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SCENT IN RICE

By K. RAMIAH.

Among the hundreds of rice varieties under cultivation in different parts of India, there are a few known as "scented rices" forming a group by themselves. The variety *sukadas* cultivated in Northern and Western India and the variety *rascadam* cultivated in parts of Madras are typical examples of such scented rices. These scented rices emit a peculiar smell, very similar to the scent of the flower of '*ilupai*' (*Bassia longifolia*) tree which finds favour with some people who grow these rices specially. The scented rices are particularly in demand by the Muhammadans in South India who cook them with meat. The special quality of fineness in rice which chiefly refers to the size of the grain has apparently no relationship with scent, as scented rices can be either fine or coarse. But a rice which is fine as well as scented like the *rascadam* of Madras gets a premium of 25 to 50 per cent in the markets over the ordinary rices.

Among the large number of rice collections, (over a thousand), available with the Paddy Specialist, Madras, there are about a dozen scented rices. They vary in grain size, colour of glumes and in flowering duration just like ordinary rices. While the majority of the scented rices are white and non-glutinous, there is also a dark purple (black) glutinous rice that is scented. The experience in Coimbatore has been that the nature of scent is practically the same in all the varieties, there being only slight differences in the intensity of the scent.

It is not definitely known in what part of the grain the scent is concentrated nor to what active principle the scent is due. While the so called scent in rice is invariably associated with the smell that emanates when the rice is being cooked, it is possible to recognise the scent even when the empty husk of the scented rice is boiled in water. The scent, when sufficiently strong, can also be made out by masticating a few husked grains in the mouth. It has been the experience in Coimbatore that the characteristic scent can be detected even when one walks along the bund of the field where a scented rice is growing, particularly when the variety is in flower. The scent at this time emanates, in all probability, from the dehiscing anthers.

That the presence or absence of scent in rice is a Mendelian character often inherited independently and occasionally associated with

other characters was evident from some of the earlier work done at the Paddy Breeding Station, Coimbatore. A brief account of the information then collected, though it was neither extensive nor conclusive, is given here just to show that it is possible to breed varieties with scent by hybridisation, if there should be any demand for a scented rice of a particular kind in any special locality. Though the smell of the strongly scented rices is not favoured by everyone, there is no doubt that a small amount of scent present in an otherwise fine rice would be appreciated and would command a premium in the market.

In the varietal plot where a number of rice varieties are grown adjacent to each other there is a fair amount of natural crossing among them which can be easily detected in the F_1 generation. In one year a large number of such crosses occurred in the plot of variety *rascadam* mentioned before. These crosses were isolated and grown separately in the following year mainly with a view to study the inheritance of glume colour. Since this variety was growing in the midst of nonscented rices, it was decided as an after-thought to examine the F_1s for the inheritance of scent as well. After the plants had been examined in the field for glume colour, the heads from some of the families were collected individually and stored in paper covers in the laboratory. An opportunity to examine them for scent did not present itself until a year later.

The procedure adopted for the test was as follows:— A few grains from each panicle were first crushed in an ordinary porcelain pestle and mortar, put into a wide mouthed boiling tube and boiled with water over a Bunsen burner for a few minutes. As soon as the water started boiling, the scent, if it was present, could be easily smelt. It was possible not only to differentiate the scented from the non-scented, but also to distinguish slight differences in the intensity of the scent. While the scent was quite as strong as in *rascadam* in some varieties it was distinctly lighter in others. An attempt was first made to have three groups in the classification, scented, lightly scented and non-scented but it was later reduced to two groups only, scented and non-scented, because of the obvious limitations in the technique followed in the test. Though as far as possible all the testing was done by only one or two individuals, personal equation did play a considerable part in the classification. Moreover after a few boilings had been made, the whole room got impregnated with the special scent and it was a problem to distinguish the non-scented from the scented. There was also an additional disadvantage in that the panicles inside the paper bags, for want of proper care in storing, had been attacked by the rice moth. Such moth eaten grains emitted a special odour often making the classification difficult. The ratios of scented to non-scented obtained are given below.

Natural crosses in *rascadam*. Family number.	Scented.	Non-scented.	Ratio of scented to non-scented.
625	192	151	1·3:1
626	423	206	2 1:1
627	191	90	2·1:1
628	333	205	1·6:1
629	462	214	2·2:1
634	273	106	2·6:1
636	272	187	1·5:1
637	206	90	2·3:1
638	263	73	3·6:1
Selections from family 637 ; 995	694	299	2·4:1
do. ; 996	474	187	2·5:1

The ratios are so variable and it is not possible to make out the number of factors responsible for scent and it is not surprising if one recognises the limitations of the test employed for the studies. One or two of the families would appear to indicate a single factor difference between the scented and the non-scented groups like 634 and 638 but in the others apparently more than one factor is involved. That the ratios obtained for glume colours were quite different in these two families as compared to the rest gives additional proof that the parents concerned were different. The actual hybrid plants (F_1s) were not unfortunately examined for scent but an opportunity that presented itself later was utilised to examine the F_1s of a cross between *rascadam* and a non-scented rice and it was observed that the F_1 did have scent though it was not quite so strong as in the *rascadam* parent.

Later some of the progenies, F_3s, of a cross between a dark purple (black) glutinous and scented rice and a red, non-scented and non-glutinous rice were examined for the character of scent. The cross was intended mainly for the study of the inheritance of colour of rice and the glutinous character of the endosperm; but the study of scent came in incidentally. As the plants were being examined in the field for rice colour and rice endosperm character, an attempt was made to classify them for scent by chewing a few grains of each plant as they were being crushed for rice examination. Although the chewing test cannot be considered quite as reliable as the boiling test, the ratios obtained in three of the families are given below :—

Families.	*Scented.*	*Non-scented.*	*Ratio.*
2489, 2492 and 2493	247	106	2·3 . 1

To be sure of the ratios, two other families were harvested individually in paper covers and later examined for scent in the laboratory by boiling tests. The ratios obtained in these two families are as follows:—

Family.	Scented.	Non-scented.
2485	41	29
2488	121	80
Total.	162	109

The ratios would appear to indicate a 9:7 ratio more than anything else. In the case of family 2488 the tabulation for scent was done along with the colour of rice which gave some interesting results.

	Rice colour.			
	Various degrees of purple & red *PR*	Various degrees of purple and white—*Pr*	Red *pR*	White *pr*
	1	2	3	4
Scented.	85 *72*	9 *19*	26 *22*	1 *8*
Non-scented	35 *48*	22 *12*	11 *15*	12 *5*

Previous work in Coimbatore had shown that a cross between purple rice (Pr) and a red rice (pR) gives 12 purple rice (PR and Pr), 3 red rice (pR) and 1 white rice (pr). The expected ratios for scent in the above family on the basis of independence of the factor or factors responsible for scent from those of the rice colour factors are given by the side in italics. X^2 test would show that the deviations of the observed from the expected to be quite significant in groups 2 and 4 i. e., wherever r (factor for white rice) is present 'there is a preponderance of scented rice. In the absence of definite knowledge about the number of genes responsible for scent it is not possible to determine the linkage values' but it can be stated that there is some association between white rice and scent.

Summary. Scented rices are characterised by a special smell emitted at the time of boiling the grain. Such smell is found to be present even in the empty glumes and the dehiscing anthers. The scent is found to be a Mendelian character controlled by either one or probably two factors. In one of the hybrid progenies examined there is found an association between scent and colour of rice.

AN UNRECORDED ECONOMIC PRODUCT

Decalepis Hamiltonii, W. & A. Family: Asclepiadaceae.

By K. CHERIAN JACOB, L. Ag., F. L. S.

Tamil: Mahali Kizhanku; Kattu Nannari.
Habit: A climbing shrub.
Habitat: Crevices of rocks.
Distribution: Anamalai Hills (Coimbatore District); hills of North Coimbatore; Kambakkam Hills (Chingleput District); Velikonda Hills (Nellore District); Madanapalle (Chittoor District) and Horselykonda (Cuddapah District).

The fleshy roots of the plant are medicinal, valued as blood purifier and appetiser and also largely used for making pickles in the Coimbatore and the Malabar Districts. But peculiarly enough no mention has been made of the plant in any of the various books dealing with the economic products of India.

The plant is a twining shrub. The young branches are nearly smooth except for a few scattered emergences. Old branches are thick, about an inch across and are characterised by a fissured condition of the rind. Leaves are about 1″—1½″ across, opposite, leathery, almost round or ovate, with usually a round tip and six pairs of arched veins. Flowers small, in axillary penduncled cymes; calyx deeply penta—fid; corolla rotate, lobes five, valvate, white, villous within; stamens at the base of the corolla; ovary of two, many ovuled carpels; fruit of two thick lanceolate, short follicular mericarps; seeds ovate, ridged, tipped with a white coma. Fruits in pairs each 2½″ long and 0·7″ in diameter at base and tapering above. Roots are brittle, 3′—4′ long and attain diameter of even ¾″—1″. The core is woody enclosed in a thick fleshy coat. It is this fleshy coat that is used for pickling. The flavour is very similar to that of *Hemidesmus indicus, R. Br.* (Country Sarsaparilla; Tamil: *Nannari*).

Market. It is available for sale in the Pollachi shandy (Coimbatore District) throughout the year. From Pollachi it is exported to Calicut, Palghat, Udumalpet and Coimbatore. At Coimbatore it is available in fairly large quantities at about 1 to 2 annas per pound.

Method of pickling. The roots are thoroughly washed and the central woody core is removed by splitting and discarded. The fleshy portion is then cut into small cubes of ⅛″ and is mixed thoroughly with pounded chillies and salt. The whole stuff is soaked in lime juice (*Citrus acida, Linn.*) and preserved in porcelain jars. In this condition it can keep well for over a year. The quantity required for daily use is taken and a little buttermilk is added before use.

AGRICULTURAL ZOOLOGY

With special reference to S. India.

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Lecture No 2.* **Agricultural Entomology.**

In my last lecture I gave you some idea of the economic importance of the different animal groups from the lowest organisms (Rotozoa) to the highest evolved group of animals (Mammals), especially from an agricultural point of view. I shall deal now with the different aspects of the Arthropoda in their relation to the S. Indian farmer, with the help of diagrams and slides, which in a subject like this, will be far more effective and telling than a torrent of the most carefully selected adjectives. I may state at the very beginning that the animals included in this big sub-kingdom of animals (Arthropoda)

* Lecture No. 1 appeared in the March issue of this journal and was delivered under the auspices of the University of Madras—Maharajah of Travancore Curzon lectures on Agriculture. The lecture was illustrated with lantern slides.

play a far more important role in the economy of man than most others and from the point of view of harm they cause to the farmer and layman, this group surpasses in importance every other animal community in the world.

The most important features of the Arthropoda consist in their bodies being made up of a series of ring like divisions or segments arranged one behind the other like the segmented worms, and their paired limbs which vary in number, being made up of different pieces or joints—hence their name (*Arthropoda*=with jointed legs). This great group includes the subdivisions shown below.

