Farming will never be a success unless the farmer had more voice in the disposal of his produce—P. Morrel.

The Madras Agricultural Journal.

(ORGAN OF THE M. A. S. UNION).

Vol. XVII] AUGUST 1929. [No. 8

Editorial

The Abode of Prosperity.—Under the above caption, Sreejut Valji Govindji Desai, contributes an article to "Young India" of the 13th June 1929. on the merits of Farm Yard Manure based on the results of the recent research work done on the subject in Madras. In doing so, he narrates a story from the Mahabharata in which *Lakshmi* (the Hindu Goddess of Wealth) is alleged to have entered a herd of cows and expressed a desire to take up her abode in their bodies if they would allow of it. At first the cows are said to have refused her permission for the reason that the Goddess of Wealth was so notoriously fickle and restless; but, on *Lakshmi* persisting in her entreaties and declaring that she did not mind in which part of their body she was lodged, the cows then said to her.

"O! thou of great fame! it is but fitting that your request should be honoured. Do then take your abode in our urine and dung, for both these are sacred, O, auspicious goddess." Thus did Bhishma explain to Yudhistira the reason why cow dung is popularly considered to be gifted with prosperity and wealth.

Whether, in ancient India, the realisation of this truth was the product of the powers of intuition possessed by the Seers of old or merely the discovery of men gifted with vision to peer into the realms of the invisible or whether it is only the outcome of the cumulative experience of generations of cultivators, it is not possible to make any statement. We can, however, say that the above story proclaims in an eloquent manner though allegorically, a truth which twentieth century science has confirmed by experiment. The experiments in Madras have shown that plants, like animals are not at their best, nor will their seed attain the fullest "reproductive quality" unless they have in addition to the mineral constituents, certain organic substances known as "auximones"—substances closely akin to "vitamins". These contribute to the maintenance of the normal metabolism of plants even if they are not conceded to be essential or indispensable, as vitamins are to animals. The auximones are, to use an expression that is not held in dispute by any section of scientific men, stimulating factors which besides enabling the plant to build up from the simple ingredients derived from the soil those organic complexes required for food by men and animals, also help the plant to elaborate the vitamins, which serve as accessory food factors for the animal organism. These auximones, or stimulating factors are produced in the soil by various forms of decaying organic matter, of which the best and least expensive is undoubtedly Farm Yard Manure which forms a secondary product in the feeding and maintenance of farm animals. The experiments have further proved that the better nutrition of the plant is reflected in the better nutrition of the animals, for it has been shown that while grain manured with farm yard manure proved quite a good normal food, the grain from the plot manured with artificials failed to provide for the normal growth of animals and that in this respect it was as bad as and in some cases even worse than, the grain produced on the plot which received no manure at all for some years in succession.

Thus, if we neglect the use of organic manures, as typified by farm yard manure, there is no doubt we shall be reducing the cropping power of the seed, so that our

future crops will get progressively worse and worse, and we shall also be producing a food for our people that would be lacking in nutritive value and consequently have a deleterious effect upon the future generations of the race, resulting in the production of a devitalised population.

No wonder, then, that farm yard manure is considered to be the abode of prosperity.

While dealing with this subject, we cannot but refer to a paper contributed by Mr. G. R. HILSON, to the Symposium on Cotton held during the Agricultural Conference in July last. His paper is pulished in extenso elsewhere in this issue and deserves careful study. It marks a departure from the usual method of treatment of sectional work and aims at putting up a generalised scheme whereby the research work of the Cotton Section as of all the research sections in general would fit into the work of the department as a whole and conduce to the amelioration of the condition of the ryot in all ways. In this scheme Mr. Hilson specially refers to the several benefits derived from farm yard manure, laying stress on the importance of building up its quality, by the free use of litter and by the necessary care in its manufacture and storage. He draws attention to various defects in the usual procedure of the average cultivator, such as the maintenace of stock kept in excess of the available supply of fodder, the burning of the refuse fodder as fuel and allowing the liquid portion of the excreta to run to waste.

