compost farming becomes the cheapest method of land refertilization yet discovered. It also is the best. By manufacturing compost with a Muck Shifter and a Water Pump and spreading it with a Mechanical Spreader, all that distasteful, back-breaking, soul-destroying work of the farm—the shifting and spreading of muck—has been eliminated.

It should be realized:

(1) You cannot overdo the compost process.

(2) You *can* overdo the application of artificials.

(3) You are adding to the capital value of the land by the use of compost.

(4) You may be diminishing the value of the land by applying artificial fertilizers.

Therefore be a Compost Farmer and 'Go to it' right away. There are one or two simple 'tips' which should be taken:

(*a*) Plan your stockyard carefully on the lines indicated.

(*b*) Let the floor of your yard be earth—never of concrete. Muck should contact Mother Earth for aeration and bacterial reasons. It will never decompose properly on a floor of concrete.

(*c*) Mix a little earth, or chalk, or ground limestone into the muck at each of your 'turnings'. These agents act as a base, and prevent the escape of nitrogen by way of free ammonia.

Although the stockyard illustrated is provided with brick walls, baled straw and wire will do equally well if easier to provide.

Most farmers will here wish to cross-examine me on a number of points which this chapter raises.

'What does this wonderful machine, this Muck Crane, and Compost Maker cost?'

In January 1945 it cost £520 f.o.r. Ipswich.

The 4,000-gallon an hour water pump, £45.

The Muck Spreader, £90.

Total some £655 for the complete equipment.

And in answer to the objection that this is a lot of money for machinery to shift muck, I have to point out that muck loading is by far the hardest and most disagreeable job on the farm. It tears a man's muscles, and exhausts his bodily fitness like no other work.

Whether the job is done by hand or by machine, it still remains the hardest of all, and a machine lifting 5 cwt. in its grab, like the 20 lb. on the end of the four-pronged fork, imposes as great a strain upon metal as the latter does on the labourer's muscles. The Muck Crane has to be well made to stand these strains. Good machinery costs money, and unless good machinery is constructed for this task the farmer had best keep to his old four-pronged fork, for he will have nothing but disappointment if he buys machinery that is not up to its work.

Assuming that a farmer of discrimination buys the Rapier machine, he gets a tool that will last for years, one that will do its job efficiently all the time. The following estimate of the total costs of working, in which tractors, trailers, muck crane, pump, muck spreaders, are all taken account of, is, in my opinion, much on the high side:

COST OF MAKING MECHANICALLY 1,000 TONS OF COMPOST

(1) A farmer with 15 cattle producing 200 tons of muck may expect 1,000 tons of compost per annum, equal approximately to 2,000 tons[1] of muck.

(2) He can load and spread this volume in 5 days (assuming an average carry of one-third of a mile) mechanically with 1 crane, 4 tractors and 3 trailers with 1 spreader.

(3) He would have to have turned this volume three times previously taking him, at most, 15 days.

Assume his Capital Charges are at following rates:

	Interest	*Main-tenance*	*Depreci-ation*	*Total*
Tractors	4%	10%	20%	34% say 35%
Trailers	4%	10%	20%	34% „ 35%
Crane, etc.	4%	5%	10%	19% „ 20%
Pump	4%	5%	10%	19% „ 20%
Spreaders	4%	5%	10%	19% „ 20%

[1] If the value per ton of compost is twice that of muck, half a ton of compost would be required where previously one ton of muck was spread.

Thus his costs against machines for making 1,000 tons compost are:

	Capital Value	*P.A. Capital Charges*	*Days Worked P.A.*	*Per Working Day Capital Charge*	*Days on Muck-ing*	*Muck-ing Cost*
1 Crane & Grab	£520 x 20% =	£104	20	104/-	20	£104
1 Pump	£50 x 20% =	£10	15	13/4	15	10
1 Spreader	£90 x 20% =	£18	5	72/-	5	18
3-Wheeled Tractors	£750 x 35% =	£260	150	34/6	5	8.7

1 Crawler Tractor	£800 x 35% =	£280	150	37/-	20	37
3 Trailers	£180 x 35%=	£63	200	6/3	5	1.5
						£179.2
Capital Charges (165.2)					=	3,584/-
Fuel					=	48/-
Wages: 2 Men turning, on crane & pumps, 2 x 15 x 12/-					=	360/-
8 Men spreading and on crane, 8x 5 x 12/-					=	480/-
Mechanized cost of making 1,000 tons compost, turned, lifted, drawn and spread					=	4,592/-
Therefore, cost per ton, turned, lifted, drawn and spread					=	4/6d.

One of the great troubles and worries of any farmer is the enormous quantity of implements he has to buy. A great proportion of this tackle is used for very short periods every year, like binders, costing £150, and working for some three weeks out of the fifty-two. This applies to much of farming equipment. It is an old saw, that most of the farmer's tackle 'rusts out, rather than wears out'.

In designing the Rapier Muck Shifter we have tried to keep this unpleasant economic feature of the farmer's life well to the fore, for we have designed an implement, which, next to the tractor itself, will probably be the most used of all the farmer's machinery.

The Rapier Muck Shifter will not only dig and load muck and turn banks of compost at high speed and low cost. It will load sugar beet—a troublesome and expensive job—mangolds, swedes, turnips, kale and potatoes. Fitted with a special grab, it will 'earth up' the potato, sugar beet, mangold, swede and turnip clamps, and thus save a lot of labour. It will excavate the silage pit, and cover the silage in with earth after the pit is closed. And it will do this at great speed, saving of cost and labour, and with efficiency. It will excavate new ditches, and clean out old ones.

Trailing a trailer behind it down the combine harvester field it will load four 2-cwt. sacks of wheat at once, instead of this heavy job being carried out by two very strong men, and in a quarter of the time.

For general heavy lifting all over the farm, and at all seasons of the year, here is a tool that will find its niche in every farm of over 200 acres that is well farmed.

If all these jobs are recorded, the costs of compost making and spreading will be more in accord with my own figure of 1s. 8d. per ton, rather than the extremely conservative one of 4s. 6d. given in the detailed estimate.

The Muck Shifter is made in two models—Mark I, and Mark II which are both illustrated here. Mark II is similar in capabilities to Mark I, but is self-propelled, and self-operating. It thus frees a Caterpillar Tractor for other work on the farm. In January 1945 the Mark II costs £750.

The tractor-operated model—Mark I—is instantly attached to, and detached from the tractor. This is a feature of the utmost importance, for there is nothing so exasperating to a farmer, or so time-wasting and expensive, as a machine, which claims quick and easy attachment and detachment, but which takes from half a day to two days to attach and detach. The Mark I can be attached or detached to its tractor in less than five minutes, and quite easily moreover.

The problem of the cost of the expensive machinery has had to be faced many times before by the agriculturalists throughout the last hundred years. When the threshing machine was originally invented costing some £700, it was intended to displace the five-shilling flail, and the farmers of that day predicted that none would ever be bought, but history records that in the year 1945 no less than 15,000 threshing machines are in service in Great Britain, and not one single flail.

Practically the same remarks will apply to the Muck Shifter. This £655 piece of equipment is intended to replace the 7s. 6d. four-pronged fork, the labourer's strong back and the necessary corollary of the labourer's weak head. Since there are few labourers in these days possessed of strong backs and the accompanying weak head, some mechanical solution of the muck problem is a matter of the utmost urgency. If the farmer would shift a mountain of muck to-day, the agricultural workers simply would not do it, and I do not blame them.

As my tonnage of muck grew, my men became increasingly rebellious and resentful, and although they believe in muck just as much as 1 do there did come a time when they told me in unmistakable parlance how sick they were of digging this heavy material.

The problem, therefore, as I see it, resolves itself into one which is identical with that of the threshing machine in its early days. The richer and larger farmer will have to buy these machines and when he has

finished his compost making and his muck carting, he will of necessity have to turn himself into a contractor and carry out this work for those of his neighbours who cannot afford to buy one.

Handling 1,500 tons of muck a year as we do, I estimate that we save by this mechanization something like 10s. per ton, or a saving of at least £750 per annum, which more than covers the cost of the machine in one year. If, in addition to this, several thousand pounds' worth of contracting is done for neighbouring farmers, there is here a very sound business proposition for any enterprising farmer who would like to kill two birds with one stone. For in helping his poorer neighbour to refertilize with humus he is helping the nation in the provision of better and more life-sustaining food and, at the same time, he is carrying out a sound business undertaking in his own interest.

Sir Albert Howard says:

'Another very pressing job could be done by the Muck Shifter. Nearly every ditch bank in this country is six to nine inches too high—due to dumping mud, etc.—on the side. In consequence the fields are made into shallow saucers and the surplus surface water cannot drain away. There should be a very slight camber towards the ditch. The Muck Shifter could be used to lower these tips and feed the spoil into a lorry for transportation to lower places.'

CHAPTER XXXI

THE ANXIETIES OF THE MAKERS OF ARTIFICIAL FERTILIZERS

Any recommendations for the reconstruction of agriculture could not be complete unless reference were made to the artificial fertilizer industry and to its attitude towards such reforms and long-term tests as may prove to be necessary.

Whenever the sponsors for the artificials are put into a corner, they reply:

'That is not proved.'

'Equally,' I answer, 'it is not disproved.'

What we advocates of humus farming ask for is proof. We are not only willing that our claims should be submitted to the most searching *long-term tests* that can be devised, but we *ask for it.*

We have asked for it twice by Motions in the House of Lords. Twice we have been refused. I asked for it personally from the chairman of one of the largest artificial fertilizing companies, and he answered quite indignantly:

'Why should we allow these tests?'

But we are going to continue to demand these tests until we get them carried out. The reason why the Government do not favour our applications can be only conjectured. Are they afraid of the powerful interests which stand behind the ramparts of this really great industry?

However, it is interesting to be able to record how the industry itself is beginning to react to the propaganda which has endeavoured to focus public opinion and thought upon this vital aspect of the nation's health. Repercussions to this propaganda reach me every day by post from almost every country in the world where some 300,000 of my Black Death articles have been circulated.

These articles have not been circulated by me. Public-spirited people in every land have taken them up, asked my permission to reproduce them, and at their own expense have extended their circulation right round the earth.

Even the artificial fertilizer industry has been awakened to the threat to their businesses that all this portends, as the following incidents illustrate. Lord Teviot has been approached in divers ways with the suggestion that he is barking up the wrong tree, that he is wasting his time, that he is misinformed, etc. Two well-known doctors of science, in the employ of one of the largest firms, asked to meet him at the Athenaeum Club in London. They told him that he had got his facts all wrong, that the action in fertility was chemical, and that humus was not nearly so important as he had been led to think.

'Excellent,' replied Lord Teviot, 'then there is nothing to stand in the way of your agreeing to carry out our suggested long-term test; for just think what a grand advertisement artificials are going to receive as a result of the proof this long-term trial will provide for them.' The two eminent scions of learning looked down their noses, and said that these tests were not necessary.

'But', protested Lord Teviot, 'I, and those who think like me, believe that they are. Suppose, however, that what you say proves to be true. You have nothing to lose, and everything to gain by the publicity. Surely if you are so certain of your claims, you will not allow such an opportunity for advertisement to pass you by?'

At this they seemed at a loss, so Lord Teviot pursued his case, with the simple observation:

'It is a curious coincidence that an industry which is so sure of its contentions should at the same time so strongly oppose a proposal for publicly submitting its extensive chemical claims to a long-term public test. Stranger, too, that so much of the opposition we are receiving to our demands for these trials would appear to come from those who are interested in the manufacture and sale of artificials.'

In October 1944, when I was in Ipswich for a day or two, I was invited to attend a public meeting and a film show arranged by one of the artificial firms. The meeting had been well advertised, but interest among the farmers of this great agricultural district was so small that chairs were available everywhere. It was very badly attended.

Mr. Anthony Stokes suggested that I should address a similar meeting, advocating the use of muck and compost and the four-years' ley. Mr. Stuart Paul, the Chairman of the Suffolk W.A.E.C, kindly consented to be my chairman. But some important officials threw cold water over the whole affair, suggesting that nobody would attend. On 28th November 1944 my meeting was held in the same hall as had been used previously when the speaker was Mr. Fison, of Fison's Fertilizers. It was packed to a state of physical discomfort such as I have seldom seen, while some hundreds of farmers failed to gain admission.