Important characters of the chief Arthropod classes.

Class.	Antenna or feeler.	Legs.	Body divisions.	Eyes.	Remarks.
1. *Onychophora* (only *Peripatus*).	One pair.	Many pairs of unjointed legs.	No clear divisions.	Two simple eyes.	Aberrant lowly organised group with characters connecting segmented worms and Arthropoda. Possess both nephridia and trachael vessels.
2. *Crustacea* (crabs, prawns, wood lice, etc.)	Two pairs.	Many or at least five pairs.	Two—(Cephalothorax and abdomen.)	Compound (often stalked).	Mostly aquatic forms with gills.
3. *Arachnida* (scorpions, spiders, mites and ticks).	No Antenna	Four pairs only.	Two—(Cephalothorax and abdomen) or no divisions.	Simple eyes.	Land forms with lung like structures for breathing. Chiefly carnivorous, some plant feeding.
4. *Myriapoda* (centipedes and millipedes).	One pair.	Numerous one or two pairs to each segment.	Two—(head and the lung trunk).	Simple eyes or clusters of simple eyes.	Worm like long forms. Land animals.
5. *Insecta* (Insects).	One pair.	Only three pairs (hence called *Hexapoda*)	Three distinct regions—(head, thorax and abdomen).	Compound eyes and very often simple eyes also.	Wings present in many air breathers. Found chiefly on land though some are aquatic.

From an Agricultural point of view the *Crustacea* are of little importance excepting for some crabs pests. Fresh water crabs of different species (*Paratelphusa*, *Potamon*, *Varuna* etc.) give some trouble in paddy fields, especially in some of the delta areas. These attack young rice plants and cause severe damage during certain seasons, destroying over 50% of the seedlings which are cut at ground level and removed to the crab holes where they are chewed. The next group—

Myriapoda—is also of little importance in that direction. Occasionally species of Millipedes (*Julus* etc.) have been found to attack ripening groundnut pods under the soil; the creatures feed on the seeds and leave the pods empty. The group *Arachnida*, however, plays a more important economic role than the two groups noted above; there are numerous species of arachnida which are known as pests of cultivated plants and as parasites on cattle and man. The plant pests include the well known mites often called as *red spiders*, *spider mites*, *gall mites* etc. In S. India we find different species attacking specially cereals, cotton, ganja, citrus and tea; these include the genera *Paratetranychus*, *Tetranychus* and *Eriophyes*. Parasitic arachnida include cattle, dog and poultry ticks (*Psoroptes*, *Argas*, *Rhipi-cephalus*, *Hyalomma*), and the skin mites affecting man (*Sarcoptes*, *Demodex*, *Peduculoides*, *Tyroglyphus* etc) causing complaints known as '*Acariasis*'. Spiders as a group are generally insectivorous and prove helpful in trapping various flying insects like moths, flies, mosquitoes etc. in their webs. Occasionally we come across spiders the webs of which are thick and cover some plants so badly that the growth of the latter is often checked.

We now come to the consideration of the group of *Insects* and their relations to man,—especially the farmer and stock breeder. Hardly any naturalist who knows anything of insects and their ways will doubt the fact that, in the keen struggle for existence going on incessantly in nature among the various animals living on the surface of the globe, no other animals have gained such remarkable success as the members of the insect world. This may be attributed among others to such important factors as their remarkable numerical strength, their peculiar life histories, their extraordinary powers of multiplication and their wonderful adaptations to put up a strong fight and survive the struggle for life. Among the various living beings inhabiting this world of ours, no other group of animals, except perhaps the fishes, can approach the insect community either in numerical strength or in the wealth and variety of species. The number of known living species of animals has been roughly estimated at about 900,000 and of this number over 60 % or about 625,000 are found to be insects. To give an idea of the comparative size of this group among the various divisions of the animal kingdom, we may take this illustration (slide shown). If we take the entire distance between the finger tips of our outstretched right and left arms across our chest to represent the size of the whole animal kingdom, then the size of all the other groups put together will not extend beyond the elbow of one arm from its finger tip, while the size of the insect group would occupy a distance stretching from the elbow of one arm across the chest and the two shoulders right up to the tip of the middle finger of the other arm. In size however, insects are comparatively small and this varies from one-seventy-fifth of an inch to six or seven

inches in length. The apparent defect in the size of insects, as compared with that of other animals, is more than made up by their remarkable numerical strength as has been shown above. As regards the distribution of insects, it may be stated that they are found all over the world; in land and water, on trees and shrubs, on other animals in households and under the soil. Knipe has described the position very nicely regarding the strength and distribution of these creatures in the following verses:—

And what of insects, present everywhere,
Through sea and land and flitting in the air?
Why, half the matter charged with light on land
These little creatures, countless, must command
See how in orders, legions filled, they rise,
Living alone, and in communities;
From mites so small as scarce to meet the eye,
To ant and bee, and gorgeous butterfly.

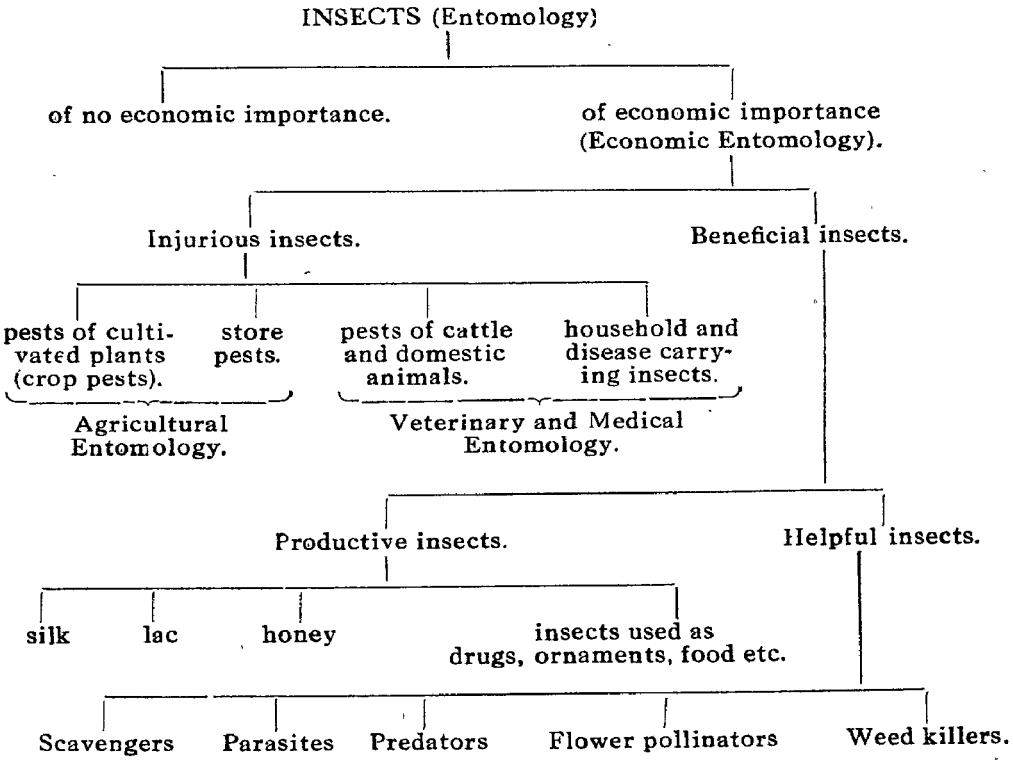
To give even a very vague idea of the remarkable adaptations possessed by insects to carry on successfully their vital activities will occupy pages of matter; so numerous, varied and extraordinary are these. Astonishing are the various adaptations for securing food, the structural provisions for offence and defence, the wonderful arrangements for communication between each other and the innumerable adjustments for sexual relations and propagation of the species. Such wonderful phenomena as parasitism and social life, the various adaptations in structure, mimicry, maternal instinct, and host of other features in their behaviour which Thompson aptly calls "*shifts for a living*" are factors very remarkable and often unique in the world of insects. One of the most remarkable phenomena in the whole animal kingdom is the peculiarity found in the life history of many insects. Unlike as in the higher animals and many other lower animals there is a phenomenon known as "*Metamorphosis*" among insects a series of striking and remarkable changes undergone by an insect as it passes from its childhood to its adult stage. The passage of a common butterfly from the tiny egg to the worm-like caterpillar or grub, into apparently lifeless objects the chrysalis or pupa, and the final transformation into the beautiful winged butterfly, all these striking changes, known together as Metamorphosis constitute a phenomenon which even many of our educated men are not aware of, though Shakespeare put it so nicely in the lines:

"There is a differency between a grub and a butterfly.
Yet your butterfly was a grub"

Most insects give rise to numerous offspring, which in their turn produce further generations in a very short period of time compared to higher animals and thus increase in numbers rapidly. These two advantages of greater fecundity and shorter life cycle play a very

important part in maintaining the remarkable numerical strength of many insects. According to Hodge "a pair of flies beginning operations in April, might be progenitors, if all were to live, of 191,010,000,000,000,000.000 flies by August, and allowing ⅛ cubic inch to a fly, this number would cover the earth 47 feet deep". But, fortunately nature keeps up an even balance in the world without allowing any one creature to multiply extraordinarily and become a nuisance.

With these necessarily brief remarks on the general features of insects I would take you to the different aspects in which insects affect human interest and especially the agriculturalist. From the point of view of a layman and farmer, insects may be conveniently grouped as below under three main groups according to their behaviour towards man and his belongings.



From the above classification we find that under 'Economic Entomology' we can include Agricultural entomology, Veterinary and Medical entomology, apiculture, sericulture and lac culture. Agricultural entomology deals mainly with pests, their bionomics, and the methods which the farmer can adopt to check pests and utilise the help of other animals to control injurious insects. Now what is the part played by insects in relation to man and to our agriculture? The answer to this question is effectively supplied by the farmer in the fields, the kitchen gardener, and the provision dealer in stores and mills. For, these are the individuals who suffer from the depradations

of various insects which destroy a good portion of their produce from the fields and their stored stocks and thereby affect their finances. During certain years cultivated crops are entirely wiped out by hordes of locusts, caterpillars or bugs, and heavy loss is sustained by the farmers. Though in our country we have no clear ideas or statistics as to the extent of losses sustained in this way, the extent of loss caused by insects has been accurately assessed in the United States of America. According to Webster: "It costs the American farmer more to feed his insect foes than it does to educate his children; the estimated damage done by insects comes annually to 400 million dollars while the common schools and higher educational institutions cost together only 300 million dollars". According to Slingerland "The yearly losses from insect ravages in our country (the U. S. A,) aggregate nearly twice as much as it costs to maintain our army and navy, more than twice the loss by fire, twice the capital invested in manufacturing agricultural implements and nearly three times the estimated value of the products of all the fruit-orchards, vineyards and small fruit-farms in the country". Mr. Noel Paton, late Director of Commercial Intelligence, Calcutta estimated some years ago the annual loss in India caused to stored paddy and rice by the small rice weevil (*Calandra oryzae*) at 120 million rupees. Alarming reports appeared in the newspapers a couple of years ago of a destructive insect pest of stored paddy (*Rhizopertha dominica*) all over the southern districts and the Madras Agrcultural Department had to take serious notice of such an outbreak. Every householder is aware of the damage and loss caused to household materials by such insects as cockroaches, crickets, ants, silver fish, etc. Silks and woollens, carpets and upholstery are not spared by these vermin if left uncared for. Nor are cattle and other domestic animals free from the undesirable attentions of insects. Flies, fleas, lice etc. pester them and some of them often transmit diseases also among cattle, poultry, horses etc. These few facts bring out clearly the most important part played by insects in the economy of man. We shall however confine our attention mainly to the role of insects in Agriculture which constitutes the subject of Agricultural Entomology.

