MR. C. E. A. DIAS spoke of the advantages of contour platforms.

MR. H. L. DE MEL said that as an individual planter and as a representative of the Low-Country Products Association, he wished to offer his tribute to those who had read papers and to those planters who gave them the benefit of their experience. He felt sure that the subject which had been prominently brought before them that day was one that should engage their attention constantly. It was difficult to lay down a rule for the island as conditions were variable. Therefore, for the advance of agriculture it behoved them who were interested in the island to make experiments, to record them and to give the advantage of those experiments at Conferences like the present one, and at meetings of the Board of Agriculture. It was only by frequent exchanges of opinion that they could advance.

HIS EXCELLENCY THE GOVERNOR expressed his thanks to those who had read papers.

CULTURAL METHODS IN THE CONTROL OF SOME INSECT PESTS.

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It has been thought desirable to bring to the notice of agriculturists in Ceylon some of the more important cultural methods which may be employed in combination with other measures for the control of insect pests of crops. The majority of the cultural methods which will be touched upon elsewhere are of practical application mainly against the pests of vegetables and other crops which are planted and harvested at short intervals; but some of them are applicable to some of the pests attacking the perennial crops such as tea, rubber, coconuts, etc.

Before passing on to a consideration of the various cultural methods, it may be of interest for me to indicate as briefly as possible the main lines along which the control of insect pests has been tending within comparatively recent times. Probably the most primitive method of attempting to control crop pests is that of collecting and destroying various stages of the insect which are actually to be found on or near the plants. This is quite an efficient measure for checking outbreaks of pests which may be crowded together over comparatively small areas, and the collection of the various stages of a pest may be quite effective even over large areas, in combination with other methods of control, if the collection can be organised and carried out systematically. Owing to the comparatively good supply and cheap cost of labour this method is still carried out in Ceylon, mainly in conjunction with other control measures, since it can usually be made part of the routine work of an estate or village garden.

In some countries, however, the collection and destruction of insects was found to be impracticable as a general measure of control for various reasons, and men turned their attention to the application of some substance to their crops which would either drive away the pest, usually on to their neighbours' crops, or which would kill the pest on its host plant. This led to the investigation of a vast number of chemical substances which might possess repellent or insecticidal properties and the development of machinery for their efficient application.

At the present time it may be said that some of the modern insecticides are undoubtedly of great value under certain favourable conditions, but that their use is strictly limited owing to certain disadvantages indicated below. In the past the application of insecticides in the form of a liquid spray has perhaps been the commonest method of getting the poisons on to the plants, but the difficulty of obtaining an adequate water-supply, the high cost of the poisons themselves and the machinery for applying them have greatly restricted their use in some countries. Within recent years attempts are being made to bring into more general use the application of some insecticides in the form of dusts or powders, and these would be of value under certain conditions in districts where the water-supply has been a limiting factor, although their high cost is still an important consideration. In the East the lack of competent labour, in addition to the other disadvantages mentioned above, has tended to reduce to a minimum the use of poisons in controlling crop pests.

Meanwhile increasing attention has been given within recent years to the investigation of the life histories and habits of innumerable insect pests of crops all over the world and this has led to a more efficient application of such mechanical methods of control as collection and spraying, both of which are employed to control pests while they are actually on or near the crops but in many cases only after the insects have done a certain amount of damage.

The enormous amount of information which has been collected about the habits and peculiarities of insect pests all over the world has also led to the development of other measures for the control of insect pests, measures which are mainly preventive in their object. I refer especially to the modification of some of the cultural practices which have been in general use from the earliest times to suit modern conditions, and to the development of other cultural methods which are based on a knowledge of the life history and habits of the particular insect to be controlled.

Speaking generally, it may be said that cultural methods are mainly preventive, their objects being, apart from the improvement of the yields of crops, to provide conditions which are unfavourable for the development of various crop pests and thereby to check any abnormal increase in their numbers.

Many important insect pests of food crops spend some part of their life in the soil and can be controlled to a large extent by actual cultivation of the soil at the proper times, while damage by other pests can be prevented to some extent by such methods as selection of healthy plants or evaded by growing early maturing varieties or by altering the time of planting so as to escape the more serious infestations.

We will now pass on to a brief consideration of the more important cultural methods, with a few illustrations of their practical application in various countries, including Ceylon.