Mr. Stuart Paul had warned me beforehand to be sure to limit my address to thirty minutes, as the Suffolk farmers would not stand for anything longer than that. I spoke for an hour and a quarter, and even then there was no sign of restiveness, while the eager discussion which took place showed the real interest which all those hundreds present were taking.

I deduce from this and from similar evidence throughout Britain that the farmers everywhere know that their humus fertility has been reduced appreciably in their heavy wartime cropping with one cash crop after another; and that the taxes they have been compelled to pay are not fair taxes on profits, like those levied on other industries, but a capital levy: for to get the crops, and those apparent profits, the farmer has applied stimulating fertilizers, exhausted the humus from his soil, and thus paid away his capital. Because his book-keeping is so bad, and his knowledge of genuine fertility worse, he cannot make the Inspector of Taxes differentiate between a tax on capital—i.e. on the land's latent humus fertility—and a tax on profits.

When they have parted with their money to the Tax Collector, the farmers now know it is like getting butter out of a dog's throat to hope that it may be handed back to them.

The farmer is being taxed out of his existence, and when he comes to restore Nature's own, he is beginning to find that his humus fertility has gone, and that artificials do not replace it.

But the farmer is not alone in being anxious about this set of embarrassing circumstances. That the makers of artificials also are becoming genuinely alarmed may be judged from the correspondence which continued for several weeks after my meeting of 28th November 1944.

In his account of the meeting, the agricultural correspondent of the *East Anglian Times,* who writes under the name of 'Lavengro', committed himself, no doubt by a slip of the pen, to this rather unlucky statement:

'There is certain to be a cleavage of opinion when it comes to the value of the earthworm in the soil and the necessity of maintaining its population to the full. I should imagine it is hardly likely that there will be two opinions that the earthworm aerates the soil in a manner that is not otherwise possible. *This should be evident when a single worm will bring up fifteen tons of soil in a year.* [1]

This resulted in a lively and instructive controversy. It began with a short letter from Mr. F. G. Clavering Fison, a Director of Fisons Fertilisers, who quoting some unreliable authority, said that Darwin found there were 158 million worms in an acre of ground, and then went on to quote *Lavengro*—following this quotation with what I regard as a gibe at myself—for the words he uses were—'and he was presumably quoting Mr. Sykes'—worms will bring up no less than 2,370,000,000 tons of soil per acre per annum, and went on to say, 'This is, indeed, rather a frightening figure.'

This letter was answered by several correspondents. Mr. F. H. A. Engleheart and Mr. A. S. Stokes brought the matter down to earth by writing as follows:

'Sir,

'Wonderful and fascinating though this creature is, I fear it cannot quite live up to the performances claimed for it by "Lavengro" and Mr. F. G. Clavering Fison; nor does a perusal of Darwin's classical *Vegetable Moulds and Earthworms* support the figures quoted.

'If, as "Lavengro" states, "a single worm will bring up fifteen tons of soil in a year" it would raise, during that part of the year when large earth casts are made, well over 1 cwt. per night. Some worm! Actually, Darwin writes: "We have no means of judging how great a weight of earth a single full-sized worm ejects during a year'; but, nevertheless, he makes an estimate from such evidence as he had and mentions 15 tons as the weight of castings thrown up annually on old pastures by all the worms in one acre. This number of worms he first takes (following Hensen) as 26,886 (not 158 million) or twice as many in gardens, but later he infers these figures are too high. He thinks each worm must eject "more than 20 oz." in the year.

'This is more than enough to make the earthworm perhaps the greatest of all the farmers' friends.

'F. H. A. Engleheart'

'Stoke Priory,
Stoke-by-Nayland,
13.12.44:

'Sir,

'Mr. Sykes's claim in fact, was that between 10 and 15 tons of worm-cast could be lifted per annum by the joint efforts of all the worms that should be found in an acre of ground and which could be found in most land if a 10-ton dressing of properly made compost were applied about every fourth year.

'The alternative and more expensive four-annual dressings of "artificials" would then become as unnecessary as he thinks they are undesirable, for the worm casts would have in them all the materials required at least to maintain the state of fertility, as they would contain

[1] The italics are mine. Author.

five times as much nitrogen, seven times as much phosphate, and eleven times as much potash as would be found in the surrounding ground.

'Mr. Engleheart's correction of Mr. Fison in his computation of the might of the earthworm will bring relief to the many of us in Ipswich engaged in the manufacture of mechanical excavators, for the alleged excavation of 15 tons per annum per worm truly presented a vision of competition at which even the stauncbest might quail.

'A. S. Stokes'

'Hintlesham Hall, Ipswich,
27.2.44.'

Mr. Clavering Fison then made a long reply. After thanking two of the correspondents for correcting his own inaccurate statements in his earlier letter, he places the blame on the shoulders of John Drummond, the author of *Charter for the Soil,* who, Mr. Fison alleges, purported to quote Darwin. He gave credit to the earthworm, however, but spoiled this reference by his argument that there is no evidence whatsoever that fertilizers tend to reduce the worm population. He did, all the same, concede that muck does increase the worm population.

It might here be mentioned, to the credit of Fisons anyway, that in all their advertising they do advocate a combination of muck and artificials. But from my point of view this always seems to me rather to beg the question. How much of the resulting goodness—or badness—belongs to the muck, and how much to the artificials? The use of the two together leaves this question permanently unanswered. I seek an answer to this elementarily important query.

Mr. Fison later went on to gibe at Mr. A. S. Stokes' remarks, which are not important, as he suggests Mr. Stokes rushes into print on a subject concerning which, Mr. Fison suggests, Mr. Stokes is poorly informed.

The effect of Mr. Fison's second letter, however, brought a second letter from Mr. Stokes, from which I will quote the final paragraph:

'It is, of course, correct that neither worms nor man make matter, but both can, and do, alter its form and distribution. In this respect the services to the community of the earthworm and "artificials" manufacturer — if Mr. Fison will not misunderstand me—are very similar. It remains only for the farmer to decide whether or not he is going to make compost to feed, and breed, a host of worms to bring up for him from the subsoil and to distribute perfectly, and unpaid, minerals which otherwise must be brought from greater depths and distances, and at consequently greater cost, with less and even deleterious effect in the long run, according to Mr. Sykes.'

Then Sir Albert Howard joined the fray and fairly pulverized Mr. Fison's arguments:

'Sir,

'A correspondent has sent me a copy of Mr. F. G. Clavering Fison's letter on the earthworm which appeared in your issue of December 30th last and has suggested I should comment thereon, as I have at the request of the publishers, Messrs. Faber and Faber Ltd., just completed a long introduction to a reprint of Charles Darwin's monograph *Vegetable Mould and Earthworms* in which I have carried the earthworm story from the point where Darwin left it in 1881 to the present day.

'Mr. Fison states in his letter under reply that "there is no evidence whatsoever that the application of fertilizers tends to reduce the worm population". This statement is not in accordance with the facts. Artificials, sulphate of ammonia in particular, not only reduce the earthworm population, but actually destroy it altogether. A great deal of the printed evidence on this point is in German and copies of Dreidax's original papers are in one, at least, of the libraries in this country. I studied them in 1937 in connection with a paper I read that year to the Farmers' Club in London on the restoration and maintenance of soil fertility. Dreidax showed most conclusively that artificials and poison sprays destroy the earthworm population. I have often verified this. In East Anglia I frequently observed that on arable areas where heavy dressings of artificials were used with or without organic manures earthworms were either absent or vastly reduced in numbers. One of the most striking examples of the destruction of earthworms by the use of sulphate of ammonia is to

be found in *Farmers' Bulletin 1569* of the United States Department of Agriculture issued in 1935. I will quote one passage from this document:

' "The results of three years' application of ammonium sulphate to sod on the experimental farm of the Department of Agriculture at Arlington, Pa., for fertilizing purposes have shown incidentally that earthworms were eliminated from the plots where this chemical was used."

'But the most serious blunders in Mr. Fison's letter are to be found in his references to worm casts, in the course of which he suggests that earthworms can only move plant food from one place to another in the soil. Earthworms swallow large quantities of earth collected from the soil and subsoil, as well as organic matter, grind up this material in their gizzards, neutralize it by means of their calciferous glands, digest it in their alimentary canals, and then excrete the residues in the form of casts. Recent work at the Connecticut Experiment Station shows that these casts are not only richer in humus, but contain five times more *available* nitrogen, seven times more available phosphate, and eleven times more *available* potash than the upper six inches of soil. These results are due to the digestive processes of the worms themselves. The nitrogen, of course, comes from the organic matter, the phosphate and potash from the vast stores locked up in an unavailable condition in the subsoil and the surface soil. The earthworm is thus an important agent in the transformation of the food materials needed by crops.

'Now that the manure heap has been mechanized and an efficient subsoiler is available to restore the circulation of minerals in the soil, the time has come when any up-to-date farmer can dispense with artificials altogether and make the fullest use of vegetable and animal wastes and the vast stores of such things as phosphate and potash from the subsoil. In this work the unpaid labour force of the soil including the lowly earthworm can be fully utilized. One result of such organic farming will be the virtual elimination of disease in crops, livestock, and in the human beings who consume the products of humus-filled soil. The importance of all this to the farmer needs no argument.

'It is impossible in the limits of a letter to deal fully with the matters raised by Mr. Fison. The reader interested will find the case for organic farming and the earthworm set out in detail in my new book—*Farming and Gardening for Health or Disease*—which is being published in this country and in the United States of America.

'Your obedient servant,

'ALBERT HOWARD'

Mr. Fison's letters illustrate the peculiar state of alarm now affecting the minds of those who advocate artificial manures—a result of the facts which Sir Albert Howard and I have been able to bring out.

Their industry is extremely powerful; and they have built up a financial strength which might be calculated to weather a storm; and I am amazed —utterly amazed—that, sure of their ground as they profess to be, they should be in the least worried about anything that either Sir Albert Howard or I may say or write.

Facts, however, are facts, and what the agriculturists of this generation demand to know is whether the claims that Howard and I make on behalf of humus are sound or unsound. The farmer has a right to know.

The artificial industry, for scores of years now, has taken untold money out of the farmers of the world. It is time that a Council of Investigators, whose integrity, wisdom and independence is unimpeachable, probed into the question whether the industry has taken those sums thanks to a false understanding of the real nature of fertility.

We humus farmers will be content with nothing less.

An interesting piece of evidence, contributed by Mr. L. F. Easter-brook, was published in *The Field* of 6th January 1945. Mr. Easterbrook's seven-year-old son astonished his dentist by the unusual excellence of his teeth. The dentist asked whether he had had any special diet. 'I told him: No, that he had eaten no meat (including eggs) up to the age of three years, but since then had eaten meat and exactly what he liked. I added, however, that we grew as much of our food as possible on composted soil and that for more than his lifetime we have never used an ounce of artificial fertilizers.'

'You have given me the answer,' said the dentist, 'now I understand why he has teeth like that.'

In my own case, my teeth used to collect huge quantities of tartar. Every year it had to be scraped off. We began using compost instead of artificials towards the end of 1936. When I went to my dentist in 1942, after a lapse (I am ashamed to say) of two and a half years, I expected a terrific scraping to occur. There was no tartar to remove. Another two years elapsed before I went again, this last time. There was a very little tartar behind two teeth, and that was all.

We have used compost for just about eight years, and for the last five of those years my teeth have lost their unpleasant habit of collecting tartar. Is this a coincidence? It might be. But I was telling this story to

someone else, and she has had exactly the same experience. Incidentally, I asked the dentist if wartime diet could have anything to do with it. He did not think it had, because he finds now just as much tartar collecting on his other patients' teeth as before the war.

CHAPTER XXXII

THREAT TO LINCOLNSHIRE POTATO INDUSTRY

W.A.E.C.'s DRASTIC MOVES AGAINST EELWORM MENACE

The future of the Lincolnshire potato industry is seriously threatened by eelworm disease. 'Thousands of acres are infected,' *The Farmers' Weekly* was told, 'and the future outlook is causing great concern among farmers and W.A.E.C. officials.'