There is a general belief that insect pests—especially crop pests, appear more frequently nowadays than in the past years and many an old farmer has asserted to me that during the palmy early years of his life they had very few and only occasional outbreaks of pests to contend with. We have to admit the truth of this statement to a great extent; for, as civilisation advances and man begins to control nature in various ways, the "Balance of life in Nature", which keeps up a sort of balance among the various living beings in the world under ordinary conditions, is frequently upset and as a result we often hear of pest outbreaks.

A. Chief factors maintaining the Balance of Life are
   1. Food 2. Climate 3. Enemies.

B. Chief factors interfering with the balance of life are:—

1. Growing of single crops in large areas.
2. The destruction of forests.
3. The destruction of insectivorous animals.
4. The frequent transport of animals and plants from place to place.

The four factors noted above are, as far as we know, the most important agencies frequently upsetting the natural balance and helping various organisms to multiply enormously and interfere with human interests. But in any case of pest outbreak it may often be very difficult to point out exactly which of these different agencies is responsible for the outbreak; for, in most cases it may be due to one of these factors or to a combination of one or more of them. The most important of the numerous stimuli which have contributed to the increased study of agricultural zoology in modern days have undoubtedly been the various attempts made by man at devising ways and means of controlling pests of different kinds. Having realised that these pest outbreaks noted frequently are chiefly the results of his own conscious or unconscious activities through decades, man has also been resorting to remedial measures to alleviate the loss sustained through insect pests.

I shall now give you some glimpses of the more important insect pests of our province by means of slides. Before doing so I may add a few general remarks regarding pests of cultivated plants as a whole.

There is hardly any cultivated plant which escapes the attentions of some insect or other though it may be found that some plants are more susceptible to their attacks than others. It is also found that among plant feeding insects, while a few of them depend for their food almost entirely on one plant (*Monophagous*), there are many others which are not so fastidious as regards their food and are found feeding on more than one food plant (*Polyphagous*). As to the nature of the damage caused to plants it will also be found that no part of a plant is free from insect attack and that every portion of it has its peculiar insect associates; the roots, stem, bark, shoots, leaves, flowers and fruits have all their characteristic insect pests. Nor is it rare to find insects of sorts visiting or temporarily remaining on plants either as mere visitors or as minor pests. Under these circumstances, it will be very advantageous if every cultivator gets to know in the first place which insects are his enemies and which are not; and of the former he might note those which constitute the major or important pests and those which are of minor importance. These are essential pre-requisites before one attempts to devise the possible control measures suited to each as necessity arises. By gradual experience, in observing and noting the different forms of damage caused to his crops by diverse insects the farmer will be in a position to more or less make out correctly

even from the external indications of the damage done, which the particular kind of pest is. Nor will he find it difficult in course of time to foresee as to the season or seasons when he might expect particular pests of different crops. In this way, experienced farmers of each different tract will be in a position to prepare what may be called insect pest calendars suited to the area and thus be not only well prepared to meet insect pests when they appear, but even be fit to prevent their appearance by methods adopted sufficiently early. In the same way, cultivators of special crops also come to know by experience as to the particular stage or stages in the growth of his crop when they can expect a particular kind of pest.

Apart from the specific pests of each particular crop there are a few categories of insects which infest many plants and cause the same kind of damage. These include, plant lice (*Aphidae*), scales, and mealybugs (*Coccidae*), locusts and grasshoppers (*Acridiidae*) leaf caterpillars of sorts, borers of different kinds (including beetles, caterpillars and flies), surface insects and underground insects of different kinds. I shall now explain to you some of the slides illustrating the more important of the general features of insects as briefly touched upon by me at the beginning, and some of the more injurious insect pests of agricultural importance found in our province, with the nature and extent of damage.

Within the past thirty years a good deal of spade work has been done in S. India in the matter of recognising our important insect pests and gathering preliminary data regarding their life histories, habits, and their relation to different crops, as may be seen from the numerous published papers on the subject. The real work however, of relieving the farmer and the cattle breeder from the losses caused by insect pests has only just started. This work which can only be carried out after much pioneering studies, is of a very important nature and is sure to tax the knowledge, ingenuity and resources of agricultural entomologists. For in the words of Curtis "The first step towards vanquishing the enemy is to ascertain correctly its habits, the next to be certain of its appearance, as not to mistake one party for the other and a third and no less important object is to be well acquainted with our friends and allies". Unless one gets some correct and definite ideas as to the real nature of the damage done, the remedies we may suggest may often prove worse than the diseases themselves. The utilisation of such knowledge and the devising of control methods should not merely be of an empirical nature; for Entomology is something more than squirting or dusting aresenicals or emulsions on the tails of insects—this is scarcely Entomology at all any more than horse shoeing is animal husbandry. The success of the Agricultural Entomologist depends a good deal on his proper up-to-date knowledge of the subject and sufficient practical experience

in the applied aspect of it. Some of the possible measures of pest control may be brought under the following heads.

1. *Preventive or Prophylactic methods (Indirect)*
   a) Field and plant sanitation
   b) Proper cultural methods (proper tilth, good seeds and manure and sufficient irrigation)
   c) Precautions against pest infestations.
2. *Curative or Direct methods.*
   a) Mechanical—collection by nets, bags, sticky boards, tray, traps, lights, catch crops etc.
   b) Chemical—Use of insecticides (dusting or spraying), fumigation, poison baiting, use of larvicides, repellants etc.
   c) Biological—Protection of natural enemies, such as insectivorous animals, parasites, predators; artificial propagation and utilisation of such natural enemies—the culture and use of fungus and bacterial diseases of insects.
   d) Legislative measures—Institution of quarantine laws, pest Acts etc. by Government in relation to important local and exotic pests.

Though it is not possible in this connection to give any details of all these different methods, a few words may be added regarding what is known as the Biological method of pest control—a method which has come to some importance within the past two or three decades. This process of insect pest control, to put it briefly consists in utilising the natural enemies of a pest to check the multiplication and serious effect of the latter. Such a process is going on in nature, as I mentioned above, in keeping up the balance of life, but when nature is helped by artificial methods in that direction we call it the Biological method of pest control. The adoption of this method on an artificial scale involves a thorough knowledge of the natural enemies of any crop pest and their bionomics. The important natural enemies of most of our insect pests are insectivorous birds, reptiles, toads, and insects themselves; and in many cases the enemies of different pests vary in number and in their relative efficiency as natural control agents. It has been found that insect enemies of insect pests such as predatory and parasitic forms render a great deal of good service in pest control. The group of lady bird beetles (*Coccinellidae*), and some groups of wasps (*Parasitic wasps*) and flies (chiefly *Tachinidae*) are insects which are highly beneficial to the farmer. As stated above the particular parasites and predators of different pests which vary in kind and controlling efficiency have to be studied thoroughly before resorting to this novel method of utilising the natural enemies of pests, for very often one comes across what is called a complex of natural enemies in relation to a single pest; sometimes a natural enemy such as a predator or a

parasite, is found to have its own natural enemy and, the latter in turn another as the doggerel runs.

" Those fleas that do us bite
Have other fleas that bite them
And those in turn have other fleas
And so *ad infinitum* "

Under the circumstances though biological control when feasible, is the most economic of all measures, the success or otherwise of each case will depend a good deal on the nature of the natural enemies, their number, their inter-relations and their efficiency in keeping the pest under check. In any case this method will have to be supplemented by other pest control measures indicated above; in this connection I might draw your attention to one or two weed pests where biological control has shown very remarkable promise of success. The most familiar example is the wonderful work of the *Cochineal* insect in eradicating prickly pear, one of our worst weeds, and another is the Lantana bug *Orthezia*, which, though not so marvellous in effect as the Cochineal, is capable of checking the wild spread of the lantana weed in some of our hill districts.

It will be unfair to the group of insects if, before finishing this theme, I do not at least make a passing reference to the brighter side of insect activities and show that, after all, we cannot condemn all insects as a whole and that there are insects which are extremely useful to man in several ways such as silk, lac and honey producers, flower pollinators, others that yield drugs, etc, and some others which are even used by man as food.

Gentlemen, I have tried in my own way to give you some ideas of Agricultural Entomology with special reference to South India and it is evident from all I have said and shown so far, how very important a subject Economic Zoology is. Professor Wilson of the U. S. A. Biological Survey has beautifully summarised the value of Economic Zoology in its relation to human affairs in the following words:—" In its relation to public welfare Economic zoology is of the most vital and far reaching importance. Animal life from its lowest organisms, among which lurk some of our deadliest foes as well as beneficent friends to the highest vertebrates, touches and affects our lives and welfare in innumerable ways. It must be studied in all its phases as never before to guard against previously unsuspected or little known diseases of man and domestic animals as well as to develop the wealth and ever increasing variety of products from which we obtain food, medicines, clothing, dyes, ornaments and an endless number of useful articles. No man can be considered well informed who has not a considerable knowledge of economic zoology in its more direct relationship to human life, while to the scientific investigator the subject has the charm of endless variety and service to mankind."

Though as I said once before a considerable amount of valuable spade work has been done in the field of Agricultural Entomology till now, a good deal remains yet to be done in the shape of bringing the fruits of the knowledge gained in that line and contributing its own share to the material prosperity of the country. In my opinion, apart from continuing the studies on the lines hitherto followed, viz., the recognition, collection, identification and life history studies and the usual treatment of pests, it is highly desirable that intensive studies and investigations should be pursued on the ecology of insect pests; in the words of Elton: "Animal ecology is a branch of zoology which is perhaps more able to offer immediate practical help to mankind than any of the others and in the present rather parlous state of civilization it would seem particularly important to include it in the training of young zoologists. It is the real foundation for applied Biology. The tropical entomologist, mycologist or weedkiller will only be fulfilling his functions properly if he is first and foremost an Ecologist". I would also emphasise the need for investigations in Agricultural Meteorology with special reference to the incidence of pests—a line of research which is full of promise in helping us to foretell the outbreak of pests and be on our guard. Nor need I emphasise the need for co-operation that is essential between the entomological worker, the plant breeder, the bio-chemist and the agriculturist in all the allied investigations and operations which have for their final aim the prosperity of agriculture in our country. I can only conclude this theme by repeating the following words of Professor Maskew in this connection—"The most important, the most vital thing in all the world is to get something to eat. If all of us here present, or mankind in general, were positively unable to obtain anything to eat for the space of one week, the affairs of this world—commercial or otherwise, would soon become of no more consequence than duckweed upon the surface of a pond. Without something to eat there would be no coal mined, no steel forged, no freight cars rolling. Agriculture in its broadest sense is the source of something to eat, and hence the original source of all subsequent action. Applied agriculture in practically all lands now recognizes that the greatest source of loss to cultivated crops can be traced to the depredations of insect pests and plant diseases".