Mr. Hilson, then defines, in no unmistakable terms, the problem before the Agricultural Department to be that of helping the cultivator, to produce in the best and most economical way as much fodder as will enable him to feed his working animals and a few breeding stock properly, and also provide sufficient litter for bedding. He then discusses the methods of attacking the problem and outlines a well defined scheme, based on figures carefully worked out, which aims at the building up of soil fertility and increased production, and at the production of better quality animals, and at the general improvements of the ryot and his farmstead.

It may possibly be said that no new information has been given about farm yard manure, but we must admit that the crucial importance of farm yard manure is surely depicted in an original way and the scheme presented by Mr. Hilson is undoubtedly the result of very careful thought and planning and urges the need of a new angle of vision for manurial problems. Some may be inclined to dismiss it as too idealistic or impracticable, but, though we have to admit that it is rather difficult up-hill work, we contend it is not at all impossible. True, he has the Tinnevelly tract in view when he elaborates the scheme; but this can easily be modified to suit other tracts as well. To our mind, the chief attraction and the main feature of the scheme lies in the fact that it aims at the all-round improvement of the ryot and his possessions.

Symposium on Cotton.—The praisewothy innovation of the previous year in arranging for a symposium on paddy was followed this year at this year's Agricultural conference by holding a similar one on Cotton. The Cotton Specialist, the Agricultural Chemist, the Entomologist and the Mycologist were invited to contribute papers. In addition the Assistant Cotton Specialist, Koilpatti and his assistant contributed two papers so that there were six papers on cotton altogether.

Mr. Hilson, the Cotton Specialist, in explaining how the work of the cotton section would fit into the scheme of the work of the whole department emphasised the importance of cattle manure in South Indian agriculture. Rao Bahadur Mr. B. Viswanath, the Government Agricultural Chemist, discussed the chemistry of the nutrition of the cotton plant and its bearing on the manuring of cotton. Rao Sahib Mr. Y. Ramachandra Rao, the Entomologist, gave an account of the present position of the Entomological section of the Institute in regard to the control of the major pest on cotton in South India. He made a clear analysis of the different kinds of pests attacking the different parts of the cotton plant at different stages of its growth, discussed the different control measures and set forth a plea for a greater combination of the Entomologist, the Agriculturist and the Chemist in effecting the control of cotton pests. Mr. Sundararaman, the Mycologist,

in discussing the fungoid diseases of the cotton plant in the Madras Presidency expressed the view that the cotton crop is not as much subject to disease as the other crops and enumerated the causes that had contributed to this comparative freedom. The climatic conditions, the system of rotation, the interval between two crops of cotton, the practice of uprooting the cotton plants and burning them, the existence of several species and varieties of cotton having a wide range of variation in their susceptibility to various diseases and the discontinous geographical distribution of the cotton tracts in the Presidency were stated to be some of the chief factors that contribute to the comparative freedom from disease enjoyed by the cotton crop.

Mr. V. Ramanathan, Assistant Cotton Specialist submitted to the conference an interesting paper on the relationship between rainfall and Karunganni cotton yields. So far as we are aware, this is the first time any attempt at correlating crop yields with rainfall has been made in Madras and we hope that in future years this important fieldof investigation will be continued.

Mr. C. Jagannatha Rao, assistant to the Cotton Specialist, in a paper entitled "Where is money in Cotton" described the scientific aspects of the work of the cotton breeder and how it is of benefit to the ryot.

The first four papers appear elsewhere in this issue and owing to want of space, we had to reserve the remaining two for a subsequent issue.

The advantages of symposiums and discussions cannot be overrated. Such discussions enable scientific workers to take stock of the situation and to look at any prablem from every point of view. They also serve another useful purpose; for, thereby the attention of the public is focussed on the nature and extent of work done on any particular crop and the part which each worker is taking towards the advancement of agriculture. We hope the symposium idea will be continued in future years also.

Cotton Research Work and its relation to the work of the Agricultural Department.

By

G. R. Hilson, B. Sc.,

Cotton Specialist.

[Paper contributed to the Symposium on cotton arranged by the Madras Agricultural Students' Union, for its conference in July 1929).

I have been asked to contribute one of a series of papers whose purpose is to make known the activities of the department in regard to cotton. From whatever point it is viewed, whether from that of the Agronomist, Bacteriologist, Chemist, Entomologist, Mycologist or Plant Breeder the subject is capable of treatment from four aspects.