So serious is the outlook that a conference of County W.A.E.C.s from all the potato-growing areas is to be called by the Ministry of Agriculture.

Mr. J. C. Wallace, Principal of Kirton Agricultural Institute and Executive Officer of Holland W.A.E.C, said to *The Farmers' Weekly* that the position was causing great concern, not only in the Holland district, but throughout the potato-growing areas of Lincolnshire. 'The disease', he said, 'has steadily spread, and now thousands of acres are infected.

'There is a tendency on the part of some farmers to ask for legislation to control sales of seed potatoes from areas known to be infected with eelworm, but before such a scheme could be put into operation a complete survey of all potato growing areas would have to be made—a really tremendous job.

'In the Holland area such a survey has been begun, but it will take three years to complete.

'Such a survey will prevent farmers unwittingly selling potatoes from diseased land, for we know that this has been done.

'Worse than Blight

'I consider that eelworm is worse than blight. For twenty years research has been going on, but so far an economic cure has eluded the scientists. Experiments have been carried on with a root juice, sprayed on to infected land, and carried by the rain into the soil, but these experiments have so far not produced a cure.

'The problem of the eradication of the eelworm is an extremely difficult one. Infected soil can be carried to clean ground in so many different ways—on implements, on cart wheels and ploughs, even on farm workers' boots.

'Infection, too, can easily be caused in areas hundreds of miles from the originally infected soil by some of the soil getting into bags of seed potatoes.

'These problems of infection will be well on the way to being solved when the land surveys are completed, but there is the bigger problem of the farmers' future in the potato-growing areas.

'The only way to stamp out eelworm is to cease growing potatoes on infected land—not for a year or two but for at least four years on land which is not too badly infected, but it may take a ten-years' lay-off on really bad ground.

'That is not a pretty outlook for Lincolnshire farmers, for they are essentially potato growers. They took up the crop back in the days of the slump. It was the only cash crop they could grow, and their problem is going to be—"What can we grow while the eelworm is being destroyed that will bring us in a reasonable profit?"

'Lincolnshire land has a peacetime value of around £100 per acre, so that the situation, both now and for the future, is causing much concern to farmers and the W.A.E.C.

'Thirty Years' Cropping

'It is difficult to see what can be done without interfering with the wartime production demands, but the problem is so serious, striking as it does at the very roots of Lincolnshire's prosperity, that orders have in some cases been made by the W.A.E.C. that farmers must not plant in certain areas, while Kesteven W.A.E.C. have instructed a widening in the rotation to one in four years.

'It is a fact that some land in the Holland area has grown potatoes without a break for thirty years.

'A prominent grower said to *The Farmers' Weekly* that while the problem was bad at present, it was bound to be a great deal worse before the cure is ultimately effected.

'Our problem is going to be to know what to grow that will be a paying crop, for land in Lincolnshire is expensive.

'Some form of control of the sale of seed potatoes is advocated by a section of the farmers, but that is only toying with the problem, to my mind. What we have to do is to get eelworm out of our land, and make certain that it never returns. But the cure looks like being an expensive one for us.'

The remedy is simple.

Apply prepared compost, and develop the disease resisting conditions without which potatoes cannot continue to survive. Twenty to thirty tons per acre of compost per annum each year for four years; grow other crops than potatoes during that time; the eelworm would then be eliminated, and potatoes could be grown again. *But* when they are again grown—use nothing but compost—and cease the use of artificials.

PART VI

CHAPTER XXXIII

A HUNGARIAN INTERLUDE

In the days before the war I used to make frequent visits to many countries in both hemispheres, and although these visits were not primarily agricultural I took the opportunity to study agriculture in every country I visited. Although my acquaintance with the farming practices of many other lands besides my own may be fairly extensive, it was not sufficiently long in duration for me to regard myself as an authority on the farming of every country I travelled in.

But a farmer is always a farmer, and with the practised eye that is his, he can see much more than would be observed by a layman; and I have learned much from my foreign travels, quite sufficient for me to make a comparison with the farming in my own country.

In 1937 I was the guest of M. Daranyi, the Prime Minister of Hungary at that time, and through his hospitality I saw a good deal of farming in the Danube basin, and particularly in that part of the Hungarian Plain which lies to the north of Budapest, and terminates at the bend of the Danube at Komarno, the Czech frontier town.

Here I saw farming as good as any I have seen in Europe, North or South America, or Africa. The standard of intelligence of the peasants is low but their husbandry and technique is thorough. Nowhere have I seen better cultivation. There can be few places anywhere in the world where better crops are in evidence, or fertility higher.

Being interested in horse breeding M. Daranyi made it possible for me to see over the Hungarian Government's famous Arabian Stud— perhaps the finest in the world—and also the British Thoroughbred Stud, filled entirely by horses of British stock and serviced by stallions of considerable achievements on the British racecourse, all of whom I had seen during their racing careers.

When I returned to Budapest after a most enjoyable time and had been shown anything and everything I wished to see, I was cross-examined on the impressions I had formed, and asked to make any comment I cared to put forward.

Naturally I spoke well, and honestly, of the good features enumerated above, but I expressed my surprise at not having seen a single tractor in the whole of my journey.

'I will explain,' said M. Daranyi. 'You see, it is all bound up with politics. In both England and Hungary we have one common problem— how to keep our lower classes in full employment. Your industrial employers, catering for an export trade, have founded their economy upon the machine, increasing outputs, dismissing men to reduce costs, and on bringing the prices of your exports down to such a point that you can send your manufactures all over the world. But this policy throws some millions of your unfortunate workers out of their employment. They resort to the dole. They live below the normal subsistence allowance. They breed discontent. Your democracy pretends to make all men equal. But the worker thinks very differently, and from time to time he demonstrates his dislike of his lot in life by riots, strikes and other social upheavals. Take your own farm, where you have several tractors, all produced by American labour, serviced with fuel and oil mined in America. It is a curious state of economy which believes that the more one exports—that is, sends away—the richer one becomes. We do not belong to that school of thought in Hungary. Even if we would belong to it, we are unable to export, for in the Treaty of Versailles all our coastline was taken from us. If we wish to send anything out of this country it must either go up the Danube to Germany or down the Danube to Rumania. But I am not entirely satisfied that, even if we could export, it would be a good thing. Is it better to have a sound agriculture which has for its object the providing of work for every man and woman in the land, or an industrial policy, like England, which seeks to throw out of employment millions of its subjects, and demoralizes them with the dole and a mental feeling that they are not wanted in the economic scheme of things? These thoughts are not really very deep, neither are they mysterious. If the most valuable crop any country can produce is its human population, is it good or elementarily sound economy to throw your humans out of work, diminish their usefulness, destroy their self-respect, and to work for paper or book-keeping profits, which in a world turmoil prove to be quite worthless? There is much, of course, in

Hungary that I would like to remedy, but leaving details out of it, and dealing with broad principles as we in Hungary see them, we always fail to appreciate the policy of England who would appear to waste its human wealth so wantonly by pursuing an economic theory that paper wealth is a good substitute for the human lives destroyed in its vain and insensate pursuit. In war, all nations think alike. Then our wealth and our security is *man power.* Why, in peace, should sound economy change *to paper power*?'

I, too, had often thought a little like this, but never had I seen the problem quite so clearly.

Unless the world bases its economy on a sound agricultural policy, I am sure it will never find a sound and equitable economy.

CHAPTER XXXIV

FARMING COMPARISONS—BRITAIN AND THE UNITED STATES

When townspeople used to bring their minds to bear upon the anomalies which existed before the war, when foreign wheat could be sold at the ridiculously low price of 18s. per quarter on the English market, when we were subsidizing our own agriculturists to the extent of making a quarter of wheat worth 45s. to the British farmer, people in the industrial areas of this country, thinking they possessed that armchair security which entitled them to criticize the home farmer however little they knew about his business, would indulge in this kind of criticism.

'One thing I don't understand is that the foreign farmer's methods are so efficient that he can deliver wheat into the English market at 18s. per quarter and the British Government find it necessary, in order to keep the English farmer alive, to subsidize his wheat growing to the tune of 45s. Why should there be this disparity between the two costs of production? Why should it be that the American and the Canadian farmer are so much superior to the English farmer that they can produce and pay all the carriage costs between Canada and Britain and deliver at nearly a third of the price of the British subsidized figure?'

My reply to all such armchair critics was this. 'Surely, even if you are unacquainted with conditions in both countries, it must be evident to you that something is materially wrong with these two figures, 18s. per quarter delivered to the English market and 45s. per quarter the price at the English farm. Do you seriously believe that the Canadian farmer can produce a quarter of wheat, that he pays all carriages, rail and shipping, and other costs at a delivered price of 18s. as against our farmer receiving 45s. at his farm?'

I have often seen people receive quite a shock when a question like that was put to them. I would go on to point out that the Canadian production per acre of wheat was perhaps only three or four quarters, whereas an ordinary English production would be four or five or even six quarters, to say nothing of such production as I have been fortunate enough to have this year when my figures have gone up to nine quarters an acre.

'Having regard to the fact that the Canadian and American production is appreciably below that of the English farmer, do you really believe that the Canadian can produce much better than we can?' And my friend would say, 'Well, would you kindly explain.'

This is the explanation. In the first place wheat, even in Canada, was definitely subsidized by their Government; it was very unprofitable for the Canadian farmers, and they would have gone broke wholesale had they not been subsidized.

It is perhaps a little invidious to make comparisons between Canadian methods of farming and British methods. There are times undoubtedly when some Canadian methods might be generally regarded as superior to those in general use in Britain, but on the other hand there are many instances in Canadian farming of the methods and the available equipment leaving much to be desired: taking the two countries as a whole, I would say that there was not much difference, except perhaps that some of the well-equipped Canadian farmers with their steady climate, their combine-harvesting methods, and with no attempt at refertilizing, were able to produce wheat at less cost than we could in this country.

At the same time, if yields are taken into consideration, it may well be that the cost of producing a quarter of wheat, even in Canada, might not be very different from a first-class farmer's cost of production in England. Therefore, we are fully justified in saying, that without the subsidy of the Canadian Government, probably 80 per cent of the Canadian farmers would have been in the bankruptcy court. There cannot be any argument about this. Had it been otherwise, the Canadian Government would not have subsidized their farmers—they simply had to keep them going.

Having much more of a farming mind than the British Government, the Canadian statesmen jumped to their responsibilities much more readily, and much more promptly and effectively than the British Government have ever done. In consequence, comparisons of the two prices on the English market are utterly misleading and worthless. The Canadian climate is a great advantage, in so far as their very dry steady conditions at harvest time undoubtedly favour the use of the combine harvester: it enables them to succeed in harvesting their grain not only under better conditions, but at much less cost. In addition to this the Canadian farmer, like the United States farmer, has taken little interest in the refertilization of his land. He has gone on the virgin prairie, ploughed it up, sown his seeds, and reaped his crop. He has had no refertilizing troubles to be worried about right up till this very moment, but the dust bowls in both Canada and the United States are now giving both Governments seriously to think, and refertilization costs in the future will definitely have to be reckoned with by farmers in both those countries. There can be no doubt that the exploitation of both Canadian and American soil is one of the greatest crimes and tragedies the world has ever seen, and both

Governments are now determined, so far as the future is concerned, that this kind of land exploitation is going to be at an end. The conditions of farming in the future may be more or less uniform throughout the world, because refertilization will be an elementary consideration in the programmes of the Governments of all countries. They now realize that the world's agricultural resources have been exploited for private gain long enough, and that the time has come when the preservation of the soil is the greatest problem in every country of the world.

By way of giving definite proof that the average American farmer is indeed far worse off, and has been far worse off for a very long time than the English farmer ever was, I will give some extracts from Anna Rochester's famous book *Why Farmers are Poor,* which took several years to write, and is largely built upon the evidence to be found in the United States Department of Agriculture.

Anna Rochester points out that Great Britain has been receiving food from all producing countries at much below the cost of production, notwithstanding that those countries were robbing their virgin soil. With all the advantages of no costs for refertilization, England has received at below cost of production the plunder, the fertility and the best that those countries could give.

