CROP PROTECTION

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INTRODUCTION

Every slice of bread that is buttered, every potato that is boiled, every cup of coffee that is consumed, represents the conclusion of another battle in the war that had gone stale when Ventidius was trying to persuade Antony to leave the Egyptian minx alone—the war that had grown cold before man had learned to use the Nile mud—a victory in the war that began the day after we were evolved and which we shall be fighting upon the day that we become extinct —the war of man against an upset balance. Man was responsible for upsetting this balance and he is constantly striving to put it right.

Somewhere between 15000 and 12000 B.C., Neolithic man decided to cease his prowling accross the plains in search of game and to adopt a less restless mode of existence. Instead of hunting for his meat and gathering what wild fruit was available, he taught himself to cultivate land, to set seed, and to wait for a harvest. If he liked bread, he found that by growing enough corn he could eat bread every day. At the same time as he was learning the rudiments of crop husbandry he was also beginning to domesticate animals. When he realised that he could eat bread every day and occasionally bread with cheese he lost most of his desire to wander. He could build himself a permanent home. Large possessions became more significant for him—they were something to create, to be proud of and to defend. In time he made the first crude attempts to select the plants that he grew. He chose plants that would yield him something which could be processed or used, and by trial and error he found that some types would bring him the greatest return for the energy that he expended. When he discovered a stronger looking plant than its neighbours he took it and used its seed to sow for the next season's crop. It was natural that he should plant these seeds close together because he wanted to submit them to the same set of cultural treatments. This was when he tipped the scales and upset the balance.

Before our forebears gave up the chase, the fertile areas of the world were clothed by a vegetation which the botanists would call a ' dynamically balanced association '. Species of plants best suited to the soil and climate grew side by side. Other species became established only slowly, and those already present took a long time to die out. Some years were good for cornflowers and there were a lot of cornflowers; other years were bad and there were fewer. But

over a period of years on a particular area of land the numbers of a given species did not alter very much. The forerunners of our present cereals might perhaps have been found as individual plants, or in small patches growing next to a primitive poppy or a thistle with some parsley beyond, a bunch of cocksfoot and then again another cereal plant.

Under these conditions an insect living upon the developing cereal grain would have to climb down a stalk, walk past a thistle, the poppy, the parsley and the cornflower, before climbing another cereal stalk to continue its meal. Sometimes the journey was uneventful but frequently disaster would be met on the way. At all events so much exercise left it little time for feeding and breeding, so that, although this species might survive, its numbers would seldom increase or decrease to any large degree. With the plants, the insects, and the disease organisms there was a continual variation about an average population. If during one year the climate was particularly suitable for one plant, then the insects that lived upon that plant would thrive and their parasites and predators (the other creatures which ate those insects) would also thrive. If the following season was less favourable, then the process would be reversed and the natural balance would be maintained.

The first man to sing 'I'll plough and sow and reap and mow' —in Arabic or some early Sumerian tongue—was guilty of initiating practices which tend to destroy this natural balance. He didn't want to walk twenty miles to gather a bushel of corn so he scratched an area of land and grew it altogether.

The insect which previously had had to undertake a hazardous journey to reach a fresh supply of food had only to slip and fall to find that it had landed upon another plant of the same kind. Under these conditions it was able to multiply rapidly and its population would have been enormous were it not for the fact that its natural enemies also benefited by the changed conditions and kept it in check. However, if the natural enemies were very sensitive to cold and there happened to be a severe winter, many would perish, and during the following season their host would become a plague.

When block cultivation is adopted, many indigenous plants that are well suited to the soil and climate find themselves rejected and unwelcome. Unfortunately weeds do not recognise political barriers and some of them return to thrive under reduced competition—for although there are periods when they have to compete for food, light and water with a sown crop, they can take advantage of the period when that crop is not in the ground or when it is immature. To harvest his crop successfully the cultivator has to

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remove continually the competition of these weeds. There are, of course, plants which fade out after the inception of cultivation—they are often those species which demand a continuous cover of vegetation upon the soil, e.g. the weeds which prosper only in permanent pastures, and which do not reappear when the land is sown with an arable crop.