I have finally to thank our president Mr. Broadfoot who has, besides honoring me by presiding over my lectures, helped me in every way with facilities for delivering my lectures at the Agricultural College, Coimbatore. I have also to thank Dr. Mulyil, Messrs G. V. Narayana, Suryanarayana and Naganatha Ayyar of the Institute for general help in making arrangements to project the lantern slides and diagrams during the lectures.

[*Note*:—The lecture was illustrated with numerous diagrams and lantern slides.]

ABSTRACTS

Coloured Insecticides for Aphids. *Scientific American 1937.* Mr. Moore concluded from his experiments that the aphids were attracted to the plants sprayed with bordeaux mixture because of increased intensity of light reflected from the sprayed surfaces. Spraying black coloured mixtures was found to be effective in reducing the infestation. V. R.

Frost Resisting South American Potatoes. *Science* vol. 85. No. 2196. The All Union Institute of Plant Cultivation of U. S. S. R. was able to collect by sending a number of scientific research expeditions to South America, a large number cultivated and wild varieties of potatoes unknown to European countries, and a few of these new varieties were found to be resistant to *phytophthora*—the most dreaded disease of potatoes. One expedition was successful in spotting out a remarkable wild variety 'acaule' resisting frost of 17°F. The Institute has crossed these with local varieties and isolated from the progenies cultures breeding true to high yield and resistance to disease and cold. As a result, the problem of sowing the potato crop in the U. S. S. R. has now been considered as solved. V. R.

EXTRACTS

The Phenomenon of Plant Growth. From a series of experiments Dr. Johnston of the Smithsonian Institution, and Dr. Burkholder of Connecticut College have studied the complementary roles of light and darkness on plant growth. According to them, nightly sleep or something very like it, is as necessary to plants as to animals. It was found that strong sunlight was destructive to the *auxins*, which are the growth-promoting substances in plants, while in an equal period of darkness, the growth-promoting power was greater. The inactivation of the auxins varied with the length and intensity of illumination, and the species of the plant. The phenomenon of growth is most rapid in darkness. It may be concluded that light is required for the synthesis of the auxins in the growing tip of the plant, but, once formed, they are most effective as growth's activator in darkness. *Science*, March 19, 1937.

Loans for purposes of irrigation work. The following are the conditions under which loans are given in Rhodesia by the Government for the construction of soil conservation works.

(a) Interest at the rate of 4½ per cent. per annum, and, if desired, the interest charges can be funded with the loan for the initial three year period during which no repayments are necessary, and the whole sum thereafter repaid in annual instalments up to a maximum period of 17 years.

(b) The loan to be secured by notice to the Registrar of Deeds for registration against the title deeds of the property concerned, or on the personal security of two sureties, who must be holders of immovable property in Southern Rhodesia.

(c) One-fifth on the loan can be paid out as soon as the applicant is ready to start the works, and the balance is paid on the certificate of an engineer of the Irrigation Division that the works have been satisfactorily completed and are valued at the amount covered by the loan.

In addition to the above financial provision an arrangement has been made with the Premier Portland Cement Company (Rhodesia), Limited, whereby

supplies of cement at reduced rates are available to farmers for use in water conservation works as under :—

1. Farmers who obtain a loan from Irrigation Loan Funds or from the Land Bank for the purpose of constructing water conservation works can obtain the cement required for the construction of these works on a Government requisition at a reduced price of 2s. 7d. nett per bag (94 lbs.) f. o. r. Cement Siding. The requisition for the supply of cement will be issued by the Irrigation Engineer responsible for the inspection and supervision of the works proposed. (*The Rhodesia Agricultural Journal Vol.* XXXIV No. 2 February 1937 Pages 85 and 86).

Gleanings.

Soil Erosion. Compiled by W. C. Lester-Smith, B.A., Dip. Rur. Econ. (Oxon), A. I. C. T. A. (Trinidad). *Tropical Agriculturist, Ceylon,* Vol. 88, No. 2.

Soil erosion is a process which goes on in all places at all times and at rates which vary according to local conditions. * * * * The distribution of rain, its daily intensity and the frequency of short-period downpours of extreme severity, are of most importance. * * * * * It has been established from observations made in widely different parts of the world that practically all the rainfall of a day's heavy rain usually falls within 10, or even within 7, consecutive hours, while a disproportionately large fraction of that amount falls within 1, 2 or 4 hours.

The results of processes of soil erosion are of the kinds which may be referred to as internal and external.

The internal results are restricted to the land which is being eroded. The surface soil, which contains the greater part of the nutrient matter and the whole of the organic food of plants is bodily removed, and with it are lost, not only the actual salts which serve to nourish the plant, but also the micro-organisms which bring these salts into this condition is thus seriously reduced and its physical properties, such as water-retaining capacity, are altered by the destruction of its tilth.

The soil, depleted of its most valuable ingredients by erosion, ceases to be able to support the crops grown on it, with result that even the protection which these crops normally give is largely lost. Erosion now reaches its second stage. The remaining top soil is washed away bodily; from the channels formed by the water as it rushes down the slopes, subsoil is scoured away and gullies and ravines develop.

The external results of erosion are many; they take various forms and are of a serious nature. One result of the removal of a forest cover is interference with the flow of streams. Water is removed rapidly from unprotected land instead of being temporarily detained. The flow of streams arising in such land becomes irregular, being decreased during fair weather and becoming torrential during monsoon weather. Irrigation channels and rivers become choked by silt carried down from the eroded land, and irrigation works are often destroyed by the rush of water during heavy weather. Agricultural areas below the eroded land, such as paddy fields, may be ruined by the deposition of large quantities of sand silt.

The control of soil erosion. Soil erosion is caused primarily by the free movement of matter on the surface of the ground. * * * * * It is not generally realised that doubling the velocity of water increases its transporting power sixty-four times.

To reduce soil erosion to a minimum it is necessary to :—

1. Protect the soil from the direct erosive action of rain water falling on it.
2. Obtain the maximum absorption of the rain water where it falls.

3. Control the removal of the surplus rain water.
4. Arrange for the collection and replacement.

It should be the aim of all who undertake any work for the reduction and prevention of soil erosion, to put into practice all the measures necessary to effect the first three of the above to such a degree that the last measure becomes unnecessary.

Reducing the force with which rain falls upon the surface of the soil involves the establishment of something to cover and protect the soil from the beating action of rain water falling directly on to it. High and medium shade, in combination with ground cover crops effectively perform function (b); * * * * Ground covers, however perfect they may be, cannot entirely prevent the movement of water on surface of the soil under rainfall of high intensity; but they do effectively reduce the rate of flow of this water, and so where the absorptive capacity of the soil is high, give it time to sink in or be absorbed.

Ground covers must be regarded therefore, as of primary importance in the prevention of soil erosion since they perform three of the four functions necessary to reduce soil erosion to a minimum.

The establishment of a satisfactory ground, cover, as rapidly as is possible, must be regarded as an imperative necessity for the prevention of soil erosion. Almost all crops will permit of this, with exception of a limited number of short period or seasonal plants. In the case of seasonal or other crops in which it is essential that no weed growth be permitted, it should be remembered that the provision and maintenance of a satisfactory surface much of organic material which has not entirely lost its original plant structure, can to some extent take the place of ground cover.

The rate of movement of water over the surface of the soil irrespective of the presence of ground cover, will vary mainly in accordance with the degree of slope of the area concerned. * * * * In the past it was customary to lead the free water of the land in so-called drains by the easiest and quickest possible route, and no account was taken of the soil which went with it. * * * The Soil Erosion Committee considered that it was possible to control the movement of surface water and stop the downward movement of surface soil by the use of ground cover; drainage systems are to be regarded as a second line of defence against soil erosion. The first line of defence should be in front of the drains, and it should be efficient enough to render the drains unnecessary in all but the heaviest and most prolonged down-pours, or to ensure that the water which finds its way into the drains does not contain silt but is clear and colourless.

In recent years various modifications have taken place in existing drains; silt pits are perhaps the most common and the least efficient. Their effective capacity for the retention of water and the collection of silt is confined to the pits themselves. Once they are full of water they cease for practical purposes to exist; the water in the drain flows unhindered over them and with the exception of the very coarse particles carries away any silt with which it may be charged.

Cameron's lock and step system, advocated by Mr. E. O. Felsinger is a distinct improvement; in effect it results in the conversion of the drain into a series of silt pits separated by narrow walls. A quantity of water equal to the storage capacity of the basin thus formed, is held up in each section and soil which it carries has an opportunity to settle. It is calculated that this system will hold 2 inches of rain before the spills overflow.

A further improvement which is subject to the same limitations however, is the following. The drain is divided by bunds as in the lock and step system but the sections between the bunds are excavated so as to be horizontal.

On gentle slopes and with an evenly distributed rainfall, the system of bunded catch water pits advocated in Java may be sufficient to provide for the holding up of all the run-off water. Rows of pits are dug in contour lines across the slope (Fig, 3)

Other works which aim at preventing the downward movement of water and soil on slopes, and thus aid in controlling the removal of surplus water, are stone terracing, the construction of contour and individual platforms and contour trench systems.

Much excellent stone terracing has been done on tea and rubber estates and there is no doubt that it does arrest a large amount of downward movement of soil on slopes. The efficiency of terraces depends more upon their frequency than on the height of the stone work, which it is considered, should not be more than 18 inches in height. Occasionally, however, much harm is done by water spilling over the tops of terraces and it is therefore essential that stone terracing should be supplemented by measures designed to ensure maximum retention and absorption of water falling on the terraces.

Contour platforms are considered to be a progressive method of opening new clearings and this system has proved its undoubted benefits. The platform slopes backwards into the hill, the inner edge being at least a foot below the outer. Small buttresses are left at intervals along the back of the platforms so that undue lateral movement of water is prevented. Silt pits are usually dug at the back of the platform, and the platforms are planted with cover crops which form a complete cover except for a space around each tree which is kept clean. There are no drains and the whole of the water falling on the land is absorbed.