1. The acual work being done.
2. The methods adopted in carrying out the work.
3. The results achieved.
4. The practical application of the results.

Items 1, 2 and 3 have, so far as the cotton section is concerned, received a fair share of attention at previous conferences. Moreover thoseof you who are able to take the opportunity of visiting the cotton section will find the latest information on these three items presented in a more interesting manner than is possible here. I am therefore in this paper limiting myself to item (4) not only for these reasons but also because it affords an opportunity of making clear how the work of the cotton section and research in general fits into the work of the Department as a whole.

Briefly the function of the agricultural department is the promotion of good farming. By the term "good farming" I mean all such practices as aid the cultivator to obtain good crops from his land in the most economical manner possible, not merely for a short time, but continuously.

Let me elaborate this point further, as it is important that it should be clearly understood. Our function is not merely the testing of new varieties and strains of different crops, the comparison of the immediate return given by different manures and the discovery of new methods of cultivation. Each of these is good in itself but by itself does not go far enough. We must be prepared when we commence to advertise our results to show how they should be combined with one another and worked into the local system of agriculture in order to produce a permanent improvement and not merely a temporary one. It is this aspect of the question seen from the point of view of cotton that I propose to discuss.

In an old and well established system of agriculture, such as prevails over the greater part of this presidency one of the greatest barriers to good farming that can exist is the failure to produce annually a reasonably adequate supply of good well-made cattle manure.

The salient features of well made cattle manure which are of interest to the cultivators of this presidency and which have been well tested or concerning the truth of which evidence is accumulated are:—

1. It improves the texture of the soil ie., it makes the soil easier to work and more permeable to moisture.

2. It improves the capacity of the soil for retaining the moisture and certain plant foods.

3. It improves the yield of crops.

4. It apparently improves the feeding quality of cereal crops grown on land to which it has been applied.

5. It apparently affects the seed of a crop grown on land to which it has been applied, in such a way, that this seed when sown develops into a healthier and more vigorous seedling than is the case with seed from a crop grown without the aid of cattle-manure.

6. In certain cases, it apparently must be applied to the land if satisfactory results from the application of artificial manure is to be obtained.

It is therefore clear that the correct handling of cattle-manure lies at the very foundation of good farming.

In this Presidency, speaking generally, the amount of cattlemanure available is well below requirements and its quality is of the poorest. If, therefore, the cultivators, as a body, could be persuaded to take steps to remedy these two defects in their cattlemanure supply, a long stride would have been taken towards making agriculture a more profitable industry than it is at present. I have used the word "persuaded" advisedly. There are very few cultivators who are so careful and so efficient in the preparation of their cattle-manure that they could not make some alteration in procedure with advantage and of the others there is none who possesses cattle who could not do something to improve their position. Fortunately in this case the procedure to be adopted in improving the puality of the the manure leads to an increase in quantity. This is in marked contrast to the position found in the case of crops, where efforts to improve quality usually automatically bring in their train a reduction in yield. That it does lie within the power of every cultivator who keeps cattle to improve his supply of cattle manure both in quantity and quality will become apparent from a consideration of the details of the process of manufacture of good cattle-manure.

In the manufacture of cattle-manure of good quality, three ingredients are needed, (a) dung (b) urine (c) litter. The action which takes place when these three ingredients are brought together under the right conditions may be briefly described in this way. Bacteria and fungi of which large numbers are present in the dung and in the litter draw upon the nitrogenous compounds supplied in the urine for their development. In so doing they cause the nitrogen to pass through certain changes with the result that from being present in a form in which it might readily be lost, it takes on a more stable form. Incidentally the woody matter of the dung and the litter, which goes to form humus in the soil on which the beneficial effects of cattle-manure largely depend, is brought into a mehanical condition which renders it easy of incorporation in the soil. In the presence of a sufficient quantity of litter the loss of nitrogen is small. With insufficient litter the nitrogen of

the urine escapes in the form of ammonia, as can be readily recognised by the smell. The best method of preparing cattle manure is to house the cattle in a stall with a hard floor. allowing each animal a fair amount of freedom of movement so that it does not always urinate in exactly the same spot. On the floor of this stall litter should be spread and each day the droppings should be scattered evenly over the litter and a fresh layer of litter supplied for the cattle to lie on. If the litter is very dry, a sprinkling of water should be given at intervals before the new layer of litter is spread in the stall. At longer or shorter intervals according to the size and depth of the stall the manure should be removed to a pit and covered with earth. There it should stay until required for use. Thus, granted that the cultivator possesses cattle, his supply of the two of the ingredients is assured. All he needs is a sufficient quantity of litter to aid him in the conservation of the valuable nitrogen of the urine and to supply woody matter for the formation of humus. It is precisely at this point that the root of the trouble becomes evident.