England may have had a golden time—those times are, happily, for ever more at an end. And no country in the future is going to allow herself to be exploited for the benefit of England.

This all goes to indicate that the England of the future, whether she likes it or not, will have to look to her own farmers for most of her food, and the farmers will have to rise to the occasion by being better farmers, understanding the technique of their industry with an efficiency that they have never known. At the same time, the costs of food to the consumer will definitely have to be more than they have been in the past.

Moreover, getting cheap food from other countries as we have done, is a short-sighted policy. When we obtain cheap food from abroad where refertilization costs have never entered into the farmers' economy, a dust bowl is inevitably created. This makes so much extra desert land which is not habitable and it deprives us, as a manufacturing country, of a future market. This is the story of the prodigal son all over again.

POVERTY HAUNTS THE COUNTRYSIDE

'Starving sharecroppers and refugees from the Dust Bowl have been flashed on the newsreels and pictured in the tabloids. Homeless poor farmers in Oklahoma, trekking desperately to a worse poverty in California, have been immortalized by John Steinbeck in *Grapes of Wrath.* But publicity and literary immortality do not feed the hungry. The farm problem is both deeper and broader than anything that newsreels and novels can convey.

'Farm poverty is by no means confined to the so-called "submarginal" or "disadvantaged" areas. Driving through almost any part of the American countryside a casual observer sees the unpainted, broken-down buildings of farmers who cannot make ends meet. Even comfortable homes, with rich broad acres of grain or cotton, orchards, large truck gardens, herds of well-fed cattle, have forlorn neighbours not far away, with poor crops, stringy cattle, and all the obvious signs of a hard existence. And many of the farmers in the comfortable houses are wondering how long they can keep going. For "recovery" from the severe crisis of 1929-33 has not restored to the farmers the gross income or the purchasing power which they had in the 1920's. And for the farmers even the 1920's were no golden era. Farmers were faring much less well then than they had fared before the First World War.

'When prices slid rapidly downward from 1929 to the spring of 1933, the farmers' gross income was cut by more than 55 per cent. After seven years of "recovery", most of the more than 6,500,000 farmers were either living in extreme poverty with a very small scale of operation and obvious hardships or were carrying on a medium-sized farm with a heavy burden of debt. Behind the cheerful air of the "middle" farmer's house and barns and fruitful fields, there often lurks a haunting anxiety and a greatly reduced standard of personal comfort.

'Uncounted thousands have been driven off the land. Tractors are obliterating the boundaries of little sharecroppers' plots in some of the older cotton regions, tossing these families from the poverty of extreme exploitation into the worse destitution of complete unemployment. Everywhere "recovery" has shown the unjust caprices of our capitalist system, widening the gap between those who have the resources for a fresh start and the many who are only pushed nearer to destitution. At the same time, thousands discouraged by the continuing mass unemployment in the cities go out vainly hoping for subsistence on the land and swelling the ranks of the rural poor. The numbers on the land have actually increased since 1930.

'Farm problems affect directly almost one-fourth of all persons in the United States, for some 32,000,000 men, women and children live or work on farms. Another 24,000,000 who are neither members of farm families nor farm wage workers live in villages and open country, and very many of these are directly and obviously dependent upon the farmers' prosperity.

'The question of well-being or misery on farms is also a matter of great importance to all other Americans. Low purchasing power on the farms cuts into the home market for industrial products and helps to increase unemployment among industrial workers.

'In "prosperous" 1929 there were already over 1,800,000 farms—more than one-fourth of all the farms in the country—yielding gross farm income of less than $600. This was a gross total before deduction of any costs of operation. And it was larger than the cash total derived from the farm, since it included products used by the farm family along with those sold or traded. On these farms lived over 7,700,000 men, women and children whose lives, in the chilly words of a government report, "were disadvantaged because of the lack of purchasing power". Some 3,000,000 farms, or nearly half of all in this land of "boundless opportunity" were small concerns producing less than $1,000 of gross income.

'When a farmer's yearly receipts are too low even for current expenses, he cannot save toward the proverbial rainy day—or for the more menacing dry days of continued drought. During the economic crisis which began in 1929, widespread drought and a sharp decline in farm prices combined to bring catastrophe to the farmers. Men in vigorous middle-age who had farmed all their lives, and young men well equipped and well schooled, had to seek aid, along with those who had struggled on the edge of destitution. The numbers of rural households on relief mounted more sharply than the number of city households. About three and a half million rural households, more than one out of four of the families on farms and in villages, received assistance from a public or private agency at some time during the years from 1930 to 1937. And this is called a conservative estimate.

Their plight has been described in a dozen or more reports by the Works Progress Administration's division of social research. Yet these valuable studies exposing the extreme poverty that has come upon rural families of all types and ages admittedly understate the true seriousness of the situation. For farm families, as the reports indicate, will struggle along half-starved and penniless, long after a city family would ask for aid. Social agencies have been far less developed in the country than in the cities. When relief was given, it averaged a little more than fifty cents a day per family in the north and less than thirty cents a day per family in many counties of the south.

'None of these figures include farmers receiving only the special loans and benefits "which operated both to help keep farm families off relief and to reduce the needs of those who were forced to apply for public assistance". Uncounted thousands more have been in need of public aid but have received none—in any form.

'Extreme farm poverty was present before the crisis years. And "recovery" did not bring prosperity. On the poorest farms the farmer himself or one of his family is usually trying to earn something from other employment. Taking account of all net income from any source except relief, "Farm families are conspicuously massed in the lower income levels—52 per cent falling below $1,000," according to an estimate for 1935-6 by the National Resources Committee. When farm families on relief (as estimated in the same report) are included with others having less than $1,000 consumer income, we have the following distribution of farm families in 1935-6:

3,825,800 farm families, or 56 per cent of all, had less than $1,000. 1,393,600 farm families, or 21 per cent of all, had from $1,000 to $1,500. 1,073,000 farm families, or 16 per cent of all, had from $1,500 to $2,500.
474,800 farm families, or 7 per cent of all, had over $2,500.
Less than 25,000, or about 4 farms in every 1,000, had $10,000 or over.

'More farmers are poor in the south than elsewhere. And Negro farmers, most of whom are in the south, are the poorest of all. In a study of sharecropper families, not on relief, in selected counties of four southern states (Georgia, Mississippi, North Carolina, and South Carolina), Negro sharecropper families averaged $294 a year in cash income, while white sharecropper families averaged $350. In releasing these figures the U.S. Bureau of Home Economics cautioned that the areas studied "often were not typical of the state as a whole, frequently being better than the average".

'If one-third of the nation is "ill-housed, ill-clad, ill-nourished", as President Roosevelt stated in 1937, then certainly more than a third of the farm population must be so described. "Rural slums" are vividly pictured in many government reports. Only 9 per cent of the farmhouses in the nation as a whole had indoor toilets in 1934; about 18 per cent had electricity; less than 4 out of 10 had water pumped or piped into the dwelling and only 1 in 13 had provision for hot and cold running water. New England farmhouses were far above the average in condition, in facilities and convenience, while southern farmhouses were far below the general average for the country as a whole. Some sharecroppers live in houses without glass windows.

' "Ill-nourished"—and illness is the result. The President's Committee on Farm Tenancy has this to say:

' "Many of these families are chronically undernourished. They are readily subject to diseases. Pellagra, malaria, and the hookworm and other parasites exact heavy tolls in life and energy. Suitable provision for maintaining health and treating disease among these families is lacking or inadequate in many localities."

'Where the needs are greatest, facilities for medical care are fewest. A national health survey revealed that about 17,000,000 people, mostly of the rural population, live in 1,338 counties that have no registered general hospital. "Remoteness from metropolitan centres, a very small percentage of urban population, and low tax income" characterize these counties. Not even a public-health nurse is employed to serve rural areas in about 1,000 counties of this nation.

'Nearly a quarter of a million women in 1936 did not have the advantage of a physician's care at the time of confinement. More than one baby in ten was born without benefit of doctors. Most of these were in rural areas. Child health centres in cities and towns have reduced illness and mortality among children: "Yet roughly two-thirds of our rural areas are without such services."

'Disadvantaged not only in physical matters of health and housing but also in educational facilities and opportunities, countless thousands of farm youth must grow up without adequate schooling or the chance to attend high school and college. Rural illiteracy is more than twice as great as urban. In 1930 there were 810,000 children between the ages of 7 and 13 who were not going to school at all. Most of these children were in the poorest rural areas.

' "In 1930 the farm population was responsible for the care and education of 31 per cent of the children, but the farmers received only 9 per cent of the national income. In the south-eastern region this disparity was still greater, the farmers of that region having the care of approximately 4,250,000 children age 5 to 17, with only 2 per cent of the national income. At the other extreme the non-farm population of the north-east, with approximately 8,500,000 children age 5 to 17, had 42 per cent of the national income."

'And what of the future for these under-privileged youth? Mass unemployment in the cities has closed the industrial opportunities formerly open for those who cannot make a living on the farms or in the villages where they were born. There results what government surveys have called the "accumulation on farms of farmers' sons lacking other opportunities", and this "accumulation" tends to be more rapid in the poorest farming areas.

'No one who has read John Steinbeck's *Grapes of Wrath* can forget his portraits of the younger Joads—their strength, their ambitions, and their thwarted dreams. Multiply the Joad family by several million and we have some idea of American rural youth and their problems. For it is not only the migrants, driven off their farms, who are in a desperate situation. Almost as serious is the plight of youth on the more than four million poor small farms and in the villages deadened by the rural poverty.'

CHAPTER XXXV

LAND NATIONALIZATION

Several of my friends have suggested that I ought to include a chapter on the highly controversial subject of Land Nationalization. There has been so much already written, and over so many years, on this contentious topic, that it grows threadbare. We are all familiar with all the arguments which are advanced by every kind of partisan, both for and against its adoption, and it might seem there is little left for either myself or anyone else to advance. I have no intention of taking up sides with either party. I think, in other words, that they are both equally wrong, and, in parts, both equally right.

There must obviously be many instances where land—both urban and rural—would be owned more equitably if it were public property. Equally, there are hundreds of instances where no advantage would be gained by the nation owning large stretches of the earth's surface.

Provided that adequate and easily operated machinery is created, whereby any, or all, land can be acquired upon equitable terms to both buyer and seller, whenever it is needed in the public interest, I really do think that no further legislation is necessary.

Some readers, remembering that I was born a landowner, might perhaps think that I have a particular interest in trying to safeguard and perpetuate the interests of the landowning class. If so I would like to disabuse their minds of such thoughts right away.

The ownership of land carries with it a tremendous responsibility and this is seldom associated with profit. On the contrary it can be truly said that, so far as agricultural land is concerned, there are few investments, taking the world all through, which are so very unremunerative.

Going right back to the feudal days of 1066, when William the Norman invaded this defenceless country, then utterly ill-equipped and unable to defend itself, and secured his 'walk-over', he handed over this land he purloined in blocks to his Barons—not as their *own* property as some seem to think erroneously—but in *fee simple.* Indeed all our land to-day is in this way held—that is, 'of the King'. There were obligations imposed by William, and, *inter alia,* these included 'management and the provision of fighting men when needed'. From that day onwards the feudal barons, and their successors, the landowners of the intervening centuries, have had to develop their lands, to erect farm buildings, cottages, churches and schools, to make roads, lay on water, etc.

All this costs money, and the true proof of the residual value of these land developments and improvements, whenever any of these estates have been sold, is the fact that not one in a hundred of them ever realizes a quarter to a half of what it cost to create and assemble.

This fundamental fact always seems to be lost sight of by those rabid reformers who believe the alpha and omega of all social reform and reconstruction lie in the nationalization of the land.

If the nation acquired all our agricultural land the responsibility would lie on the shoulders of the nation to continue in perpetuity the development of these vast stretches of agricultural property. The return to be expected by the nation could not possibly be any more than it is now for the private landowner. Literally, two thousand million pounds are needed to rehabilitate our agricultural land. Is the would-be land-reformer so unwise that he would shoulder all this onerous burden which now rests on private individuals? Thousands of landowners will hail with joy the day when compulsory measures are taken by the Government for the acquisition of their burdensome properties, for they will then employ every skilled land valuer and manoeuvring tactician to get for them the highest value they can extract, and they all know how much better off they will be with their money, rather than with their land.