In the contour trench system evolved by Mr. Denham Till the size of the trenches is first calculated so that they shall be sufficient on any area to contain the run-off water from the probable maximum downpour thereon. A level trench of the required dimensions, usually 3 ft. by 3 ft.; is cut at the base of the hill. Assuming that rubber is to be planted in rows 24 feet apart, the next trench, also level and of the same dimensions, is cut 24 feet from the centre of the first one and so on up the hill. The surface soil removed from the trench is thrown to the upper side and the subsoil to the lower side. The subsoil is used to form a bund on the lower side of the trench and creeping or other cover crops are grown on the bund. The trench is not filled in until immediately before planting, when it is half filled with top soil. Any rain which has fallen between the time of trenching and that of planting will have replaced some of the original surface soil thrown above the trench, and this may be increased by scraping the top soil from the ground above the trench until the requisite depth of soil is obtained. If no cover crop is grown other than that on the bund, local erosion taking place between the trenchs will result in the formation of a series of contour terraces.

The measure of next importance is to ameliorate the soil so that it attains its maximum absorptive capacity. The more water that is absorbed by the soil the less there is to run down the hill carrying soil with it. On hill side or sloping land the possibility of water logging does not require consideration, and the aim should be to absorb the maximum amount of water on such slopes both for the prevention of erosion and for the benefit of the soil itself. The cultivation of the soil is thus a matter of importance as it affects absorption, percolation, and the retention of soil moisture. Deep cultivation is preferable to superficial scraping, but while deep forking has a value in aiding absorption it will not prevent soil erosion. The results of experiments have shown that plain envelop forking increases erosion. It is necessary, therefore, that forking should be

supplemented by protection of the surface of the soil and by green manuring. Green manuring leads to the formation of humus which increases the water, retaining capacity of the soil, to the aggregation of soil particles by flocculation, and to the production of tilth.

The fertility value of the eroded and transported soil particles is considered to be sufficiently great to render their return to the area under cultivation extremely desirable. The accumulations in silt pits, contour trenches, drains, etc. render this easily possible after the water that was in them has been disseminated through percolation, absorption, etc.

The regular return of this soil to the cultivation area will enable these silt traps to be maintained in an effective condition. The location or silting of them in the necessary places will reduce the distance this eroded soil has to be transported back and thus save a considerable amount of labour and expenses.

Agricultural Fottings

BY THE DEPARTMENT OF AGRICULTURE, MADRAS

Coconut nurseries and the selection of seedlings. The importance of raising a nursery for many agricultural crops is well recognised. It is particularly important for the coconut.

Seed nuts should not be planted in the field direct, but a nursery should be raised. This would facilitate easy selection of desirable seedlings, proper watering, control over pests and would prove not only convenient but economical.

A suitable piece of land with good drainage and close to a water source should be selected for the nursery. Sandy soil at least a foot deep is to be preferred. Besides the good drainage facilities it affords, it keeps off white ant attack commonly reported in the coconut nurseries.

The best time to start a nursery is the end of May or beginning of June so as to take advantage of the south west monsoon rains. Also it should be remembered that the seednuts which are harvested during the summer months should not get too dry.

The nut with the husk intact is buried in the soil to a depth of three-fourths of its length or flush with the soil, with the stalk end upwards. From various experiments conducted by the Agricultural Department it appears that the best position for planting is the vertical one, in which the germination is the quickest. The spacing to be given in the nursery depends upon the age of the seedling required, i. e., the length of the period for which the seedlings will be retained in the nursery. For obtaining 9 to 12 months old seedlings the nuts may be planted one to one and a half feet apart. Manuring of any sort is not necessary. Germination will commence in about two months and will extend to the fifth or sixth month. Watering is very necessary when the rains fail and during the hot season. While in loamy soils watering twice a week will suffice, in sandy soils it should be done every alternate day. The seedlings should be examined periodically for beetle and white ant attack. If the sun is too hot and scorching, partial shading by way of thatch may be provided so as to avoid scorching of young leaves.

The seedlings will be ready for transplanting by the commencement of the following year's south west monsoon rains Where the soils are light and easily drained, planting may be done at the beginning of the monsoon. In heavy soils and in places where the rains are heavy it is desirable that the transplanting is

done at the close of the monsoon as otherwise, water collects in the pits and dislodges the seedlings, due to the persisting nut which easily floats on water. The usual practice is to transplant a year old seedlings. But in some parts of the Presidency three to four months old seedlings are transplanted in the north-east monsoon. This is undesirable for it is not possible to make a proper selection in very young seedlings.

The importance of proper seed selection in a perennial crop like the coconut is well known to all planters. But the selection should not stop with the seed alone. It should be done in the seedlings as well. The question is often asked whether it is possible to judge the bearing capacity of a coconut tree from the nature of the seedlings from which it is raised. This problem is obviously of utmost economic importance to the planter, for the coconut comes to bearing only in ten to twelve years after planting. Intensive studies carried out at the Agricultural Research Stations (Coconut) on the west coast have shown that certain characters of the seedlings are related to the future performance of the palm. Based on this knowledge, it is recommended that seedlings with characters mentioned below should be selected, as they would ensure early and high yield.

1. Early germination of seed.
2. Large number of leaves in the seedlings.
3. The leaflets in the seedlings are united together unlike in the older palms. The united leaflets begin to split or separate at varying ages of the seedling. The earlier the separation the better is the seedling.
4. Short and strong leaf-stalks and closely set leaflets.
5. Thick stem and
6. Large number of roots.

Sugarcane cultivation in Tanjore District. Paddy is the main crop of the Tanjore delta. Due to fall in prices, its cultivation at present is not so paying as it was some years ago. Even under the present conditions, it would not be replaced by other remunerative crops on a large scale due to various causes limiting their introduction and cultivation. However, with the fall in prices of paddy, extension of cane cultivation has become an economic necessity. Therefore wherever conditions permit, sugarcane cultivation has been advocated and introduced with success and the area under the improved varieties is extending year after year. About 33 per cent. of the total area under canes last year was under the varieties advocated by the Department.

Before the introduction of the departmental strains there were two main varieties viz., 'Rasthali' and 'Nanal' under cultivation in principal sugarcane growing regions of the district. Thick exotic canes were introduced to replace Rasthali, while medium canes of the Imperial Cane-breeding Station, Coimbatore have been advocated in Nanal tracts. The spread of the thick canes has been far below expectation due to the fact that they are not only of longer duration but also require plenty of moisture and manuring and do not withstand water logging conditions. The spread of the Coimbatore medium canes, Co. 281 and 285 has been more rapid and the ryots have taken to their cultivation more enthusiastically and these varieties do not suffer the disadvantages of thick canes. These are of short duration requiring less cultivation expenses and capable of withstanding drought and water logging conditions. With Co. 281 good jaggery is obtained in 8 to 9 months amounting to about 6000 lb. per acre on an average and it ratoons satisfactorily. This variety is replacing the exotic canes and also the local Rasthali in places where it is not grown for chewing purposes.

The other improvements in cane cultivation such as planting in trenches to prevent lodging as far as possible, manuring the crop economically and better preparation of good jaggery have been introduced. About 33 per cent. of the

total area was under trench planting in the last season. Iron mills have been demonstrated and introduced for better extraction and Scindvahi furnaces have been constructed to save fuel; for better germination, short cropping is being advocated. Many ryots prefer to sell their canes to the factory. This saves them the trouble of milling but the net gain obtained is almost similar to their milling and disposal of the produce as jaggery.

Green manuring and application of phosphatic manures to paddy crop in Tanjore District. It is well known that organic manures are necessary for increasing the yield of paddy; of these, those readily available in the country are cattle manure and green leaves. The former is not sufficient to manure even the one-twenty-fifth of the area, and the latter is not available in any large quantity due to lack of large forest areas in the district. Therefore the Agricultural Department has been advocating the growing of green manure crops in paddy lands. Although the system of growing green manure crops is spreading, it has not as yet become a general practice throughout the delta. Due to high prices obtained for paddy in pre-depression days, much heed was not paid on manurial side. But with the reduction in prices with little hope of recovery in the near future, Tanjore mirasdars, as their fellow cultivators in other districts, are faced with the situation to increase the outturn, so that, what is lost in prices may be made up to some extent by enhanced yield. Towards this situation, the cheapest way of manuring i. e. raising of green manure crops in paddy fields and applying the same with phosphatic manures like bone-meal, has been advocated as in the past and the response received to this propaganda work has been fairly satisfactory. In various parts of the district, demonstration plots were laid out in the last season and the yields obtained in almost all the cases not only paid the cost of manuring but also left a fair margin of profit amounting to about Rs. 2 per acre on an average while in some individual cases it amounted to as much as Rs. 7 to 8.

The present area under green manure crops is about 32, 917 acres and during the last season 2, 30, 918 lbs. of green manure seeds were distributed by the combined efforts of the department and other agencies such as Co-operative Societies and Agricultural Associations. The persistent propaganda to prevent cattle trespass in case of raising Daincha and Indigo is having its effect and successful crops are now being raised on lands where Kolinji does not fare well or fails. The economic depression, which is compelling the mirasdars to increase the cultivation by cheap manuring, acts as a factor to guard against the cattle trespass and raise other kinds of green manure crops for which a response has been made.

College News and Notes.

The college reopened on the 15th June 1937 after the summer holidays for the students of B. Sc. Ag., classes II and III.

Weather Review (APRIL 1937).

The unsettled conditions in the Bay of Bengal have developed into a depression which later moved rapidly and centred close to the coast between Madras and Nellore. There has been nearly general rain associated with thunderstorms in south east Madras, Malabar, and local rains on the Madras coast, with a few falls in the Madras, Deccan, Mysore, Lower Burma and the Punjab hills.

The weather during the month was characterised by thunder showers and local rains in the Peninsula. Rainfall was above normal throughout the Peninsula.

RAINFALL DATA

Division	Station	Actual for month	Departure from normal @	Total since January 1st	Division	Station	Actual for month	Departure from normal @	Total since January 1st
Circars	Gopalpore	1·2	+0·50	9·4	South	Negapatam	1·3	+0·7	8·9
	Calingapatam	1·9	+1·1	5·5		Aduthurai *	1·6	+0·7	3·1
	Vizagapatam	2·2	+1·5	5·3		Madura	1·0	−1·1	1·5
	Anakapalli *	5·7	+4·5	11·36		Pamban	3·5	+1·9	10·2
	Samalkota*	6·9	+6·3	8·5		Koilpatti *	3·6	+0·6	6·3
	Maruteru *	2·2	+1·7	3 1		Palamkottah	2·4	−0·1	6·3
	Cocanada	5·3	+4·7	6·1					
	Masulipatam	2·7	+2·1	5·3					
	Guntur*	2·6	+0·5	3·1	West Coast	Trivandrum	8·5	+4·0	13·8
						Cochin	8·8	+4·1	11·1
Ceded Dists.	Kurnool	3·3	+2·7	4·4		Calicut	5·7	+2·5	5·9
	Nandyal*	5·6	+5·2	7·1		Pattambi *	3·5	+0·4	4·1
	Hagari *	2·7	+2·0	3·7		Taliparamba *	0.0	0·0	0 0
	Bellary	3·3	+2·6	5·1		Kasargode *	7·0	+4 3	7·0
	Anantapur	3·9	+3·4	4·6		Nileshwar*	4·2	+2·5	4·4
	Rentachintala	4·1	...	5·9		Mangalore	4·5	+3·2	4·5
	Anantharaju-pet *	4 2	+3·3	4·2					
					Mysore and Coorg	Chitaldrug	0·9	0·0	1·1
Carnatic	Nellore	2·3	+2·0	29·8		Bangalore	6·4	+5·1	9·0
	Madras	2·6	+2·1	2·7		Mysore	4·3	+2·0	5·9
	Palur *	0·5	+3·6	4·1		Mercara	4·6	+2·0	9·4
	Tindivanam *	0·5	0·0	2·7					
	Cuddalore	0·5	−0·1	3·7					
					Hills.	Kodaikanal	7·2	+2·9	11·9
Central	Vellore	3·7	+2·7	4·4		Coonoor*	8·1	...	22·0
	Salem	2·4	+0·6	2·4		Ootacamund *	10·2	+6·6	13·5
	Coimbatore	3·2	+1·8	4·1		Nanjanad *	5·7	+2·4	10·0
	Coimbatore A. C. & R. I.*	3·7	+1·5	5·9					
	Trichinopoly	7·9	+6·2	8·6					

* Meteorological Stations of the Madras Agricultural Department.