The average cultivator, the man with a pair of working bullocks a cow or two and a she beffalo is usually insufficiently provided with fodder to feed all his animals properly. Further he is usually of the opinion that he cannot afford to purchase fuel. The procedure he follows is therefore this. He feeds his fodder first to his work cattle. What they leave he passes on to his cows or buffaloes and what they refuse he uses as fuel. In addition he usually makes no attempt to collect the urine his animals excrete. He is however usually more careful of the dung, which he collectes daily and consigns to the heap in which he puts his ashes and sweepings. Fortunately the dung dries quickly and therefore suffers little change before it finds its way to the land.

This procedure suffers from three grave defects.

(a) The number of stock kept is greater than the supply of fodder warrants.

(b) The refuse fodder is burnt.

(c) The liquid portion of the excreta is allowed to run to waste.

Consider these three points in turn.

(a) The usual argument offered in support of this position is that the animals which are in excess of the number required for work are kept for their manure. Were it the case that the liquid and solid excreta of these animals were used in rotting down quantities of litter this argument would carry some weight. As this is not the case the practice is indefensible. In the first place the quantity of manure obtained does not depend soely on the number of cattle kept. It depends also on the quantity of fodder fed. For example, suppose the amount of fodder on hand is sufficient to allow of four animals being fed at the rate of 15 lb. of fodder per head per day. If six animals are kept the quantity of fodder fed daily to each animal will have to be reduced to 10 lb. if the supply is to last an equal length of time. The amount of manure produced in each case is the same.

Secondly animals which are kept in a continuous state of semi-starvation are (a) of low value, (b) produce progeny which are of low value (c) do not breed regularly (d) when in milk do not produce sufficient milk to feed the calf and supply a reasonable surplus for household use (e) are more liable to succumb to disease if attacked than animals properly fed. They are therefore less profitable to keep than animals which can be fed properly. Here it may be remarked in passing that as in the case of cattle manure the quantity of good cow's milk produced is a long way below requirements. Fortunately the steps taken to remove the one defect can be made to serve in removing the other.

(b) Here we come into contact with the fuel question. Fuel is an absolute necessity. When the inability to purchase fuel is not real, it is false economy to burn refuse fodder. Weight for weight refuse fodder used as litter is more valuable than wood purchased for use as fuel. Where the inability to purchase fuel is real, the only real cure is to remove the disability. A way round the difficulty is for the cultivator to collect green leaf from waste lands for use as litter, or to grow some green leaf himself.

(c) There is no justification for this practice. Under the worst conditions it is possible to use earth as absorbant of

the urine. This is not as good as using litter but it is better than using nothing.

It is clear then that if the cultivator is to improve his supply of cattle manure in quality he must make some adjustment of his fodder cattle ratio, by increasing his supply of fodder or reducing the number of animals he keeps or by doing both. He must also adopt the practice of bedding down his cattle with litter and must arrange for an adequate supply of litter for this purpose. The position at which he should aim is the production of as much fodder as will allow him to feed properly his working animals and a few breeding stock and to provide sufficient litter for bedding. If he can eke out his supply of litter by collecting green leaf from waste lands or by producing it himself he will arrive at this position so much the sooner.

This problem, the problem of determining the best means of helping the cultivator to arrive at this position is by far the most important of the problems which confront the agricultural department. It is capable of being attacked directly and indirectly. The lines of direct attack may be classified as follows :—

1. Those concerned with the manure itself, e. g., proper methods of manufacture, use of green leaf as litter and earth as an absorbant etc.

2. Those concerned with the cattle themselves e. g., grading up of poor stock by using a bull of good strain and gradually replacing unprofitable animals by profitable ones.