1. *Rotation of Crops.*—This is a very old-established agricultural practice and one which is not only highly beneficial from an agricultural standpoint but has also come to be regarded as one of the most important factors

in the control of some insect pests of those crops which are planted and harvested at frequent intervals, such as vegetables and other food crops.

Some insects are known as selective feeders, that is, they feed mainly on certain plants or on groups of related plants, so that the crops should be rotated in such a way as to ensure that neither the same crop nor any of its relatives is grown successively on the same land or on adjacent areas. Suppose, for instance, that two crops of maize are grown consecutively on the same area, then the insects which have attacked the first crop will be well-established on the plot, and, unless extraordinary care is taken in clearing up the remains of this crop, they will be likely to attack the second crop of maize as soon as it comes up. The pests of maize would also be liable to attack any other related crop, such as kurakkan or sorghum, or even paddy if it were to follow the maize in the same or an adjacent area. Therefore in order to avoid an increase of the pests of maize and its relatives it is essential to rotate with some other crop not related to maize, as for instance a legume, such as dhall, or a root crop, such as sweet potato. By practising regular rotation the insect pests of each crop in turn are starved out in each particular area of land. Emphasis may here be laid on the necessity for co-operation among village cultivators, especially as to the arrangement of their crops, so as to avoid growing two related crops on adjacent areas.

2. *Altering the time of sowing or planting.*—This is a measure which is employed in many countries to reduce damage by various crop pests. For instance, it has been noticed in Ceylon that paddy planted early, say in July, and brought on by high cultivation is far less liable to injury by the swarming caterpillar than an area of paddy planted as late as October. In some districts the time of planting is dependent on the coming of rains and if these are delayed the later planted paddy may be seriously attacked if an outbreak of the caterpillar happens to occur.

In California a study of the life history of the broad-bean weevil has shown that this pest lays its eggs only on green pods in the field from the middle of March to the middle of May. Experiments showed that beans planted late, that is, from March to May, which set their pods in May and June, were much less infested than those planted earlier, from October to February.

In St. Vincent, West Indies, it has been found that cotton planted in May always attracted cotton stainers or red bugs, but that in the case of later plantings the insects did not become numerous until the bulk of the crop had been reaped.

3. *Selection of good seed or clean healthy plants.*—Far more attention should be paid by village cultivators to the selection of good uniform seed in order to obtain vigorous and high yielding plants. This is especially important in the case of grain crops, such as paddy, maize, etc. In the case of those crops which are usually grown from suckers or roots, such as plantain or sweet potato, only healthy and pest-free material should be used for planting. This is one of the measures employed in controlling the plantain root borer and the sweet potato weevil.

4. *Clean cultivation.*—Several important measures for reducing insect injury to crops may be considered under this heading.

(a) *Removal of weeds* and related wild plants from cultivated areas and their surroundings. Many insect pests of cultivated plants breed normally on related wild plants. For instance, such paddy pests as swarming caterpillar and paddy fly exist normally on grasses growing near the paddy fields, and the removal of the wild grasses from the vicinity of paddy areas serves to reduce the numbers of these pests which might otherwise attack the main crop.

To take another example, the cotton plant has many relatives among wild and cultivated plants belonging to the order Malvaceae, and the removal of the wild malvaceous plants from the vicinity of cotton areas has come to be recognised as one of the essentials of the success of the cotton crop in all countries where cotton is an important industry. During an outbreak of the cotton leaf caterpillar (*Cosmophila erosa*) which occurred a few years ago in the Southern Province, it was observed that the caterpillars were breeding freely on various malvaceous weeds, such as Abutilon.

One of the most noted examples of the reduction of an insect pest by the destruction of its wild host plants is that of the " cotton stainer," or red bug, which was such a serious pest of cotton in St. Vincent, West Indies. Some ten years ago it was becoming impossible to grow clean cotton in St. Vincent mainly owing to the prevalence of this bug which not only caused a certain amount of direct injury to cotton bolls by piercing the seeds and damaging the lint, but was also found to be an important agent in the spread of a boll disease from plant to plant. This disease was responsible for a large percentage of stained lint. There was a close season in St. Vincent from February to May each year during which period no cotton was allowed to be grown, but it was found that the red bug was able to tide over the close season by breeding mainly on the pods of silk cotton tree (*Eriodendron anfractuosum*) and the mahoe (*Thespesia populnea*). This latter plant is known in Ceylon as the Tulip Tree. The removal of these two wild malvaceous trees from the vicinity of all cotton areas throughout the island was undertaken, and for a start some 1,500 Eriodendron and over 11,500 Thespesia were destroyed at a cost of £ 300. These plants have been kept under control since 1917 and the red bug has gradually been reduced to a position where it can be controlled by systematic trapping and destruction.