The idea of a natural balance is provoking and exciting, for it points to the overall efficiency of the machinery of our universe. That the balance exists can be demonstrated by examining the condition of the under-developed areas of the world. The dense tropical forests do not become denser and gloomier to infinity; they reach a limit under the prevailing climate. They are by no means static; young life is always evolving, and old fading away. Similarly when one walks abroad one is not continually confronted by skeletons and rotting corpses. The earth consumes her debris as readily and as rapidly as she creates it.

That man can alter the poise of this balance has been shown on the Chota Nagpur plateau of North East India. Just over 100 years ago vast stretches of this plateau were humid and covered by forest. Much of this forest has since been cut down to make room for tea gardens, and in consequence the distribution of rainfall has become much less favourable to tea, as well as to many of the indigenous plants. There will be a limit to this readjustment and nature will establish a new balance.

Ultimately nature always does strike a new balance when a factor has been removed, but it often takes a long time and it will not always favour man.

To ensure the survival of our packed society we must endeavour whenever we remove a factor in the natural balance to replace it by a factor of equal consequence. If we neglect this duty we can be responsible for an outbreak of plague dimensions. Serious plagues have brought great civilisations toppling to the ground.

Each outbreak of a pest or disease, and each scourge of weeds, serves to remind us of the disastrous results that can ensue when extensive areas are sown with one crop. Since it is inevitable in the twentieth century that men should grow their crops in this manner, it seems that some useful purpose might be served by examining the types of pest, weed, and disease problems that this modern husbandman is likely to have to face, and also to consider the possible ways in which he may be able to counteract these evils.

First, the types of problems that exist will be discussed and afterwards some of the methods of solving these problems will be indicated.

Weeds can be defined as plants growing out of place; they are like the gentlemen who 'wear sporting breeches at a ball'. Here are the types of weed problem that have to be faced:

1. Broad-leaved weeds growing in a narrow-leaved crop, e.g. docks growing in corn, or thistles in grass.
2. Broad-leaved weeds growing in a broad-leaved crop, e.g. docks growing in beans.
3. Narrow-leaved weeds growing in a broad-leaved crop, e.g. couch grass growing in coffee.
4. Narrow-leaved weeds growing in a narrow-leaved crop, e.g. couch grass growing in sugar-cane.
5. Hard woody weeds growing upon grassland or other land fit for development, e.g. brambles, sodom apple, or woody legumes growing upon potential pasture.
6. Weeds growing off the cultivated land and acting as alternate hosts for insect pests or plant diseases, e.g. the barberry acting as an alternate host for *Puccinia graminis*—the organism responsible for the well-known stem rust of wheat.

These, then, are the types of weed problem that have to be faced and overcome. The width of the leaf of the plants has been stressed above. This has been done because the plant kingdom can be divided into two distinct groups:

A. the Monocotyledons—generally plants with narrow leaves like the grasses and cereals, and

B. the Dicotyledons—plants which generally have a broad leaf habit, like the beans or roots.

These two distinct groups show distinct differences in behaviour, a fact which is often used by agricultural scientists as an aid in overcoming various weed problems. This matter will be referred to later.

So far as the insect pests are concerned, the types of problem that they present are not as numerous as those presented by the weeds, but when they do begin to demand attention their demands can be very large. The problems that they present can be broadly classified as follows:

1. Pests that are sown with the crop, e.g. the sowing of cereal grain that is already infected with the larvae of an insect, say a grain beetle, which will prevent germination.
2. Pests that are present in the soil when the crop is sown, e.g. wireworms and cutworms, which are both the immature stages of beetles.