3. Those concerned with the fodder crop e. g., use of better strains or varieties, better methods of cultivation including correct methods of dealing with pests and diseases, better methods of manuring and so on.

The lines of indirect attack are numerous. Every crop specialist who deals with a crop which is rotated with a fodder crop is a potential source of a means of indirectly solving the problem. Taking Cotton as an example, the lines of work being carried on are :—

1. The testing of varieties.

2. The production and testing of new varieties.

3. Investigation of better methods of cultivation, time of sowing, spacing, devising and trial of implements to reduce cost of cultivation etc.

4. Investigation of the best method of manuring.

5. Investigation of the best method of irrigating and of the optimum amount of water to be given.

All these lines of work are directed to one end and to one end only, viz., the improvement of the return per acre which the cultivator can obtain from his cotton crop. The uses to whtch this improvement, when obtained, may be put are of course various. But as an aid to the solution of the problem we have outlined this improvement would be most properly used as a lever to induce the cultivator (1) to purchase fuel and so set free litter and dung for the manufacture of good cattle manure or (2) to reduce his area under cotton and replace it by a fodder producing crop with the object of improving his fodder supply or (3) both.

At first then a reduction in the area under cotton as a result of an improvement in the return obtained from the crop, provided that it were accompanied by an increase in the area under fodder crops, in the appearance of the cattle and an increased production of cattle manure would be viewed with satisfaction. The increased production of cattle manure would if rightly used result in an increased return from all crops and in the end were it found the most profitable course to take a return to the original area under cotton would be possible.

As a concrete case take a holding of 20 acres in the black soils area af Tinnevelly, cropped with cotton and cereals in rotation, the cereals consisting of cumbu and fodder cholam in equal proportion alternating with one another. For such a holding one pair of bullocks is all that is necessary for cultivation purposes.

Fodder cholum will yield one ton of hay per acre i.e., 5 tons in all. Cumbu, apart from grain will yield ¾ ton of straw per acre or say 4 tons in all. 5 tons of hay will give 4½ tons of consumable fodder and ½ ton of waste useful as litter. The whole of the cumbu is best used as litter. This amount of hay, 4½ tons, is just sufficient to feed one pair of animals properly. The same amount of straw will provide litter for two pairs of animals. 2½ tons of litter plus 4½ tons of fodder consumed will give under loose box conditions 20 cartloads of good cattle-manure. A cart load is taken as 800 lb This is sufficient for an application of 4 cart loads per acre to one quarter of the holding. If all the litter is used 28 cartloads of manure will be obtained, sufficient for 7 acres at the same rate of application. If another 4½ tons of fodder could be produced another pair of animals could be kept and the amount of cattle manure produced could be raised to 40 cartloads, and one half of the holding could be manured every year. Under the climatic conditions which prevail over the greater part of this presidency an application of 5 cart loads of well made organic manure per acre every other year is reasonably adequate and is better than double the quantity applied once in four years. How is this extra 4½ tons of hay to be produced.

The procedure to be followed may be varied to suit the temperament and financial position of the cultivator concerned.

The first step is to persuade him to convert all his straw and waste fodder into good manure by using it as litter. He will thus produce 28 cart loads of good manure. He must in addition be persuaded to compost all his cotton stalks. This will give him a further 12 cartloads of good organic manure. He is now in a position to manure the whole of his cereal crop at the rate of 4 cart loads of manure per acre.

At the end of the first cropping season in which this quantity of manure is used, the yields of the cereal crops will have risen, cumbu grain by 10 per cent straw by 15 per cent and cholum hay by 25 per cent. He will thus obtain Rs. 4 per acre more from his cumbu grain, 4½ tons of

The Manuring of Cotton.

By

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Government Agricultural Chemist.

[Paper contributed to the symposium on cotton arranged by the Madras Agricultural Students' Union, for its Conference in July 1929].

The growth of cotton, as in the case of every other crop depends on the maintenance of the correct balance in the three agents, constituting the system, soil—soil solution plant.

It is the business of the Agricultural Chemist to study the several factors that contribute to the harmonious working of this system, ascertain how the one influences the other and to devise ways and means of correcting any abnormality and finally reduce his findings to a simple formula so that the cultivator can profitably work it with the means at his disposal.