In Ceylon the cotton industry is still in its infancy, but already there are indications that the control of its insect pests and diseases may become an important problem. There are several cultivated and wild plants related to cotton in Ceylon, some of which breed insects which are known to attack cotton, and the proper regulation of these alternate host plants of cotton pests is a problem which may have to be faced if the growing of cotton becomes more general in the drier districts of the island.

(b) Clearing up and destruction of the remains of crop after harvest. The practice of leaving the remains of a crop on the ground after harvest is far too common in Ceylon, especially in the case of cereal crops such as paddy, maize, etc. The chief danger of this practice is that such insects as stem-borers remain in the stubble and after emergence may continue to breed on wild grasses until the next crop is planted. There are indications that in those districts where rotation of crops is practised the paddy stem-borer is rarely a pest.

In many cotton growing countries the growers are required by the regulations of an Ordinance to root out and burn all their cotton plants by a certain date every year, and as a further precaution the time for sowing the new crop is fixed so as to ensure a close season of at least two months.

(c) Clean conditions on estates. The breeding of the Rhinoceros beetle on coconut estates can be prevented by burning all old stumps and logs and by regulating the disposal of heaps of manure and other refuse. The removal and burning of jungle stumps from estates will help to keep down the scavenging white ants.

5. *Trap-crops or Catch-crops.*—A trap-crop is one which is planted ahead of the principal crop to serve as an attraction for various insect pests. The trap-crop may be of the same variety as the main crop or it may consist of some other plant which is known to attract the insects which it is desired to control on the main crop. For instance in some parts of India one of the measures employed in controlling the cotton boll-worms (*Earias* spp.) is to plant Bandakka (*Hibiscus esculentus*) around or near cotton areas. This relative of cotton not only serves as a trap-crop for boll-worms which would otherwise have attacked the cotton but brings in revenue by sale of the undamaged bandakka pods. It should be mentioned that these particular trials of a trap-crop were carried out on experimental farms and were therefore under strict supervision, taking into account the habits of the pests. The growing of trap-crops cannot however be recommended for general use by village cultivators since the trap-crop may not always be destroyed at the right time, in which case it simply becomes a breeding ground for the very pest whose control is intended.

6. *Ploughing and forking.*—In those countries which have a winter season the advantages of a late autumn ploughing are generally recognised not only from an agricultural stand-point but also as a means of controlling the various stages of certain insects which may be found in the soil. An early spring ploughing also serves to reduce the numbers of any soil insects which may have survived the winter.

In Ceylon the turning over of the paddy stubble by deep ploughing would be of great value in destroying the larvae and pupae of the stem-borer which remain in the stems or in exposing the larvae and pupae of the swarming caterpillar to the attacks of their enemies and to weather conditions. It was suggested by Iliffe in his leaflet on Paddy Cultivation that in districts where only one crop of paddy is grown the land which would otherwise remain unproductive of anything but weeds should be ploughed up after the paddy crop is harvested and that the land should be used for growing some vegetable or other food crop, provided always that sufficient water is available. Incidentally, the ploughing and the growing of another crop on the same land would tend to reduce insect pests of paddy and any other crops which are rotated with paddy. Even where two crops of paddy are grown annually on the same areas it is a sound practice to plough up the stubble soon after the harvest not only from an agricultural point of view, but as a means of killing insect pests. This system of ploughing soon after harvest may not always be practicable in some districts owing to the conditions under which the land is leased or to local objections against disturbing a long established custom.

Forking.—On tea estates deep forking is useful in destroying such soil insects as cockchafer grubs and cut-worms. The former are often prevalent in tea areas cleared from patna soils and their numbers can be reduced by a thorough and regular cultivation during the first few years after tea has been planted.

The eggs of the Spotted Locust, a local pest of mixed crops, are laid in the soil, and can be destroyed by forking over the egg-laying grounds deeply so as to expose the eggs to weather conditions and to the attacks of their enemies.