@ From average rainfall for the month calculated upto 1935 (published in Fort St. George Gazette).

Weather Report for Research Institute observatory.

Report No. 3/37.

Absolute Maximum.	...	98·2°F.
Absolute minimum.	...	71·0″
Mean maximum.	...	93·5″
Departure from normal.	...	−2·4
Mean minimum.	...	73 0
Departure from normal.	...	+0·1
Total rainfall.	...	3·73″
Heaviest rainfall.	...	1·27 (recorded on 17th)
Number of rainy days.	...	6
Mean daily wind velocity.	...	1·3
Mean humidity.	...	71·5
Departure from normal.	...	0·7

Summary. The mean maximum was below normal by 2·4°F while the mean minimum and humidity was about the normal. The rainfall was in excess by 1·53″. During the month dry weather prevailed in the first two weeks while in the third and fourth week fairly humid conditions existed.

P. V. R. & P. G.

Departmental Notifications.

1. Promotions.

1. M. R. Ry. K. Govindan Nambiar, A. D., II grade provisionally substantive to be substantive from 23--2—37.

2. M. R. Ry. K. M. Jacob, A. D., III grade provisionally substantive to be substantive from 23—2—37.

3. M. R. Ry. T. V. Krishnaswami Rao, A. D., IV grade provisionally substantive to be substantive from 28—9—36.

4. M.R.Ry. G. Sitaram Sastri, A.D., IV grade provisionally substantive to be substantive from 23—2—37.

5. M.R.Ry. T. G. Anantarama Ayyar, F,M., L.R.S. Hosur, from III grade to II grade with effect from 23—2-37.

6. M.R.Ry. D. Panakala Rao, A.D., II Circle, from IV grade to III grade with effect from 23—2 -37.

7. M.R.Ry. V. K. Kunhunni Nambiar, F.M., A.R.S., Pattambi from Vth grade to IVth grade with effect from 23—2—37.

8. M.R.Ry. K. Balaji Rao, A.A.D. Hospet, from III grade to II grade to take effect from 16—9—36.

9. M.R.Ry. K. Achyutan Nambiar, A. A. D., Mycology, from IV grade to III grade, to take effect from 16—9—37.

10. M.R.Ry. T. A. Rangaswami Ayyangar, A. A. D., Nanilam, from IV grade to III grade, to take effect from 1st January 1937.

11. M.R.Ry. P. V. Hanmantha Rao., A. A. D., Palladam, from V grade to IV grade, to take effect from 16 -9—36.

12. M.R.Ry. C. V. Sankaranarayana Iyer, Sub Assistant Paddy Section, Coimbatore, from V grade to IV grade, to take effect from 16—9 36.

13. M.R.Ry. B. Venkataraman, A. A. D., Yellamanchili, from V grade to IV grade, to take effect from 16—9—36.

14. M.R.Ry. T. V. Ayyaswami Ayyar, A. A. D., Tirupathur, from V grade to IV grade, to take effect from 1st January 1937.

2. Transfers.

Name of officers.	Transferred	
	From	To
Mr. P. V. Samu Ayyar	A. A. D. Kulitalai.	Fourth Circle.
„ C. A. S. Ramalingam Pillai	A. A. D. Fourth Circle	A. A. D. Ariyalur.
„ S. Mahadeva Ayyar	A. D. Ariyalur	A. D. Trichinopoly.
„ S. V. Doraiswami Iyer	A. L. A. Coimbatore	F. M. Guntur.
„ M. Alagiriswami	A. F. M. Coimbatore	A. D. Fourth Circle.
„ E. Kunhappa Nambiar	A. L. A, Coimbatore	F. M. Taliparamba.
„ K. Ramaswami Iyer	A. D. Sixth Circle	A. L. A. Coimbatore.
„ K. Sanjeeva Shetty	F. M. Nileshwar	A. L. A. Coimbatore.
„ P. A. Narayanan Nambiar	A. D. Cannanore	F. M. Nileshwar.
„ R. Guruswami Naidu	L. R. S. Hosur	A. R. S. Guntur.
„ A. Shanmugasundaram	L. R. S. Hosur	A. R. S. Aduturai.
„ Azimuddin	F. M. Aduturai	L. R. S. Hosur.
„ A. Gopalan Nair	F. M. Taliparamba	A. D. Tellicherry.
„ K. Govindan Nambiar	A. D. Tellicherry	A. D. Cannanore.
„ T. K. Thangavelu	A D. Coonoor	A. D. Ootacamund.

Mr. B. Dasappa Malli	—	A. D. Coonoor.
„ K. G. S. Bhandary	A. D. Ootacamund	A. D. Tirupur.
„ S. Kanakaraj David	Asst. Paddy Section	Chemistry Section.
„ K. Veerabhadra Rao	Asst. Chemistry Section	First Circle.
„ S. Sundaram	Asst. Madras Fodder Cholam Scheme	Asst. Cotton Section, Coimbatore.
„ A. Ramadoss	Asst. Cotton Section	Asst. Pempheres and Physiological Scheme.
„ S. Anantam	Asst. Pempheres and Physiological Scheme	A. D. Saidapet.
„ M. R. Balakrishna Iyer	Asst. Madras Fodder Cholam Scheme	Asst. Chemistry Section.
„ S. Ramachandra Rao	Leave	Asst. Paddy Station, Buchireddipalayam.
„ N. Annaswami Ayyar	A. D. Chittoor	A. D. Tirupattur, VI Circle.
„ M. C. Krishnaswami Sarma	A. A. D. Tirupattur	A. A. D. Dindigul.
„ A. Chidambaram Pillai	A. D. Dindigul	A. D. Madura.

3. Leave.

Name of officers.	Period on leave.
Mr. T. Varahalu, Asst. Chemistry Section	Extension of l. a. p. for one month from 4th June 1937.
„ N. Subramania Iyer A. D., Trichinopoly	2 months l. a. p. from the date of relief.
„ T. G. Anantarama Iyer, L. R. S. Hosur	l. a. p. for one month and 13 days from 17—5—37.
„ T. R. Naganatha Iyer, Sub Asst in Botany	l. a. p. for 2 months from 30—5—37.
„ V. M. Ramunni Kidavu, A. D., Perintalmanna	3 months on m. c. from 27—4—37.
„ M. Subramania Pillai, A. D.	Extension of l. a. p. for 1 month on m. c. from 1—6—37.
„ V. Achyutharamaiah, A. D.	l. a. p. for 2 months and 15 days from 5—5—37.
„ M. P. Narasimha Rao, Asst. A. R. S. Maruteru	2 months on m. c. from 3—5—37.
„ R. Venkataram i Iyer, A. D. Vridhachalam	l. a. p for 2 months from 23—5—37
„ P. Parthasarathy, F. M., Kodur	Extraordinary leave for 4 weeks from 2—6—37.
„ C. S. Sankaranarayana Iyer, F. M., Nanjanad.	l. a. p. on m. c. for 2 months from 14—5—37, and 11 days from 3—5—37 without m. c.
„ G. Sakharam Rao, A. D., Udipi	1 month on m. c. from 13—6—37.
„ S. Veeravarada Raju, A. D., Avanashi.	Extension of l. a. p. for one month from 1—6—37.

UNIVERSITY OF MADRAS

B. Sc. Degree Examination in Agriculture, 1937

FIRST EXAMINATION

1. AGRICULTURE

Monday, 5th April. 7 A. M. to 10 A. M.

Maximum: 60 marks.

Answer six *questions. Questions 2 and 6 are compulsory.*

1. Describe a rain-gauge. State what precautions you would take in locating a rain-gauge. What is meant by the term 'an inch of rainfall'? (9 marks.)

*2. *(a)* Explain the cause of the Indian monsoons, and show how they are influenced by the pressure distribution and rainfall in other parts of the world.

(b) State how the croppings of the agricultural tracts of India are regulated by the monsoon rains. (12 marks.)

3. Give an approximate idea of the range of temperature and humidity in Coimbatore and its neighbourhood during the different seasons of the year. Explain in a general way how the variations occur. (9 marks.)

4. How are soils formed? What are the special characteristics of the Indian black cotton soil? Draw a sketch of its distribution in South India. (9 marks.)

5. Examine in a general way the nature of the soil profiles presented by a cutting into the soil, say, to a depth of 30 feet in a place in the upper reaches of the Tanjore Delta and in the Agricultural College Farm, Coimbatore, and discuss how the differences, if any, are brought about. (9 marks.)

*6. Define 'tilth'. What steps would you take progressively to prepare the land to a fine tilth? What time, labour, and cost would it entail to make a five-acre piece of black soil fit for sowing? (12 marks.)

7. Describe a 'disc plough' and show how and when it can be worked. Compare the land broken with the disc plough with that worked with a mould board plough. (9 marks.)

8. Write short notes on:—clouds, sub-tropical belt, trade winds, laterite, felspar, sand-dune, buck scraper, bed former, reversible disc plough. (9 marks.)

2. BOTANY

Tuesday, 6th April. 7 A. M. to 10 A. M.

Maximum: 60 marks

Answer six *questions*, three *in* A *and* three *in* B. Questions 3 and 5 compulsory.

The answers to questions in A *and* B *must be written in* separate *answer-books.*

A

1. Name six different plants whose underground parts are of economic value. Give a sketch of the subterranean portion in each case, and discuss its morphology. (9 marks.)

2. The vascular system is continuous from root to stem. Show, with sketches, how transition is effected from the root to the stem structure. (9 marks.)

*3. Classify the following plants into their families, and mention the distinguishing characters of those families, with floral diagrams:—*Hevea brasiliensis, Ricinus communis, Triticum vulgare, Phyllanthus emblica, Pennisetum typhoideum,* and *Saccharum spontaneum.* (12 marks)

4. What is the advantage of the dispersal of seed and fruit to the species? Enumerate some typical instances of dispersal of seeds and fruits and the adaptations which fit them for such dispersal. (9 marks.)