Against this, I know, will be advanced the argument: 'Yes, we know that the land needs much money spent upon it, but these landlords cannot spend that money, they are too poor, and the country will have to do it anyway.'

In substance that may be so, but personally I would rather see a loan for land improvement, properly controlled, with a first charge over the land itself, upon which foreclosure would be possible in the event of default, rather than that the Government should, perhaps, be tricked into buying land at a too high price, and then be faced with the cost of all the necessary improvements in addition. Under such an arrangement, if the landowner defaulted, the nation would get the entire freehold for the cost of the improvements. On the other hand, the landowner, realizing the perils of his position, would see to it that his estate was well managed, and therefore well farmed, so as to avoid the possibility of his losing the capital value of the property.

Speaking as a business man—if a farmer may—I know which method I should follow, assuming the decision in the interests of the nation was mine to take. Leave the land alone is my advice to one and all, so far as its actual ownership is concerned. Control it, certainly, by all means.

As a landowner I know all the benefits of owning land and I know its disadvantages too; and weighing the one against the other I believe that the nation ought to think many times before assuming such an unnecessary responsibility.

'Well, that is all very well for you, Mr. Sykes. You are your own landlord. You can do as you like, and you have got *security of tenure.'*

I have heard this argument so often, and I know, in so very many cases, what there is behind it. I will content myself with reciting only one out of many cases.

A farmer I know was farming some 300 acres. He was a young man, well educated and well financed by a rich father. He took considerable interest in his local N.F.U. and was loud in the expression of his opinions, political and technical, about farming. He was a great believer in artificials, and regarded the 'muck cart' and the farmers who still believed in it as an anachronism. He could not make his farming pay in pre-war days, so in high dudgeon he called upon his landlord just before Michaelmas and demanded a reduction in rent, producing as evidence the losses he was sustaining in his farming. Their conversation went like this:

'What reduction in rent do you suggest, Mr. X.?'

'I am now paying £1 per acre. I suggest you reduce the rent to 10s.'

'That would be a reduction on your three-hundred-acre farm of £150, would it not?'

'Yes, that is so.'

'According to your figures, you are now losing over £400 a year, are you not?'

'That is so.'

'Then if I agree to your proposals, and your figures of farming remain constant, you will still be carrying a deficit of £250 a year. How do you propose to meet that?'

'Out of capital.'

'What, for all time?'

'Oh, no. I expect that farming will improve.'

'Then do I understand your suggestion to be that, when farming improves, you will come back to me and suggest restoring the old basis of £1 per acre rental?'

'Oh, no. This farm is much too high rented. It is not worth more than 10s. per acre.'

'Suppose I agree, for the time being, and because farming is bad, that that is so. Surely when times are better, if you can make a profit I ought to share those good times with you, since you now ask me, meanwhile, to share your losses?'

'I am afraid I do not agree. I run all the risk in farming, and if I make a profit I have earned it, and I need it.'

'You may think so, but your arguments strike me as singularly unfair and unsportsmanlike. You cannot farm without land, and the land you elect to use happens to be mine. You cannot make your farming pay, because the times are bad. When they are good you say the profit you make must be all yours, but you still need my land to gain those better profits. I am a little disappointed in your outlook, and in your reasoning. May I ask you a few questions?'

'Certainly.'

'What weight of wheat did you get from my land when you started farming it?'

'As much as twelve sacks (six quarters) to the acre.'

'How much are you getting now?'

'I got this year less than seven sacks (three and a half quarters).'

'How do you refertilize?'

'Entirely with artificials, in the latest and most scientific style.'

'You may have forgotten, Mr. X., that I farmed your farm prior to your coming into occupation. When you took over you admit you could grow twelve sacks of wheat to the acre. Now you can grow only seven. I was an old-fashioned farmer, you would think, for I used nothing but the "muck cart and livestock". That gave you a fertility reserve which you have tapped, and now, with your scientific methods of application of nothing but artificials, you have robbed my land—which is my capital —in that farm to such an extent that you can now get only seven sacks per acre, where you got twelve when you went into occupation.'

'I am not going to carry any livestock. I have sold them all. Farming does not pay as it is. It will involve me in bigger losses still if I go to back to livestock.'

'Well, Mr. X., I have listened patiently to your appeal, and have shown fortitude in your recital of how you think you can continue reducing the capital value of my farm by further applications of artificials, and to

your amazing statement—to *me*—that you do not propose to carry any more livestock. I am here and now able to take a decision in this matter. I am going back into farming. My solicitors will give you notice to quit as from this coming Michaelmas term, and in the reasons for such notice will be found these words, "That you are not farming according to the rules of good husbandry".'

Well, of course, Mr. X. went off the handle, and swore what he would do, so on and so forth. He got his notice. He was deprived, because of those fatal words the notice contained, of his two years' compensation for disturbance provided by the Act. He went to another estate. He applied artificials there, brought down the fertility again on that farm to a low ebb, and then got a second notice like the first one.

This man is now vociferous at many of the important National Farmers' Union meetings, demanding the 'nationalization of the land', 'down with the landlords', and all the rest of it.

There may be exceptions, of course, but the cases of unfair disturbance by the *old landlords* are rare indeed. Farming families there are, in great numbers everywhere, who have enjoyed over one hundred years' uninterrupted occupation of their holdings. Consult this class of old yeoman farmer. Ask them whether they would change if they could choose, and seldom will you find them vote for any change whatever. A good landlord is an old institution, but that does not necessarily mean that he is a bad institution.

Pray recall those words of wisdom most profound—uttered, I believe, originally by Confucius—'An idea is not necessarily good because it is new.'

'Equally, an idea is not necessarily bad because it is old.' When we change, let us try to change for the better. Until we are quite sure that we are going to change for the better, would it not be just as well that we remain 'as we are'?

In reference to this chapter Sir Albert Howard wrote:

'In days of old the landlords provided the Cokes of Norfolk—ideal leaders. What will nationalization furnish—Yes-men, quislings and bureaucrats?'

CHAPTER XXXVI

SUMMARIZINGS: A PARABLE

Let us suppose a surveyor is called in to give an opinion in company with a professional architect, on a subject like this. Suppose there is a hundred-foot tall building, say, in Piccadilly, London, which has developed a serious 'crack' in its superstructure. Architect and surveyor are called in by the proprietors to make a careful examination and to advise. After due deliberation they submit this report:

'We have duly examined this building in all its details. We have compared its design with the plans from which it was built, and after the most careful study and investigation have reached and made the following deductions and decisions.

'This building was built upon foundations that have proved insufficiently strong for the superstructure they have been called upon to carry. We find that the volume of concrete was inadequate, and the reinforcement not nearly enough, even if the former had been much more ample. The original architect and his surveyor cannot have been aware of the real character of the subsoil on which they were erecting so high a building, for this subsoil called for better provision in stout foundations than have been provided, and for pile-driving in addition. The crack, therefore, in the superstructure is due, not to any faulty material or fabrication within itself, but is entirely caused by subsidence of the foundations in a subsoil which was not good to build upon. The remedial measures that might be adopted are two. One is of an extremely temporary nature; the second is much more drastic, but will prove inevitable in the end.

'The temporary expedient is that we can "bond" the superstructure, force in a quantity of liquid cement and sand at certain points, and by a development of some such methods can give you an uncertain life of usefulness for your property. This, however, at best, is but a palliative. Eventually you will have to face the unpleasant and blatant fact; that the building must be demolished, the existing foundations disintegrated, pile-driving undertaken, new foundations, larger and better reinforced, will have to be provided, after which your superstructure can again be built, without fear of its ever developing a crack in the future.'

Please recall this parable in reading the final conclusions to be found in the remainder of this book.

What are the joint findings of the reader and the author as a result of the perusal of these close on three hundred pages of matter?

They are these, are they not?

(1) That the farmers of Britain, ill-equipped in every way—in talent, implements, stock, fertility, organization—have done a man's job in this war-effort of theirs. From feeding only a third of the nation, they have risen to feeding at least two-thirds. They have shown an aptitude, in spite of almost overwhelming shortcomings and grave disadvantages, to try to meet the national emergency with resourcefulness and patriotism. They have never—either masters or workers—gone on strike, because they could not always get a fair hearing or decent treatment. They have dealt with the enemy at their gates, first and foremost, and left the redress of their grievances for a later discussion. They have never exploited their position—which would have been quite easy to do—they have put their country first, and have preserved the age-old tradition of the land, realizing that in the hour of need, the farmer and his fellow workers could always be depended upon. This is a grand record. Would that I had the pen of a Kipling so that I might here pay fitting tribute to an achievement surpassed only by the men of the fighting services.

(2) In doing this, with inadequate labour on the land, they have been unable to obey 'Nature's Law of Return', and put back to the soil the muck and humus of which their wartime cropping has robbed it. One and all, they are mindful of the slogan—and with a fair appreciation of its true meaning—that 'There is nothing like Muck'. They have been compelled to farm as best they could, with the labour and implements available. There was no alternative to manual labour for performing the act of muck shifting until quite recently, and therefore the job could only be partially done, it done at all. All farmers, even those better equipped with both tackle and labour, had to reduce it to the minimum—to the great detriment of fertility. During the war, our farming methods have had to be based not upon what the farmers knew to be best for their land, but upon what work they could get carried out. The pages of this book show—if they show nothing else—that this enforced neglect of the land's fertility has gone quite far enough.

(3) The neglect of our land and its steady decline ever since the Repeal of the Corn Laws in 1846 have brought about diseases in our livestock to a very alarming extent. Concerted action on the part of the Ministry of Agriculture, the veterinary profession, and farmers alike is called for most urgently. While inoculations may prove their worth, and may be the immediate palliative, and while for contagious abortion

they ought to be compulsory, they will achieve no degree of permanence unless they are accompanied by a better technique, by a much wider scientific knowledge of farming generally, and by a speedy return to the practices of humus farming.

(4) That the technique of 'subsoiling' should be studied and practiced by all farmers is a *sine qua non* of all my contentions, for otherwise, owing to the increasing 'compacting' of our soils by the use of tractors, the inexhaustible source of the earth's minerals will never be tapped and made available to man.

(5) Our farming, and the education that goes with it, should in future be conducted from its biological angle, rather than from its chemical and analytical standpoint. The lowly earthworm, the bacteria, the fungi, and the other myriads of micro-organisms of a benevolent character whose habitat is the soil, should be bred in increasing numbers. These—the unpaid labour force of the farm—are man's greatest benefactors. Without them and their immense labour capacity man cannot live. The deserts of Babylonia, Libya, Carthaginia, and the rest, are standing evidence of what happens to the soil clothing the earth's surface when these lowly inhabitants of the land are exterminated by acts of bad farming, soil mining, and land banditry. Compost and muck are the breeding ground and food for these myriads of organisms. They cannot survive without it. And our desert lands show that even man cannot survive without them.

(6) The farming education of the future is a problem of major importance. The prospective farmer ought to leave school at the age of about fifteen or sixteen, after taking either his School Certificate or his Matriculation. He should then go for two years to a well-chosen farm, the like of which he hopes to possess one day. Then he should go for two years to a first-class Scottish Border sheep farm, where he would learn everything possible in that time about the management of this valuable item of our livestock industry. He should then go to a first-class poultry and pig farm, perhaps for a year or more, where he would brighten his ideas on this type of farming activity, and then to Wye College for three years or so and take his B.Sc. in Agriculture. If he is worth his salt, and with a training like this he ought to be worth a lot of salt, he will then be fit to go and farm *anywhere.* It is important that the young student should learn to do manual work at quite an early age. Notwithstanding the inventions of muck shifters, combine harvesters, caterpillar tractors, robot transplanters, and the whole host of other implements that have been, and yet will be, introduced, the life of a farmer will always remain a hard one in which physical endurance will count for much. Unless a boy, wishing to become a farmer, learns to get into the collar at an early age and acquires a real love for a turn at hard work, he will never take to it when he has passed the age of twenty. It is of the utmost importance that our young fellows should be 'broken to the plough' when they are impressionable. We break our thoroughbreds when they are two-year-olds. If we wait until they are five, we can do nothing with them. It is the same with human nature. Let boys learn to work early enough, then send them back to their schooling. They will bring their practical experience to bear upon their theoretical lessons, they will appreciate their studies, and will finish up citizens of the world the like of which have not yet been seen on our farmlands. Unless we educate our future farmers—and educate them properly and with real sense—agriculture will show that it is capable of sinking even lower than the depressions of 1920 to 1939. The courage and the spirit of our farming people were at a low ebb between those two dates, and if agriculture is again thrown on the scrap-heap by the callousness of the urban voter—then those who work our land will lose all heart.