7. *Irrigation.*—This measure is useful mainly in controlling the swarming caterpillar of paddy by drowning or by bringing the caterpillars to the top of the flooded areas where they can be collected or are exposed to the attacks of birds.

8. *Draining of flooded areas.*—This measure is sometimes employed in controlling the paddy case-worm, the larvae of which have aquatic habits and can be killed by depriving them of water. The draining of paddy fields is not always practicable since the water may be needed for the paddy crop.

9. *Manuring, Cultivation, Drainage, etc.*—It has been claimed that certain artificial manures have under some conditions a direct value in killing those soil larvae which live mainly on the surface soil. Among such manures may be mentioned calcium cyanide or nitrolim, nitrate of soda, basic slag, and kainit. Generally speaking, however, it is not probable that an artificial manure applied in the quantity usual for manurial purposes will have any marked direct insecticidal effect. It is more probable, however, that any value derived from applying manures to insect-infested crops would appear to be due to their stimulation of the plants to a more vigorous condition which may enable them to recover more easily from the effects of an attack by certain kinds of insects or even in some cases to throw off an attack temporarily.

The experiments carried out by Andrews in Assam over a number of years in an attempt to control Helopeltis on tea by cultural methods have indicated that while nitrogenous manures should be used with caution, lime and potash manures give evidence of beneficial results, and that the bushes will respond to the application of well-balanced manuring in spite of being seriously affected by the pest. Further, all the available evidence has indicated that attention to proper sub-soil drainage is a matter of prime importance.

These investigations by Andrews are being carried on further in the hope of rendering bushes immune from, or at any rate resistent to, attack by Helopeltis, since it was found that immunity could be procured experimentally on individual bushes.

I have mentioned these experiments in order to indicate the lines along which modern control methods of some insect pests are tending, that is, towards the improvement of the general health of crops by good cultural methods with the idea of increasing their power of resisting the atacks of certain kinds of insects. These methods appear to hold out distinct possibilities of success, especially in the case of permanent crops such as tea, coconuts, cacao, coffee, etc., which are liable to be seriously attacked by certain kinds of piercing and sucking insects.

It is true that many attempts have been and are being made to produce pest and disease resistant varieties of plants by breeding, but perhaps more success has been obtained against fungous diseases than against insect pests. The breeding of insect-resisting varieties of crops seems to offer more chances of success in the case of short-term crops, such as vegetables and grain crops than in the case of permanent crops whose rate of propagation is so much slower and which possibly may not breed true.

I have tried to indicate in the course of my remarks the trend of the development of modern cultural methods employed in controlling some insect pests in combination with other control methods as collection and spraying. It is now becoming generally recognised by agriculturists that insect pests have to be fought with every weapon available and by aiming at some weak point in their development. I do not for a moment intend to imply that even certain insect pests can be controlled by cultural methods alone, but have tried to indicate that in a judicious use of certain cultural measures in conjunction with other methods lies our best chance of fighting the various crop pests of this island. Ceylon is essentially an agricultural country and there are many old-established agricultural practices, but it may be necessary to modify some of these not only in order to cope with our insect pests, but in order to increase our crop returns.

In conclusion, I would urge on all agriculturists the prime necessity for co-operation in carrying out all measures for the control of the various insects pests of the island.

REFERENCES.

Fletcher, T. B.—Some South Indian Insects, 1914.

Carpenter, P. H., and Andrews, E. A., Indian Tea Association.—A note on the value of different insect control methods in tea and against mosquito blight in particular, 1922.

Andrews, E. A., Indian Tea Association.—Factors affecting the control of the Tea Mosquito Bug, 1923.

Wardle, R. A. and Buckle, P.—The Principles of Insect Control, 1923.

MANURING IN RELATION TO THE CONTROL OF SHOT-HOLE BORER OF TEA.

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Agricultural methods of controlling crop pests, where they are applicable, have many advantages over the older and more familiar methods of control, being more permanent in their effect, usually more readily applied and frequently less expensive to carry out. The possible utilization of such methods should, therefore, receive early consideration in any scheme which is being devised for limiting the injury caused by a particular pest.

As the general question of pest control by cultural methods has been the subject of a paper read at this Conference, the following notes are intended to illustrate the practical application of one of the forms of control which have been referred to, namely—control by manuring. During recent years,