B

*5. Describe an experiment to show that respiration takes place in plants. What is respiratory quotient, and what are the factors influencing it ? (12 marks.)

6. Give instances of leaves which show movements. What is the significance of these movements ? (9 marks.)

7 Describe in detail the process of meiosis in plants, and discuss its significance. (9 marks.)

8. Write short notes on :—plastids, parenchyma, bordered pit, laticiferous tissue, chemotropism, primordial utricle. (9 marks.)

3. CHEMISTRY

Wednesday, 7th April. 7 A. M. to 10 A. M.

Maximum : 60 marks.

Answer six *questions*, three *in* A *and* three *in* B. *Questions* 4 *and* 5 *are compulsory. The answers to questions in* A *and* B *must be written in* separate *answer-books.*

A

1. How would you establish the presence of the following groups in an organic compound :— CH_2OH ; NH_2 ; CN ; CHO ? (9 marks.)

2. Explain clearly what is meant by primary, secondary, and tertiary alcohols, giving examples. Describe *two* methods by which you would distinguish them. (9 marks.)

3. Write notes on the following, illustrating your answer by selecting suitable examples :—homologous series, aldol condensation, isomerism, and optical activity. (9 marks.)

*4. Describe the preparation of urea. What are its chief chemical properties ? How would you prove that it is the diamide of carbonic acid ? (12 marks.)

B

*5. How are the two hexose sugars united in the molecules of (*a*) sucrose, (*b*) maltose ? Describe a simple experiment to illustrate the difference. Explain why, while both the sugars are optically active, maltose reduces copper solutions but sucrose does not. (12 marks.)

6. What experiments would you perform to establish that glucose is an aldehyde while laevulose is a ketone ? (9 marks.)

7. Mention the general groups of substances that form the ultimate units of the protein molecule. Give the methods of their preparation and their more important properties. (9 marks.)

8. Starting from benzene, how would you prepare the following substances:—phenol, benzaldehyde, and benzoin ? (9 marks.)

4. ZOOLOGY

Thursday, 8th April. 7 A.M. to 10 A.M.

Maximum: 60 marks

Answer six *questions. Questions* 1 and 3 *are compulsory.*

*1. Write an essay on *either* 'The Influence of the Environment on the Organism', *or* 'Inherited Adaptations in the Animal Kingdom'. (12 marks.)

2. 'Hydra is probably a degenerate type of the class Hydrozoa and is therefore hardly representative of that class.' Examine the validity of this statement. (9 marks.)

*3. Describe, with the aid of diagrams, the essential features in the morphology and internal organization of any annelid that you have studied, and point out those advanced characters which clearly separate it from a coelenterate or a nematode. (12 marks.)

4. Explain, with the aid of examples, the following terms :— parapodia, metamerism, triploblastic, vestigial structures, commensalism, hermaphrodite, and binomial nomenclature. (9 marks.)

5. What are fossils? How are they formed? What is their biological importance? (9 marks.)

6. Describe briefly how the following animals feed:— amoeba, sea-urchin, earthworm, house-fly, grasshopper, prawn. (9 marks.)

7. What is the nature of the evidence available at present to show that birds are descended from reptilian ancestors? (9 marks.)

8. Write brief notes on:-- cytoplasmic inclusions, notochord. vomerine teeth, edentates, marsupials, cysticercus, Aristotle's lantern. (9 marks.)

SECOND EXAMINATION

1. AGRICULTURE. PLANT HUSBANDRY. I

Monday, 5th April. 7 A. M. to 10 A. M.

Maximum: 100 marks.

Answer six *questions.* Questions 1 and 3 *are compulsory.*

*1. Under what category of manures would you classify the 'farm-yard manure'? Give reasons. Describe the best method of preparing farm-yard manure. Would you recommend this method for general adoption in all circumstances? If not, what alternative would you suggest? (18 marks.)

2. Explain what you understand by the terms 'green manuring', 'green leaf manuring', and 'green soiling'. Discuss how these three methods could be fitted into the normal agricultural practices of the Province of Madras. (16 marks.)

*3. Lay out a scheme of five-course rotation for a typical garden land area (loam) in Coimbatore, introducing a fallow, green or bare, and mentioning the advantages or otherwise of so doing. Discuss the effects of each crop in the rotation on the soil and on the succeeding crop. (18 marks.)

4. How would you effectively eradicate Hariali grass from a black soil area? What different methods would you have recourse to, taking into consideration cost, availability of labour, and local practice? (16 marks.)

5. What is 'pati mannu'? How has it originated? What use is made of it agriculturally? Are you aware of large applications of this material to any crop or crops? What effective substitutes would you recommend in places where this supply has run short? (16 marks.)

6. What are the various methods followed to prevent the ill-effects of erosion in cultivated lands? Mention one such method which you recommend for adoption in black soil fields. (16 marks.)

7. Describe the various methods that obtain among the farmers of this country for reclaiming alkaline lands. What is the role that sub-soil drainage plays in this reclamation? What are its limitations? (16 marks.)

8. Write brief notes on:—fire fanging, poudrette, leaf mould, red soils, partial sterilization of soil, rab-burning, activated sludge, guano. (16 marks.)

2. AGRICULTURE. PLANT HUSBANDRY. II

Tuesday, 6th April. 7 A. M. to 10 A. M.

Maximum: 100 marks.

Answer six *questions.* Questions 3 and 8 are compulsory.

1. Describe the improved pattern of the South Arcot circular mhote. Compare its efficiency with that of the old model and of the ordinary picottah. (16 marks.)

2. (*a*) What do you understand by (i) percolation wells, (ii) spring wells, and (iii) artesian wells? Under what conditions and in what parts of the Presidency of Madras do you find such classes of wells in large numbers? How is the water table affected in each such class of wells in different seasons?

(*b*) Distinguish between sinking a well and digging a well. When is the former method resorted to, and why? (16 marks.)

*3. Define duty of water. What duty would you fix for the following crops:—summer cholam, fodder sorghum, sugar-cane, tobacco, and cambodia, granting that you have a flow of water through a 12-inch vent with a velocity of 2 feet per second? Is this duty variable? If so, under what conditions? (18 marks.)

4. Describe the various improvements in the cultivation of sugar-cane and preparation of jaggery. (16 marks.)

5. Discuss the rationale of dryland cropping in the circars, with paddy as main crop, on the same land year after year. (16 marks.)

6. In Kistna and Guntur it is invariably the rule to thresh paddy long after it is harvested. Discuss the economics of this practice in all its bearings. (16 marks.)

7. Give the variations in seed rate for the following crops as grown in parts of the Madras Presidency, and explain the reason for such variations:—groundnut, bengal gram, cholam, cumbu. (16 marks.)

*8. Write a short account of the cultivation of any one of the following crops:—chillies, turmeric, plantains, ginger, and prepare a balance sheet. (18 marks)

3. AGRICULTURAL ENGINEERING

Wednesday, 7th April. 7 A. M. to 10 A. M.

Maximum: 60 marks.

Answer six *questions*. Questions 3 and 6 are compulsory.

1. (*a*) Compare compass surveying with chain surveying from the points of view of accuracy, scope, applicability, and rapidity.

(*b*) When would you prefer to use a compass and when a plane table? Give your reasons. (9 marks.)

2. (*a*) What are the important varieties of timber available in India for engineering works, and what are their special qualities?

(*b*) Describe one of the best methods of artificial seasoning of timber.

*3. A warehouse 60 feet by 25 feet is to be provided with Mangalore tile roofing. The internal height of the wall is 20 feet. Timber trusses are placed 10 feet apart. Draw to a scale of 1 inch=3 feet a cross-section of the building, showing details of the truss, purlins, common rafters, wall plates, ridge piece, pole plates, and side walls with suitable foundations in a gravelly soil. Give dimensions of all the parts. (12 marks.)

4. Describe and give sketches of a pumping installation for a well 70 feet deep with a variation in water-level between 25 and 65 feet, yielding normally about 5,000 gallons of water per hour for 8 hours in a day. (The depths are measured from the surface.) (9 marks.)

5. (*a*) What are the various parts of an improved plough? What care has to be taken in the manufacture of such a plough to make it function efficiently?

(*b*) What are the types of such ploughs that you are familiar with, and under what conditions are they used? Include in your answer ploughs used for mechanical draught.

(*c*) What are the materials used in the construction of an improved plough? Describe their properties. (9 marks.)

*6. Describe the principle on which the internal combustion engine works. What are the differences between the indicator diagrams of a steam engine, a gas engine, and a Diesel engine? How do you account for the differences? Name the different kinds of internal combustion engines and their use for pump irrigation. (12 marks.)

7. What are the usual troubles encountered in a pumping installation consisting of a centrifugal pump and a kerosine engine, and how are they overcome? Give your answers under the heads engine and pump separately. (9 marks.)

4. AGRICULTURAL ZOOLOGY

Thursday, 8th April. 7 A. M. to 10 A. M.

Maximum: 60 marks.

Answer six *questions*. Questions 1 and 2 are compulsory.

*1. In the uninhabited forest or the untilled plain, there is such a harmony of interaction among organic groups that insect pests are of very rare occurrence; but in countries occupied by man there are few crops free from the ravages of insect pests. How do you account for this difference? (12 marks.)

*2. Describe with the aid of diagrams the structural differences observed in the mouth parts of insects, and point out how a knowledge of these differences helps (*a*) in the classification of insects, and (*b*) in the determination of control measures directed against injurious insects. (12 marks.)

3. What are the principles involved in the following entomological practices:—(*a*) fumigation of stored products; (*b*) the use of light traps; (*c*) mixing crude oil emulsion in irrigation water; (*d*) ringing of coco-nut palms with tin bands; (*e*) the application of a combined spray, and (*f*) the raising of trap-crops? (9 marks.)

4. What are predators? How do they differ in their habits from parasites? Mention some of the non-hymenopterous insect predators, stating in each case the Order and Family to which it belongs and its economic importance. (9 marks.)

5. Give an account of the more important insect enemies of domestic animals in South India under the following heads:—(*a*) the name and Family of the pest (*b*) the nature and extent of the injury caused, (*c*) the control measure or measures you would suggest. (9 marks.)

6. What is the agricultural importance of earthworms, eelworms, millipedes, the Russel's viper, the king-crow, and the flying fox? (9 marks.)

7. Write short notes on:—chaematropism; parthenogenesis; muscardine; book solution; royal jelly; scarabidae; filariasis. (9 marks.)

8. Write an essay on:—'Insect pests of vegetables and how to control them.' (9 marks.)

5. ANIMAL HYGIENE

Friday, 9th April. 7 A. M. to 10 A. M.

Maximum: 60 marks.

Answer six *questions*. Questions 1 and 4 are compulsory.

*1. Describe the mechanism of rumination in the ox with the aid of a diagram. (12 marks.)