It is a sad but all too true saying, 'That human nature is mindful of favours to come, and forgetful of the favours that are past.' If, when this war is over, the townsman forgets his farming saviours, thus repeating his scandalous conduct after the last war, he can rest assured that in time there will be few occupants of the land remaining, and little or no fertility remaining either. The farm lands and their occupiers are the world's *primary producers,* and this fact should be the only basis of the world's future economy.

Unless we face the fact, and realize that these holocausts of recurring world wars are due to some fundamental and basic cause, to something which is rotten to the core, these devastating outbreaks of mass slaughter and wholesale destruction will revisit the world again and yet again. Their causes may not be difficult to diagnose. The putting right of them, however, is a work of major size and worldwide undertaking and agreement. It is like the parable of the cracked building, told at the opening of this chapter:

Our social superstructure is irretrievably cracked and there is nothing for it, but to pull the entire building down, to lay well-conceived, reinforced foundations—with pile-driving preceding everything for additional security—and then to build thereon a new social order, economically sound, which will weather for all countries the passage of time.

Let us put first things first.

The primary producers of the world are the first elementary needs of man and of everything that is alive on this planet. The future political economy of the whole world should be built upon an economy with the primary products as its sole basis.

Every country's capacity to produce primary products should be ascertained by an international committee. The corresponding requirements of the world's populations should then be quite easily calculated. These data would show the right directions in which to make adjustments ; one country must not have too much, and another too little, of the various primary necessities.

This war has produced two of the greatest statesmen the world has ever seen—Roosevelt and Churchill. To the former belongs the credit for the innovation 'Lease-Lend'. Without it the war could not have been fought; for all the machinery of accountancy encircling the Old Economy was insufficient to meet its unprecedented needs.

'Lease-Lend', therefore, let it be admitted, made the task of overwhelming Germany *possible.* If the Old Economy could not carry on the war to a successful conclusion, is it even remotely probable that that rotten old machine will prove equal to solving the even greater problems of 'Peace'? For let us be under no delusion; the real war will only begin now the 'fighting' war is over. Our old economy could produce nothing better for international relationships than the two greatest wars that ever happened, and hundreds of millions of unemployed throughout the world. Is this the best that we can do for ourselves? Must a very few have more than they can make use of, while untold millions have neither work nor food, and other still greater numbers of millions live below the subsistence level, while distraught shallow-brained statesmen can do no better for the citizens they lead than order shiploads of coffee to be taken out and sunk in the Atlantic, or order thousands of tons of wheat to be fed into railway locomotives in place of coal, or order the tax-payers' money to be paid over to farmers for hogs they are encouraged *not* to produce. Is this economy? Or is it the most advanced degree of lunacy? No wonder that Hitler, with his brains, thought that he would trample on the democracies when the best evidence of their abilities to rule was acts of unparalleled madness like these.

It will prove to be that Mr. Roosevelt's successor may have no alternative but to order an indefinite extension of 'Lease-Lend' to establish the peace. This may be of many years' duration. During this time due stocktaking can be made of the world's real capacity to produce the primary products and also its secondary manufactured goods. In the meantime we must explore and discover some workable system of equitably maintaining international relationships and trade, which will not inevitably develop into further wars. There can be a steady, well-planned redistribution of the world's population over the open spaces of the earth's surface. By degrees we shall all learn new values and new appreciations. Services will be a measure of value as between nations, while money, as it should be, will be a token of exchange within each country. The yardstick of gold will disappear for ever as an index to exchange, and records of services rendered and of real goods supplied will figure in international records in its place. Gold, which at best is only useful as an adornment for women, as a casing for watches and in other everyday needs, can still have its place, but it must never again be allowed to dominate the world of man with the tyranny that the bullion brokers, bankers, gold-mine owners, and other interested people manipulated for it. Of all the senseless objects of worship! ... A worthless commodity, uneatable, almost useless, dug out of one hole in the ground in Africa to be buried in other holes in the ground of other countries—why should gold be granted this power? Except for the people dealing in it, there is no latent virtue to be found in it at all. The primary products of life are the only basis for an economic system. Any nation is rich or poor according to its ability to produce foodstuffs upon which its humans and animals can live—not on its ability to produce gold, which cannot sustain life. In our present system of economy we are taught to deceive ourselves into really believing that the more goods we can make and *export,* the richer we become. Ask any seven-year-old schoolboy whether he would be enriched if he was persuaded to give away all his toys. We mine our coal; we manufacture countless products; we build ships, and conduct vast insurances. In return we create for ourselves foreign credits and build up thousands of millions of foreign investments. But to achieve all this, we beggar and pawn our home agriculture, render our land infertile, we diminish our standing army and our air force (to avoid taxation), expose our island home to the invader, and encourage aggressive neighbours to make war upon us. Then, to save our skins, in a few short years, we have to dissipate the whole of our foreign investments— or, rather, the remainder of them which have not been repudiated—and we begin to realize that we are, after all, a very foolish simple-minded nation, whose capacity for thinking ahead is of a very low order indeed.

During the past hundred years, while we have been deliberately ruining ourselves by fostering our exports, and sending our vast mineral wealth and manufactures abroad for nothing, we have been trying to persuade ourselves 'that true political economy is the balancing of an Inverted Pyramid'. No matter what we do, it will keep toppling over; first one way—and we prop that side with a subsidy; and then it overbalances in another, and we throw out a buttress made of quotas. When that leads to still another loss of balance we hastily construct a flying buttress by making some kind of preferential trade agreements, which involve more support from the taxpayer. Food is subsidized, so is coal, so is shipping, and so is almost every major commodity we produce. In times when unemployment in this and every other country is growing, doles and

other hastily and demoralizing attempts to stave off trouble are in vogue everywhere. There is no effort made anywhere to turn the pyramid the right way up and to start all over again—to start on a basis of primary products.

There are only two assets of value to any nation. One, its human population. Then for heaven's sake keep it well fed. What kind of a farmer would you think I was if I allowed my 250 cattle to wander round this farm half-starved? But this is just what is being done when a large proportion of the population is allowed to exist well below the subsistence level. If it is important you should feed your people, you must see to the primary products. They are produced from our own soil, and if our soil is adequately farmed—which means farmed according to the standards set out in this book—we can support a population twice as large as that of Britain to-day. Why then do we neglect our primary and greatest industry?

And last, but by no means least—what of the health of the nation? The unassailable medical evidence such as I have produced in this book should make every British citizen ashamed of the administration of the country in which he holds a parliamentary vote. If we are ill, we are doped with M. and B. or Penicillin. We are not taught from the cradle how to live healthily and develop bodies that will not be so prone to ailments.

Many, if not all, of the diseases of which both man and animal and plant are suffering, *come from the land.* In language unmistakably plain at times I have tried to tell you that all this can be put right. We have to learn to farm better. We must be much more thorough in our cultivations. We must understand that, just as we cannot live without air, so the aerobic micro-organisms of the soil, which are so necessary to our very existence, cannot live without it. This calls for a greatly improved technique in our general farming. Then, we must get away from the reckless application of artificial fertilizers. They are not only unnecessary, but have led during the past fifty years to a much depreciated standard of husbandry. By their easy application farmers have been content to skimp their methods, the oxidation of the soil has been shockingly insufficient, and our land has become unbalanced and disease-ridden. Good cultivation *alone* is the invariable rule for restoring the land to usefulness. Refertilization must be *organic.* It is ordained, as an essential part in the cycle of Nature, that the effete matters of one generation should be brought into general circulation for the use of the next. This is a basic indispensable condition which the land demands. Disobedience to this law brings disease to plants, animals and man. The citizens of the towns of Britain *must* take an interest in *their* farms. The land is theirs and the farmer is but their servant. They must be made alive to the fact that for their own health's sake *they* must take an interest in good farming. It is their responsibility. It may be the farmer's as well, but if those who eat the food are not interested in its quality and its life-giving ingredients, you cannot expect the farmer to get very excited about it. If the consumers of food demand good food, they will get it and, automatically, the land of England will be well and truly farmed, and health will inevitably ensue. The consequences of such a cataclysmic event as the world has suffered cannot be estimated. It may be that great care will be needed to prevent them from provoking, if only because of their shattering impact and the consequent upsetting of every balance of power, a new world crisis.

We may be sure that immense labour will be required to enable the world to survive. An economic and political abyss gapes wide where there was but yesterday the formidable German Reich: an area of dilapidation and ruin covers almost the whole of Europe, never in any war has such a legacy of ruin been left before. There was never such need for a long, an assured, and a stable peace in which to clear the earth and to rebuild all the nations so distraught.

Is this suitable peace in view?

Let us for one moment examine what took place after the last war. There followed a period of bad health when the influenza epidemic took possession of the whole of Britain and of Europe, and effected more deaths in its ravages than the whole of the war accounted for.

This war, even greater than the last, will exact a more terrific toll. There is food shortage in every country throughout the world, and particularly throughout Europe. Almost every country without exception has endured food privations during the past five years. Typhus and a dozen other epidemics are almost certain to be the lot of all these countries (possibly including Britain herself) and we may see a devastation, produced by disease, which none of us can visualize.

So far as I am concerned, I am satisfied that, while the inhabitants of the Western civilizations continue in their sordid materialistic outlook and all their economic calculations are governed by money and materialism, the world will never be brought to view the biological aspect of life which indeed governs everything.

Mens sana in corpore sano. There cannot be sane thinking from the mind of man if the body in which that mind reposes is not sound and healthy.

So great has been the transformation of everything that I have seen in farming during the last nine years, since I refertilized entirely with humus, improving the health of both man and beast out of all knowledge,

that I am quite satisfied that the real deliverance of the world—and I am fully alive to the magnitude of the claim I am making—is in the hands of the farmers. The farmers of the world must be brought to understand that the only way to farm is to maintain the humus fertility of their land, and that fertility is based upon the preservation of the living content of the soil. That living content can only be maintained by the continuous refreshment of further supplies of life, in the form of humus; there is an unescapable and natural sequence—from the health of the soil to the health of the plant, and thence to the health of the beast and of mankind. This is the only basis of a true economy.

Everything in Nature that we examine shows the greatest care in the preservation and the use of every sort of waste. Nothing anywhere in Nature is allowed to run to waste, but everywhere in the activities of man, whether it is in peacetime pursuits or the appalling ravages of war, man vies with man in finding methods to destroy everything with which he comes in contact. His inventions in recent times, instead of proving the greatest benefit for one and all, have been prostituted for his own destruction.

Nature's methods are based upon health, and health cannot be built up in either man, the beast, the plant, or the soil by the supplying of estimated chemical deficiencies, but by realizing that everything in life forms one living mass and that all have to be brought into unison to live together.

'The true arsenal of democracy is a fertile soil, the fresh produce of which is the birthright of the nations.'

APPENDIX

WHY I AM DISAPPOINTED IN ROTHAMSTED

On 24th February 1945 the London Science (Research) Society promoted a scientific debate on soil biology at the British Medical Association. Dr. Scott Williamson, the famous Biological Research Scientist, head of the Peckham Experiment (perhaps the greatest human biological experiment yet conducted) occupied the Chair. Dr. E. W. Russell of Rothamsted spoke for forty minutes and Lady Eve Balfour countered by setting out a biological as distinct from a chemical outlook.

In the discussion which followed I explained the reasons why I was very disappointed in the work that had been done at Rothamsted during its 101 years of life. I suggested that the Institute had been brought into existence by the interest and activities of Messrs. Lawes & Gilbert, the founders of the artificial fertilizer industry, and that throughout the past hundred years its programme of work had been almost entirely —if not entirely—chemical, and not nearly enough of a biological character.