3. Pests which come from outside to attack the growing crop, e.g. the greenfly or the ever-present threat of the locust.
4. Pests which attack the crop in storage, e.g. the grain weevils.

The plant disease problems that have to be faced can be grouped in the following manner:

1. Diseases that are sown with the crop, e.g. covered smut of barley, the spores of which are often present to contaminate the seed which will be sown in the following year.
2. Diseases which are present in the soil when the crop is sown, e.g. *Armillaria* root rot of tea, which may be present in pieces of decaying, infected tissue and which will attack the woody tissues of freshly planted trees and shrubs.
3. Diseases which move on to the plant, by means of airborne spores, from another plant where they have spent one part of their life cycle, e.g. stem rust of wheat.
4. Diseases of finished products, e.g. the storage rots of fruits.

Here, then, are fourteen different types of problem which the agriculturist must learn to deal with if he is to survive. The answer to a specific problem is not always easy to find—especially in time for it to be of any value.

There are five main ways in which one may attempt to control a pest, weed, or disease; they are as follows:

1. *Ecological Control*

Employing an ecological method of control necessitates bringing about a radical change in the environment of the crop and pest so as to favour the survival of the crop, e.g. the flooding of an area of land in order to kill insect larvae at a susceptible stage, or the draining of marshy land to eradicate the *rush* grasses.

2. *Cultural Control*

This method of control demands a modification of the system of culture, e.g. the planting of spring wheat early so that by the time the wheat bulb fly appears and is ready to strike, the wheat is in such a condition that it can withstand and overcome the attack. Sometimes an alternate crop may have to be sown.

3. *Biological Control*

Several pests and weeds have natural enemies that will keep them in check. If these natural enemies are not very abundant, or

are absent from an area, it is often possible to encourage their development or to introduce them. Biological control is sometimes neglected these days because of the difficulty of finding and rearing large numbers of suitable parasites; however, when it is fully understood and practised with discretion it can be remarkably successful. e.g. the control of the coffee mealy bug in Kenya has largely been due to the introduction by Melville of a parasite from Uganda.

4. *Control by Breeding of Resistant Strains of Crops*

Sometimes disease or pest problems can be overcome by breeding for a variety of crop which is resistant to the attacks of the pest or disease, e.g. in some cases red rots of sugar-cane have been overcome in this way.

5. *Chemical Control*

All the above methods of control demand for their application a forewarning of the attack, and require time to become effective. Often it is possible to employ a chemical method of control to fill the gap until one of the above methods may be used.

What might appear to be the most obvious method of dealing with a crop protection problem—chemical control—has been mentioned last. This has been done deliberately because there is a dangerous tendency for farmers today to rely upon chemicals as though they were a panacea. This is a most unfortunate development because although chemicals are often indispensable as immediate remedies, all the chemicals in the world will not replace good husbandry. There are cases when it can be firmly stated that the application of a chemical has been responsible for creating more problems than it solved. The best example of this is the present-day abundance of the red spider mite in many apple orchards due to the application of various poisons against the codling moth—as well as killing the codling moth these poisons also destroyed the natural enemies that had kept the red spider in check.

In backward lands those persons responsible for the introduction of agricultural chemicals should ensure that they are understood and handled intelligently—for once the initial scepticism of the small cultivator has been overcome he is likely to accept a chemical as a kind of Ju-Ju. It is reassuring to note that in the agricultural administration of most backward countries the emphasis is being laid upon teaching sound cultural practice.

When a problem arises it is nearly always necessary to apply some immediate form of control to prevent it from getting out of

hand; this usually proves to be a chemical method. After the emergency is over some alternative method must be looked for.

In order to apply any method of controlling a weed, pest or disease, it is essential to gain a thorough understanding of the life-history and biology of the undesirable organism in relation to the biology of the crop plant. For until this knowledge has been acquired it is not possible to synchronise the remedy with the moment when it will be most effective and lasting.