2. Describe the patella joint. What would you do in the case of dislocation of the patella in the ox? (9 marks.)

3. What do you understand by the following, and how do you deal with each of them:—(*a*) sinus, (*b*) abscess, (*c*) impaction of rumen? (9 marks.)

*4. Describe the aetiology, symptoms, and course of contagious aphtha. What preventative measures would you adopt in an outbreak of the disease? (12 marks.)

5. Define the following terms and give two examples, with dose for cattle, of each of them:—(*a*) anthelmintics, (*b*) antispasmodic, (*c*) antiseptic, (*d*) carminative. (9 marks.)

6. Describe the causes, symptoms, and treatment of choking in bullocks. (9 marks.)

7. What are the causes of retention of placenta in the cow? How would you treat a case? (9 marks.)

8. Describe the symptoms of blackquarter in cattle. What causes it, and what measures would you adopt in preventing the spread of the outbreak? (9 marks.)

FINAL EXAMINATION

1. AGRICULTURE. ECONOMICS AND FARM MANAGEMENT

Wednesday, 14th April. 7 A. M. to 10 A. M.

Maximum: 100 marks.

Answer six *questions.* Questions 1 and 5 are compulsory.

*1. Equip a farm of 100 acres with human labour, cattle, and dead stock, to enable one to carry on mixed farming—growing crops (wet, garden, and dry) and fruits, producing milk for a colony of fifty middle-class families, and rearing poultry to give 100 eggs daily. Limit wet and garden crops and fruits to 10, 25, and 5 acres respectively. Draw a neat sketch showing the allotment of the various crops, farmstead, buildings, roads, drains, and wells. (18 marks.)

2. Explain what is meant by 'statistical significance' in field experiments. Lay out a scheme of experiments for comparing two selections of a grain crop with a local standard type, and indicate all the details you would attend to in installing the experiments and carrying them through. Show by a set of hypothetical figures how the results can be interpreted to be significant or otherwise. (16 marks.)

3. What are the agents of production? How is each factor to be remunerated for the part it plays in productive activities? (16 marks.)

4. What kind of live fence would you prefer to have for a farm? Give reasons for your choice. Estimate the cost of establishing such a live fence for a farm of 100 acres, the shape of the farm being rectangular, with length about twice the breadth. (16 marks.)

*5. Discuss briefly the law of supply and demand, and draw up a diagrammatic representation. State how far the marginal utility and marginal cost of production influence demand and supply. (18 marks.)

6. What problems confront the sugar manufacturer at the present time, and how is he to be helped in his solution, safeguarding at the same time the interests of the cane grower? (16 marks.)

7. What is meant by distributive co-operation? How far is the co-operative stores movement in this province representative of this phase of co-operation? It is said that co-operative stores have not been such a success in this country. Discuss the causes and propose remedies, if necessary even by suggesting modifications of the by-laws. (16 marks.)

8. Write explanatory notes on:—margin of cultivation; unearned increment; law of diminishing returns; vertical and horizontal combinations; bartering; elastic and inelastic demands. (16 marks.)

2. AGRICULTURE, ANIMAL HUSBANDRY AND DAIRYING

Thursday, 15th April. 7 A. M. to 10 A. M.

Maximum : 100 marks.

Answer six *questions.* Questions 1 and 5 are compulsory.

*1. Prepare a score card for the best type of a stud bull, indicating how you would award marks for (*a*) breed points, (*b*) utility points, (*c*) fancy points. State how these various features are to be evaluated in respect of the three breeds—Ongole, Kangayam, Mysore. (18 marks.)

2. What is a general purpose animal? How far would the maintenance of Scind stud bulls in parts of the country for the improvement of dairy cattle fulfil the purpose? Have you any other proposals to make? (16 marks.)

3. What practical steps would you take to provide a regular supply of fodder and pasturage for a small dairy herd of twenty-five cows for a year? Calculate the cost. How would you compute the quantity of concentrates required for this herd on an economic basis? (16 marks.)

4. Give a short account of the Coimbatore sheep. How are they ordinarily bred and reared? Suggest improvements. What practical methods would you adopt to improve the mutton and wool? (16 marks.)

*5. What would it cost to produce one pound of butter from buffalo's milk as against cow's? From the figures you obtain, consider the desirability of starting a ghee trade to meet the requirements of fifty middle-class families in the town of Coimbatore? Work out a profit and loss statement for a herd of milch animals maintained for this purpose.

6. Explain the process of ripening cream and converting it into butter What quantity of butter do you obtain from milk containing 5 per cent. of butter fat? What are the various details you are required to pay attention to in order that you may keep the butter sweet as long as possible? (16 marks.)

7. How do you feed calves? What is your view as regards weaning calves at birth in this country? Work out the cost of rearing a calf for one year. (16 marks.)

8. Write brief notes on:— (*a*) process butter, (*b*) homogenized milk, (*c*) pasteurization of milk, (*d*) milk powder, (*e*) whey, (*f*) starter, (*g*) pedigree, (*h*) Atavism. (16 marks.)

3. AGRICULTURAL BOTANY. I

Friday, 16th April. 7 A. M. to 10 A. M.

Maximum : 100 marks.

Answer six *questions.* Questions 2 and 5 are compulsory.

1 Enumerate the forage plants that are, or can be, grown in tropical India, and state how you would improve the fodder resources of the Madras Presidency. Taking any *one* fodder plant, describe it botanically. (16 marks.)

*2. Describe in detail the floral structure and the method of pollination in the following crop plants:— (*a*) sugar-cane, (*b*) cotton, (*c*) tobacco. (18 marks.)

3. State the directions in which there is scope for improvement in the undermentioned fruit crops, and the way you would effect the improvements:— (*a*) mango, (*b*) papaya. (16 marks.)

4. Describe the germination of pollen-grain and the process of fertilization. Mention the adaptations that exist in plants for the protection of pollen against rain. (16 marks.)

*5. Name the elements that are essential for the healthy growth of plants, citing experiments to show their essential nature. Give in detail the function of the following elements and their distribution in various plant parts:—magnesium, iron, boron. (18 marks.)

6. What difference in form and structure do you find in (*a*) submerged, (*b*) floating, (*c*) amphibious plants, as compard with mesophytes. Illustrate your answer with sketches. (16 marks.)

7. Name *four* perennial weeds and mention the family to which each belongs. Give an account of their distribution and the methods for controlling their spread. (16 marks.)

8. Write notes on:— law of limiting factors; plant pigments; enzymes; wilting coefficient. (16 marks.)

4. AGRICULTURAL BOTANY. II

Saturday, 17th April. 7 A.M. to 10 A.M.

Maximum: 100 marks.

Answer six *questions. Questions* 4 and 5 *are compulsory.*

1. Write a short essay on the salient features of the phenomena of linkage and crossing over. (16 marks.)

2. Bring out briefly the bearing of a knowledge of cytology on crop improvement. (16 marks.)

3. Give a short account of the genetics of rice as you understood it after your visit to the Paddy Breeding Station at Coimbatore. (16 marks.)

*4. A local sorghum variety has pithy stalks and yellow grains. A good imported variety has juicy stalks, but is red grained. Describe, generation by generation, how you would breed to fix the two desired recessive characters, sweet stalks and yellow grain. (18 marks.)

*5. What are the chief differences between rusts and smuts in their life history? (18 marks.)

6. Give an account of the reproductive process in ferns, and compare it with the same process in angiosperms. (16 marks.)

7. Describe in detail how you would prepare a pure culture of any fungus and inoculate a healthy plant. (16 marks.)

8. Write short notes on:—pure lines; alternation of generations; intergeneric crosses; mutation. (16 marks.)

5. AGRICULTURAL CHEMISTRY. I

Monday, 19th April. 7 A. M. to 10 A. M.

Maximum: 100 marks.

Answer six *questions.* Questions 1 and 8 *are compulsory.*

*1. Write briefly what you know of the contributions of (*a*) Liebig, (*b*) Lawes, (*c*) Gedroiz, and (*d*) Winogradsky to the progress of soil science. (18 marks.)

2. Discuss the importance of mechanical analysis in interpreting the fertility of a soil. Describe in detail any *one* method of carrying out such an analysis, explaining clearly the principles involved at each stage. (16 marks.)

3. Write notes on:—(*a*) deflocculation, (*b*) denitrification, (*c*) H-ion concentration, (*d*) base exchange, and (*e*) aluminium toxicity. (16 marks.)

4. How many tons of mono-calcium phosphate can be obtained by treating a ton of rock phosphate, which analyses 32 per cent. PO_4, with sulphuric acid? How much extra sulphuric acid must you use if the rock phosphate contains 3 per cent. of calcium carbonate as an impurity (assume no other impurities)? (16 marks.)

5. What is 'nitrolim' and how is it manufactured? What do you know of the course of its decomposition in the soil? (16 marks.)

6. How are alkali soils formed? Describe methods by which such soils may be reclaimed for successful cultivation, discussing clearly the principles governing their reclamation. (16 marks.)

7. Trace the historical development of our conception of 'humic acids'. (16 marks.)

*8. Describe, in detail, the process of liberation of ammonia in the decomposition of plant and animal residues by micro-organisms. What factors influence this process? (18 marks.)

6. AGRICULTURAL CHEMISTRY. II

Tuesday, 20th April. 7 A. M. to 10 A. M.

Maximum: 100 marks.

Answer six *questions.* Questions 1 and 5 are compulsory.

*1. State what is meant by 'respiratory quotient'. What is its average value for herbivorous and omnivorous animals? Give reasons for the difference.

An animal used up during a twenty-four hour interval 500 litres of oxygen, eliminated 425 litres of carbon dioxide, and excreted 12 grams of nitrogen in its urine. Calculate what amounts of protein, carbohydrate, and fat have been catabolized during the interval. (Respiratory quotient is 1·0 for carbohydrates, 0·7 for fats, 0 8 for proteins; one gram of protein, carbohydrate, or fat requires 1·0, 0·83, and 2 06 litres of oxygen respectively for combustion.) (18 marks.)

2. Write short notes on the following:—(*a*) the vitamins of milk, (*b*) the proteins of the wheat grain, (*c*) fasting metabolism, (*d*) renal threshold. (16 marks.)

3. What is a fat? How is it different from a wax? What physical and chemical constants would you determine to characterize it? Describe in detail the method of determining one of them. (16 marks.)

4. Comment on the use of the following as food for cattle:—(*a*) cholam straw (grown for fodder), (*b*) cholam straw (grown for grain), (*c*) paddy straw, (d) maize grain, (*e*) rice meal, (*f*) cotton-seed cake, (*g*) linseed cake, (*h*) lucerne. (16 marks.)

*5. Trace in detail the fate of the products of decomposition of proteins from the time they are absorbed from the intestine till they are excreted out of the animal body. (18 marks.)

6. What are the changes that take place during the deterioration of butter? How are these brought about? (16 marks.)

7. To what class of substances does lecithin belong? What is its importance in the lactating animal? (16 marks.)

8. How would you determine dry matter in a sample of milk? How and to what extent has the principle of the method been adopted in the commercial manufacture of milk powders? (16 marks.)