I went on to say that the work of the scientist at Rothamsted and at kindred experimental stations was to formulate a scientific theory of a practical character which would eventually be handed over to the farmer, and it was left for him to translate the scientists' theories into everyday usefulness by acts of husbandry on the farm. The whole tendency of Rothamsted during the past hundred years, having a chemical bias, had brought about a chemical mentality throughout the whole of the farming community in almost every country, to such an extent that practically every farmer everywhere used artificial fertilizers, sometimes to the exclusion of muck, and at best only in combination with muck. Economic pressure throughout the world was also helping this general trend because methods of refertilization involving the use of muck were much more costly and involved a great deal more labour—two things which had weighed heavily in the farmer's economic balance,

The farmer, led by Rothamsted, has increasingly been brought to believe that refertilization was almost, if not entirely, a chemical process, and as each generation during the past hundred years has gone by the disposition to use muck as a fertilizer has become less and less. A great part of the responsibility for this present tendency can be laid at the door of Rothamsted: for Dr. Russell, in his address at the British Medical Association, actually made the statement that, economic considerations being left out entirely, it was possible to farm more or less indefinitely with the aid of artificial fertilizers alone.

I drew attention to the practical disagreement with this view which is exemplified throughout the country in the press by Messrs. Fisons Fertilizers, and I quoted one of their current advertisements which I had taken from the newspaper only a few days before:

'THE MOTHER OF MONEY. . . .

'The forthright saying that "muck is the mother of money" still holds good. Farmyard manure, or muck, is the best of the bulky organic manures. But the quality is lacking—owing to the shortage of rich imported feeding stuffs—and the quantity as well. That is why it is so important to make the most profitable use of what there is. Therefore, muck the root crops in the rotation and maintain a balanced system of manuring by giving fertilizers as well.

'A century ago, muck was, with the exception of lime, the only manure known to farmers. We now know that muck and fertilizers help each other—that if one is the MOTHER then the other is the FATHER of money.' This was obviously inconsistent with Dr. Russell's claims. Fisons Fertilizers must know the value of muck and, with their wide experience, they know that if anything will fortify their business and keep them in existence it must be using their fertilizers in *combination* with muck.

I went on to say that what we farmers are most anxious to ascertain is whether indeed the claim made by Fisons Fertilizers can stand: that muck and artificials are a desirable means of refertilization; or whether muck—or better still, compost, run in conjunction with the four years' deep-rooting ley—is not an even superior means.

Some of us humus farmers, I suggested, might think we knew the answer, but I put it to the meeting that there were two schools of thought —first, there were those who believe, as I believe, that muck or, better still, compost combined with the deep rooting four years' ley provides the only safe and permanent fertilizer whether the quantity of the crop, or its quality, or its life-sustaining capability, is taken into account. Secondly, there were many capable and commercially minded farmers— and unfortunately all farmers in these economic days have to be commercially minded—who considered that a mixture of muck and fertilizers was the ideal thing and that if pure quantity were the sole consideration, then this method of application secured the best results.

Dr. Russell admitted that all their experiments at Rothamsted during the past hundred years had been entirely quantitative and that quality had nowhere figured in their programme. I pointed out that quantity is only of value if it includes quality, for quality implies that the food produced is life-sustaining and disease-resistant. These fundamental issues, I urged, were literally all-important to me as a farmer breeding and rearing a very large head of pedigree and thoroughbred livestock, and I declined to follow a policy which had no other object than the production of mere 'quantity'. I asked the meeting to support a finding that the scientists' policy at Rothamsted was disappointing, that a revision of their programme was long overdue, and that years ago they ought to have conducted such practical biological experiments, making use of cattle and animals of all kinds, as would have proved beyond doubt that by fertilizing either wholly with artificials, or partly with artificials and partly with muck, or entirely with muck, or entirely with compost, or with a mixture of compost and the long-term ley, foods of a definitely ascertained character could be grown. All this knowledge ought to have been in their possession these many years, whereas they had not even begun to think about the experiments needed, and we farmers had a definite complaint to lodge against a great institution for this grave neglect. Speaking for the rapidly growing number of those who believe in organic fertilization, I said we were determined that these long-term tests should take place.

In his final summing up, Dr. Russell admitted the impeachment which I had made against Rothamsted, and he excused its sins of omission by saying that he and others at Rothamsted felt that these experiments ought to have been carried out but that this had never been possible through lack of sufficient funds.

Unfortunately, it was not possible for me, according to the rules of the meeting, to ask further questions but if I had been permitted to do so I should have asked many and among them would have been these:

Is it a fact that the greater part of the funds by which Rothamsted has always been supported come from the manufacturers of artificial fertilizers? If so, is it likely that those people who provide very large sums of money for chemical experiments, which must be presumed to be basically intended to promote the sale of artificial fertilizers, are going to risk experiments being conducted which may prove—and which from my own experience as a farmer I know will prove—that the artificial fertilizer does not produce food of the same life-sustaining quality as refertilizing with muck and compost? Unfortunately, my experience counts for little or nothing because none of my experiments and general work have been conducted as a means of combating the scientific findings of Rothamsted. My experience has had no scientific supervision at all and the results which I have achieved are consequently open to suspicion and doubt. Having regard, however, to the fact that when I make compost I do so entirely for my own consumption and not for sale, I do claim that my findings are disinterested and are actuated by very different motives from those of the ordinary vested interest. If Rothamsted has throughout all time, and if Rothamsted is still receiving, its major financial support from the vested interests of the artificial fertilizer, chemical and allied trades, there can be little hope of that great institution ever being able to give a report of a truly independent and unbiased character. If this be so, the urgency of creating a new institution which will carry out a twenty-year term of biological tests on foods, grown under various systems of refertilization and tested out on the cattle themselves, must be evident to everyone. It is a matter of the greatest concern to the health of our nation and of the nations of the world. The soil erosion which is taking place in every country is largely, if not entirely, due to the absence of humus from the soil, to the acts of banditry perpetrated by man in that kind of farming which is land exploitation and soil mining, and to the reckless felling of forests throughout the world without any systematic plan of re-afforestation. These acts of national scandal, crimes which can be laid at the door of every country in the world, are calling for the most urgent solution by every Government. For far too long the soils of the world have been used and exploited for private gain—the time has arrived to call a halt. And since the laws of nature are everywhere being defied and controversial issues are being raised by vested interests of every kind which are opposed to a wholesale reversion to nature's laws, the long-term tests for which we ask become all the more urgent. For the strongholds that have been built by many of the great industries are so immensely powerful that, under the present economic system in which money is the only measure of value, they will not yield ground until public opinion, backed by scientific proof, is available and beyond question.

Dr. Scott Williamson summed up very fairly and judicially the various speeches both from the platform and from the floor of the hall and his findings were that biological research into the problems of the soil, for all practical purposes, had been neglected; that there was accumulating evidence everywhere to suggest that research of this order would probably prove itself in the course of time to be of far greater importance than the chemical issues ever were; and that the scientific society present at the meeting were of opinion that the Government should be pressed to carry out biological studies into the condition of the soil, as one of the most urgent features of scientific planning.

The issue here seems to be very simple. If a farmer's wife makes a pudding for her farmer husband she expects him to eat it, and the life-sustaining pleasurable features in the eating of that pudding will cause the

farmer to make either a request for more, similar puddings or a peremptory demand that she never makes another pudding like that!

If, on the other hand, the farmer suggests to his wife that instead of submitting the pudding to the test of eating he should have it examined through the powerful lenses of a microscope to ascertain if its 'cellular build up' is correct, the farmer will be a lucky fellow indeed if he lives to taste another pudding.

This simile exactly fits the practices at Rothamsted. The plants which they grow are submitted to microscopic examination for 'cellular buildup' and sometimes to chemical analysis to ascertain their alleged food value.

But the purpose of growing food is to feed that food to either cattle or humans, and if we would really know its practical effect, the tests to be carried out should be feeding tests and not be based on microscopic observation and chemical analyses.

There is only one aspect of farming which is fundamentally important, and that is the maintenance of the health of the human beings and the animals that consume the food grown by the farmer. Of all problems this is the most pragmatic, and it is high time that we scrapped many of our laboratories and employed our scientists in keeping the most accurate records of the effect on health of the foods grown on the land. This need is so simple and so obvious that it must have been either completely overlooked or intentionally and studiously disregarded. It can be disregarded no longer. The public who consume the farmer's produce demand it; the farmer, surrounded as he is by a dozen diseases in his livestock, calls for it, and the time to do it is *now*.

APPENDIX II

THE PABULUM

In the winter of 1945-6 I gave a number of lectures throughout England and Scotland. These events are always of unfailing interest to the speaker as well as his audience. Never quite the same questions arise, and sometimes they are a little startling in the disclosures they provide.

On the subject of phosphate deficiencies I have always a number, and on one occasion, at a large South Country Farmers' meeting, an Executive Officer of the County observed, 'That my address had provided him with the answer he had been seeking for a long time to a problem he had been unable to solve. In the western side of his county he had reclaimed large areas of land which, on analysis, showed marked phosphate shortages. Artificial phosphates had been added. Pioneer crops had been grown and consumed by sheep *in situ.* Subsequent analysis had disclosed a far heavier phosphate content than all the accumulated artificial phosphates he had added to the soil. After my address, he guessed the answer, but would I give my explanation?' This was my reply.

'The addition of basic slag could be justified wherever derelict land showed a marked phosphate shortage on analysis. The addition of this artificial has the effect of getting the seeds of rape and Italian ryegrass going. It is important, however, that this crop should always be consumed *in situ,* for by so doing, the whole crop, consisting of all that came from the soil (5 per cent) and all that came from the air (95 per cent) went back into the land as an organic activator. This acts as a decomposing agent, working upon any available vegetation, and humus is thus manufactured. Humus is food for the micro-organic population, which is now being brought to life by the reclamation of this derelict soil; and those organisms, earthworms, and fungi, in their turn, begin to work upon, disintegrate, and generally solutionize all the phosphates and potashes that once were unavailable, into available plant foods, thus increasing the fertility potential of the soil, and providing it with an analytical content entirely different from that which showed itself when operations on this derelict land were begun. It is important to grasp the fundamental understanding, that the *Pabulum* of feeding the plant is *through* the micro-organism, and *not by direct feeding to the plant itself.*

'In this way unavailable minerals are *conditioned* by the living population of the soil, and continued analysis will disclose a steady increase in all the essential plant foods provided always humus-manufacture is kept going.'

It is interesting to note too that after the soil is brought back to life by this treatment, it is not necessary to make further addition of slag.

APPENDIX III

THE CONSERVATION OF LIQUID MANURE ON EVERY FARM THROUGHOUT BRITAIN

After a lecture in one of the best agricultural districts in Scotland, I was invited by the leading farmer of that locality to go over to his farm. He was a first-class man, and one whose thoroughness was much to be admired. He told me he had never been so impressed by an address, and inquired earnestly whether I thought he would ever be able to abandon the use of artificials, which cost him the average round sum of £3,000 per annum. I assured him that he could abandon them entirely if he transformed his rotations into those of alternate husbandry as outlined in this book. I then asked him if he would show me his cowsheds. This he did with great pleasure, for they were brand new, of the latest pattern and equipment. He was proud of them. He had a first-class herd of cattle, all attested. He made good money out of his very large dairy.

I moved round the buildings quietly, and took an interest in all he had to show me, and when we had spent some time looking into every detail, he turned to me, 'Now, Mr. Sykes, what do you think of that?'

There was commendable pride in his gesture—so much that was so richly deserved—that I hated to criticize in the slightest degree. 'I have seen much that I can envy, Mr. X, both in buildings and efficient management, but I have also seen where you can save the whole of the costs of your annual bill of £3,000 a year for artificials.'

He literally stared at me in open-mouthed amazement. 'Where?' he gasped.