During the past decade, due to the impetus of the war and a hungry post-war world, there have been many great developments in the science of crop protection. Chemicals with remarkable properties have been produced and fine apparatus has been designed to apply them. These materials, if they are not abused, can be of great value as aids to the production of clean crops.

This book does not pretend to be a textbook upon crop protection or a treatise upon chemistry or light engineering. It is an attempt to integrate the achievements of the biologist, the chemist and the engineer and to make them intelligible to the man who should benefit by those achievements—the practical agriculturist. It is hoped that it will enable farmers and advisers to appreciate what range of crop protection chemicals and equipment is available upon the market and what sort of problems those materials and machines are likely to help them to solve.

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CULTURAL CONTROL

Although it is possible to overcome many pest, weed or disease problems by applying ecological, cultural, biological or plant breeding methods of control, such methods will not always be immediately effective.

However, before a farmer resorts to a chemical treatment he must assure himself that it is not possible to apply some other more direct non-chemical method.

Bad weeds becoming dominant in a pasture during a favourable season have sometimes been successfully controlled by a period of abnormally hard grazing. This has been particularly the case when the weeds have been noticed at a young succulent stage in their development. Under these conditions, provided that the weed is not exceptionally unpalatable or noxious to the stock concerned, the animals that are left short of that extra succulent bite will devour the young weeds greedily. If this is the case then it is unlikely that they will appear in such great numbers in the following season.

Topping a meadow or a pasture that has got out of hand can very often produce the same results. In this case the operation must be carefully timed and the mower set at the right height to produce the maximum effect on the weeds with the least loss of grass. If this operation is carried out too early insufficient of the weeds will have germinated and the operation will be wasted. 'They must show their heads before you can cut them off!' On the other hand, if the operation is too late, then many of the cut flowering heads will complete their development and shed their seed in any case. This very often happens to thistles when they have been topped.

If a crop is very badly affected by a scourge of weeds which looks as though it may recur in the following season, and if it seems certain that the unaffected area of the crop, even if it yields very highly, will not provide a sufficient return to justify the expense of a chemical treatment, then it is sometimes wiser to be 'bloody, bold and resolute' and to plough the crop in and bare fallow the land. In the first instance it is wiser to drag a harrow or a springtine cultivator over the land to expose the vegetation to the withering effect of the sun and wind. When a farmer is satisfied that he has

killed the undesirable weed then he may plough the whole lot in. Bare fallowing after a crop has been sown is a disheartening business, especially for the farmer, who must always feel that the crop might yield him something, because he is an optimist; otherwise he would never have chosen farming in the first place! Conditions have certainly got to be bad before the decision is taken, but once that decision has been made there must be a great show of resolution, because unless the job is done thoroughly the cleaning effect will be negligible and worthless. If bare fallowing is carried out properly it can be a very effective method of weed control, the benefits of which may be felt many years afterwards, and if a crop is ploughed in there is always the consolation of knowing that at least some humus and some other nutrients have been returned to the soil.

When a cereal crop has been damaged beyond redemption by leather jackets, it is often worthwhile turning over the soil to allow the sun to dry up and kill these insects which are attacking the roots of the plants. It is also surprising how quickly the birds will become aware of the free meal and turn up in their thousands to pick them off.

For real success all fallowing operations demand a period of dry, preferably hot, weather following the ploughing or harrowing. If bare fallowing is followed by an extensive and unusually wet period, then its effect will be largely lost.

Weeds like couch dragged to the surface, burnt dry by the sun and apparently dead, will suddenly spring to life and prosper because of the lack of competition from a crop.

Often it is possible to take a quick growing catch crop after the fallowing has been successfully carried out, provided that sufficient late season moisture is expected to give the crop a start. The act of fallowing usually ensures that a seed bed will be easy to obtain. However, it is dangerous, in some parts of the world, to allow the soil to remain exposed to the action of strong winds for long periods.

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