He has to study the constitution and composition of the soil, the likes and dislikes and the whims and fancies of the plant that grows on the soil, how the nutrition of the plant and animal is influenced by soil conditions and how men and animals that live on the produce of the land can return to the soil a major portion of what they have taken. This, briefly stated, is the function of the Agricultural Chemist and the aim of chemical research as applied to agriculture.

Other conditions, such as climate, texture of the soil and its water relations being satisfactory, the two factors that contribute to increased production are (1) the quality of the seed and (2) manure. The introduction of improved varieties of crops will not in itself be sufficient. The fullest advantage from an improved seed cannot be realised unless it is aided by liberal and judicious manuring. I say judicious manuring, advisedly, because the conception of a manurial scheme should aim not only at improving the quality and the quantity of the resulting crop but it should be capable of reacting beneficially on the soil, the rotation and the live stock and finally the general welfare of the farmer. I shall, therefore, confine my attention to the subject of manuring Cotton.

With the establishment of Experiment Stations in the important cotton tracts of the presidency systematic field experiments began about the year 1910 but these were, however, of a diverse nature and of varied conditions. The results of these experiments were, in the light of recent experience, contradictory and inconclusive in many cases. They have, however, added much of value to our knowledge and indicate certain conclusions.

The direct application of manures, even of farm yard manure has had no consistent beneficial effect on cotton and has even resulted adversely in some instances. This was especially so in the case of rainfed cotton.

We are, thus, not yet in a position to formulate any definite schemes of manuring for a given set of conditions and foretell the result with any degree of accuracy.

With a view to find out the requirements of the cotton plant, its chemistry has been under investigatiou for six years now and covers a wide range. This is neither the time nor the place for a detailed discussion of these investigations, except by way of making brief references in so far as they are pertinent to the manuring of cotton.

A field study of the development of the cotton plant and the distribution of the mineral matter at different stages of its growth has shown that the production of dry matter by the plant occurs at an accelerated rate during the period of growth corresponding to the formation and maturity of bolls and that this accelerated growth is due mainly to boll formation and development.

The increase in the mineral content of the plant keeps pace with the increase in dry matter and an accelerated rate is evident also during boll forming period indicating a strong pull on the soil constituents. This pull is strongest on lime.

Nitrogen and potash seem to be most in demand during the early stages of growth, an accelerated demand for phosphorus coming later during the branching and flowering stages.

Lime accumulates in the leaves during the stages of flowering and the formation and development of boll, making its appearance in the flowers and young bolls. It

seems to be largely concerned in the formation and maturity of bolls.

The mineral nutrient requirement of the cotton plant is high and it is interesting to note that lime is absorbed in the largest quantity. This, perhaps, is why soils with high lime content are more suitable to cotton.

Seeing that the cotton crop is cultivated for the yield of kapas and that the plant has a definite partiality for lime, it being absorbed in lage quantities during the bolling stage, the formation and development of the boll is also under study.

In the early stages of boll development, a very rapid increase in the production of dry matter takes place in the boll. This coincides with the alternate accumulation of nitrogen and potash on the one hand and lime, magnesia and phosphoric acid on the other, the former set of substances always preceding the latter

The available evidence points to the direction that nitrogen and potash are utilised first in the development of the boll and that lime and phosphoric acid are subsequently used functioning, perhaps, in the condensation of the lower carbohydrates of the types of simple sugars found in young bolls, into the series of higher carbohydrates finally resulting in the form of lint in the matured and burst boll.

Analyses of young bolls, of bolls that burst too early and too late, as also of bolls burst normally on the plant and artificially in the laboratory, show that the composition of the seed, while varying greatly in its early stages attains a marvellous uniformity when the seed formation is complete. The wide variation in the composition of the immature seeds and of immature lints and the constancy in the composition of the mature seed coupled with the persistent variation in the composition of the mature lint would point to the direction that the surplus material after the formation of the seed is conveyed to or through the lint. The quality and the composition of the lint appears, therefore, to be determined by the surplus amount available after seed formation. The general trend of the experimental evidence is that the quality of the lint can be correlated with its lime and phosphoric acid contents. Analyses of lints of different lengths lend support to this view.

The effect of the different mineral constituents on the growth of the plant and the yield of kapas was next studied, in artificial *cum* solution cultures. In this study, the basal solution was so made as to resemble in composition and dilution that of the soil solution and the effect of the different constituents was tested by superimposing on the basal solution the constituent under test.