'Why do you waste all your liquid manure down that drain? You take pains to recover your dung, and to see that it is returned to the land. Why do you allow all your urine to run to waste? Do you not know that urine contains 80 per cent of all the nitrogen emitted from the animal's body, as well as all the potash? That the urine is worth more to you as an organic activator than all your artificials, for it is the most useful agent in reducing your straw into humus! Your artificials may feed your crops somewhat imperfectly, and give you a financial return for the time being, but the urine you are wasting will do all that much more efficiently, and will build up the capital value of your land at the same time by increasing the supplies of humus, which your artificials exhaust. Arrest that waste as soon as you can, and catch your effluent in this way.

'Build a circular reinforced concrete tank, five feet deep, twenty feet diameter. Into the bottom of this spread a foot of beech sawdust. Then a layer of waste straw. Drain all your cowhouse urine and washings into this tank and allow it to spread itself over the whole area of the tank. When this is promising to get "slushy", put in a little more sawdust and more waste straw, and continue this until that tank is full. The contents must be saturated, but not sloppy. Then they are in such a condition that the tank can be easily emptied by the Rapier Muck Shifter or by hand with a four-pronged fork. Then mix this with your compost heaps, for here you have an ingredient of the greatest possible value as a decomposing agent. Your compost will be enormously improved in its content, and its effect on the land will be most marked.

'At the time that your root drills are just about to come through, take this slightly moist material, and cover with two inches of it every line of your root drills, and you will find your roots will never suffer from turnip fly. Do all this—do it thoroughly—and you will not find it necessary to spend £3,000 per annum on artificials to maintain your revenue.'

The advice that I gave to this distinguished Scottish farmer is such as I can give to almost every farmer in Britain. I never visit a farm anywhere and find the arrangement for catching and using the urine even remotely satisfactory. In ninety-nine cases out of a hundred it is all run to waste. Nothing is ever done about it. Here is the most vital product of the farm which ought to be jealously guarded and conserved. How can farmers expect their fellow townsman to foot bills for subsidies while pieces of scandalous waste such as this are in evidence on nearly every farm? And yet, a piece of wastefulness which can be so easily arrested, thus turning a by-product into the greatest source of revenue, viz. the building of organic fertility into the soil.

APPENDIX IV

THE BLACK HARVEST

What a curious coincidence that this book should open with a chapter entitled, 'Will there be a Second Black Death?' and circumstances should be so ordained that I find myself concluding my story with an account of The BLACK HARVEST OF 1946'.

In this fateful year there would be few men farming who were not distressed with their experiences of the anxieties of that disastrous harvest. In the course of my travels as a Farming Adviser and Consultant, I travelled far and wide in August and September, from the county of Dunbarton to Kent, and westwards to faraway Cornwall. Without exception I saw the same evidence everywhere. Corn laid by gales, sodden and ruined by continuous rain. Stooks sometimes waist-high in water, grain shooting in the ear, land so softened and heavy that modern machinery dare not venture upon it. This sum total of damage, as I write, cannot be ascertained; nor the violence of the blow estimated to the nation's food and to the general finances of the agricultural industry.

'Hope springs eternal in the human breast', and of all people the farmer has continually to draw upon this 'spring' for sustenance. Day after day, week after week, he felt the rain must cease. But it never did. It just kept on and on. And after two months most farmers were faced with a degree of despair and ruin such as they have never had to contemplate, not even in the dark days of the 'thirties, just before the Second World War. The seed position for 1947 season is in jeopardy, and promises to be even shorter than next year's bread, so far as home-produced supplies are concerned. Oats on which the farmer relies for his winter stock-feeding simply will not be there. Sprouting grain, unfit for human consumption, even though it might be harvested, has little value in it for animals. Blighted and sodden acres of potatoes offer as dismal a prospect as the fields of corn. No man living can recall a year to equal that of 1946.

For many farmers this year will mean bankruptcy. Urged by emergency measures produced by hysterical departmental legislation, every farmer everywhere has loaded himself up this year with prisoner labour to a greater extent than he ever did before. He has had an enormously increased current expenditure. All this in a year when he may have lost the whole of his harvest.

Through an exceptionally wet season, weeds on every farm have outgrown the farmer's capacity to hoe them down. The land is dirty and foul in consequence, while it is so sodden that any chance of autumn cleaning is quite out of the question. So that whatever kind of winter may lie ahead, the farmer starts at the greatest disadvantage. Next year's difficulties loom ahead with menacing foreboding, even before we are able to estimate the full impact of the troubles of the year that is passing.

Such wholesale disasters are an experience in which the farmer stands alone. Other industries share with him the general anxieties associated with production and commercial trading, but they do not usually carry out their work exposed to the weather, and have the whole of their year's work ruined in four weeks by elements they cannot control. Those who risk the perils of the sea do not share the same economic risks as belong only to the man who tills the soil. When the seaman meets with bad weather and dire straits, his chance may come again. The farmer's will not.

The sympathy of the townsman—for even he has been made painfully aware of the fact that food comes from the farm, and not simply from the 'shop around the corner', may be of little avail. Although this Black Harvest has stared at the townsman in his newspapers for several weeks, and he is suffering inconvenience and restriction of bread rationing, it is very difficult to bring home to him the continuous risk the farmer runs, and how little the townsman has to pay for the food which keeps him alive. The farmer all the time knows his risks. He understands even the year of 1946 as one of the natural hazards of his calling. But the townsman here and now ought to be made to appreciate how very necessary it is that the farmer should be granted a fair price for all his produce, for he has to try and build up a financial bulwark to guard against such a calamity as that which has befallen nearly every farmer in England in the Black Harvest of 1946. If the present appalling disaster has brought that fact to the mind of the consuming public, we farmers may almost be glad of it, and gather ourselves together again for all the difficult problems which lie ahead.

So much for genuine and practical sympathy for the farmer. Everyone shares this to the full.

But how much of it might have been avoided? What are the causes of this trouble, or some of them? Just as we hold an inquest after an accident, let us inquire whether any of these disasters might have been avoided.

The first trouble to be seen everywhere, was the immense acreage of grain that was 'laid'. Scarcely a farmer anywhere who could report that all his corn was standing erect as it ought to do. What is the cause of this?

I contend that the primary cause is the lack of strength and vitality in the straw. Why should this be? This is caused through incorrect and inadequate feeding throughout the plant's life. First the root system is insufficiently grown and developed, this then fails to sustain the plant during growth, and when the rain and whirling winds come the plant is twisted off its roots, breaks, and goes down. Can this be avoided? Yes, indeed. We had some two hundred acres of corn. We are 800 feet above sea level on one of the windiest and most exposed farms to be found anywhere. We did not lose more than one acre of corn. Why did we not get our grain laid? Because the root system, nurtured now for several years on purely organic re-fertilization, was sufficiently perfect to provide nutrients of the right life-sustaining kind and in plentiful supply, and thus—and thus only—our corn did not go down.

In 1946 we have had some 1,300 visitors to this farm, and they nearly all remarked how extraordinarily strong our corn crops appeared, and even when the storms were raging everywhere, and others were losing their corn through 'lodging', ours was still standing.

'But even so, Mr. Sykes, you have still your tasks of harvesting. We know we have had "lodged" crops through using artificials indiscriminately, and not enough muck, but how can you harvest in England in the bad weather such as we have had this 1946?'

Well, we got ours in without losing ten sacks of grain. We used TRIPODS.

Tripods are the greatest invention that have ever been introduced to farming. After a season like this every farmer surely ought to use them.

All our grain is BONE DRY, and of superb quality. None of it is grown out. Its germination is of the highest. This had been saved by TRIPODS.

On 17th August I was summoned by telegram to attend a meeting with Mr. Eugene Randag, the tenant of the farms on the Chequers estate. Chequers, as everyone knows, was given by Lord Lee of Fare-ham to the nation, to be kept as a permanent country estate for the Prime Minister.

There were several hundreds of acres of corn in a parlous state, and with the prevailing weather it looked as if all of it might easily be lost. Proctor, the inventor and maker of Tripods, was called in to advise, but the sad spectacle was almost too much for his courage, and before taking a decision he asked me for my views. I was in Lancashire on work when I received his telegram. I left at once for Chequers, where I met Randag and Proctor. I confirmed Proctor's opinion that those crops could be saved if we could lay our hands on the necessary Tripods. So, regardless of cost, 2,000 Tripods were got there in a few days, and in less than three weeks over 200 acres were reported to me as being 'safe' in the Tripod.

Is it not a strange thing, that here is an invention, some ten or twelve years old by now, which has received the highest awards at the Highland Agricultural Shows, and it is barely known to the great mass of farmers, and still less used. This great harvest of 1946—one of the greatest of the country's wartime efforts—could have been as completely saved and made secure as we have saved our own individual harvest at Chantry. Why does the farmer fail to make himself acquainted with this method of harvesting—the only method that is practicable for both hay and corn in our very undependable climate? I fear it is a combination of both indolence and ignorance. On the 14th September Milns of Chester, the famous seedsmen, organized a large rally of farmers to visit our farms at Chute. These visitors came and saw over 1,600 Tripods in commission. They saw all the corn crops standing there in the rain— and it was raining very hard that day too—and all the corn was BONE DRY.

Now that we have harvested and saved some of the crops that looked as though they were lost, and these were growing right under the windows of the Prime Minister's country house, is it too much to hope that the Government will begin to take a hand and demand that farmers everywhere shall harvest by Tripod; and that the Board of Trade shall forthwith be stopped from importing Combine Harvesters, a machine which has proved itself well-nigh impotent in this very severe and difficult season? We can make all the Tripods in our woods at home, and surely we can do with all the dollars that will be needed to pay for the steady stream of Combines. I believe there are some 4,000 of these machines—all imported—in operation in this country. They don't satisfy either the miller or the maltster in the product they provide. Their continuous importation calls for foreign exchange which is badly wanted for other things. The making of Tripods in millions will employ a large head of British labour.

I wonder, with this practical object lesson at his door, will the Prime Minister take effective action on this subject of Tripod harvesting, and thus safeguard England against a possible repetition of this national calamity, the Black Harvest of 1946?

APPENDIX V

RAPIER-PRIESTMAN DITCH-CLEANING GRAB

For very many years there has been a cry from informed farmers who understand the need for proper drainage, and latterly from Ministerial sources, for a machine that would quickly and cheaply carry out the heavy and disagreeable job of ditch cleaning.

Though machines have been on the market for some time, particularly of the dragline type, which are able economically to dig a new ditch or clean out an old one in the case of relatively large ditches, no machine hitherto has been produced of a practical kind that could economically clean out the many small ditches which surround nearly every farm in England.

An additional use to which the Rapier Muck Shifter has successfully been put is this very job. By provision of a two-rope type of grab, which calls for an additional barrel attachment, the 'Rapier-Priestman' type of grab can be operated satisfactorily after only a little practice and by this means as much as 170 yards of ditch have been cleaned in an eight-hour day.

Grabs hitherto supplied for this purpose have suffered mainly from two disabilities. Either they widened the ditch too much at the bottom, with the result that the sides in time fell in, so again blocking the ditch and increasing the already high percentage of land surface occupied by ditches or, in being narrow to avoid this objection, they failed to empty themselves of the actually small amount of material which their short-stroke nature permitted them to grab.

The introduction by Messrs. Priestman Bros., who have an international reputation in this class of work, of this 'Extenso' type of grab, modified by Messrs. Ransomes & Rapier to make it produce suitable results with ditches of the kind under consideration, makes possible for the first time mechanical ditching at a speed sufficient to justify mechanization. The grab used, when open, spans 11 ft. of ditch and because of the patented horizontal or level cut it makes by being restrained on the 'holding' rope attached to the added drum, as few inches as desired can be shaved from 11 ft. of ditch at each stroke.

This ensures a high average of worthwhile grabfuls and cuts may be made in successive lengths of ditch at the same or any desired level. It is quite remarkable how the water in a ditch immediately begins to flow, as there are no pockets to fill before it can do so.

The accompanying illustrations make clear the remarkable width of the stroke of the grab and the narrowness of the bucket, which will be seen to be so shaped that a batter is provided at the bottom of the ditch and, consequently, the minimum desirable bottom width. The bucket is so shaped internally that self-clearing is assured in any reasonable conditions.

38. The Ditching Grab fully extended

39. The Ditching Grab half extended

40. The Ditching Grab entering the ditch

41. The Ditching Grab loaded