Name of solution.	Dry matter.	Kapas
Basal	5:75	2.17
do. N	9.28	0.64
do. P	5.88	Bolls shed
do. K	5.83	2.91
do. Ca	5.07	1.16
do. Mg	4.27	0.94
do. Ca plus P	6.47	3.97
do. Mg plus P	5.24	1.06
do. K plus P	4.54	1.06

In the basal solution the growth of crop and the yields of kapas may be taken as normal. Nitrogen has induced vegetative growth but depressed the yield of kapas while phosphate by itself contributed to the shedding of bolls. Lime by itself gave less than the normal but the combination of lime and phosphorous resulted in the largest yield of kapas. The next largest yield of kapas occurs in the solution containing potash.

The results of carefully controlled pot cultures with soil, are more or less, in a line with those of solution cultures in regard to the normal requirements of the cotton plant. Under field conditions, however, it is not such an easy matter to induce the plant to absorb the particular constituent applied to the soil. For instance, it was possible in solution cultures to apply lime and phosphate to the plant with beneficial results. Under soil conditions the direct application of these constituents resulted in almost the reverse effect.

An examination of soils and crop under differently manured conditions shows that the liberation of the different manurial constituents to the soil solution occurs in a series of base exchange processes.

Lime can be made available to the plant not by directly applying it but by the application of nitrogen in the form of ammonium sulphate or potash. Direct application of lime results in the withholding of potash to the detriment of the plant. The availability of phosphate is assisted by the application of nitrogen and likewise a sufficient supply of phosphates helps the use of nitrogen.

It is interesting to note that farm yard manure when applied to a soil controls the feeding of the plant to the best advantage as is reflected in the yields and analyses of kapas.

The findings of the Bio-chemical investigation may be briefly stated thus :—

(1) The physiological balance of the soil solution in which the cotton plant grows is of a very delicate nature and that the plant is easily susceptible to changes in the equilibrium.

(2) organic matter, especially farm yard manure assists considerably in the maintenance of this equilibrium by holding moisture and by inducing in the soil suitable base exchange reactions.

(3) apart from nitrogen and potash, the presence of lime and phosphoric acid are essential for the development of boll and the yield of kapas,

(4) it is preferable to make these mineral nutrients available by the ordinary base exchange reactions occurring in the soil than by direct applications.

We may now enquire how far this knowledge is capable of being put into practice.

A mature cotton crop is made up approximately, by weight of:—

Roots	....	5
Stem	...	24
Leaves	...	37
Bolls, flowers, buds etc.	...	34
Total	...	100

Lint forms about 7 per cent of the weight of the whole plant.

The bolls being the important item in a cotton crop, its manuring may be done to increase their yield in several ways

(1) The number of bolls may be increased, without at the same time affecting their average size;

(2) both the size and number of bolls may be incrased;

(3) the size of the bolls and the quantity of lint per boll may be increased.

Treatment.	Average bolls per plant.	%shed per plant.	Yield of kapas per plant	Yield per boll.
N	5.3	57	5.5	1.0
N plus K	6.0	44	7.1	1.2
N plus P	7.2	47	6.8	0.94
N plus K plus P	7.5	44	7.2	0.96
K plus P	7.9	40	7.7	0.97
K	5.0	50	6.4	1.3
P	5.6	53	6.8	1.2
Farm Yard Manure.	8.6	40	7.7	0.95

Farm yard manure has given the largest number of bolls and so the largest yield of kapas, but it has not increased the quantity of kapas per boll.

Potash by itself has given the largest yield per boll but has given the least number of bolls. Its combination with nitrogen is not very helpful, but with phosphate it does very well occupying a place next to farm yard manure.

Phosphate, by itself, has behaved similar to potash.

Combinations of nitrogen, potash and phosphoric acid, rank third in the order of merit

It is very probable that a larger number of bolls with increased content of kappas may be obtained by the application of artificials on dressings of farm yard manure. American experience in cotton manuring lends support to this view. It the manurial history of American cotton we find that the American farmer has had experiences similar to our own and he could increase his yields only when artificial fertilisers were combined with sufficiently large

quantities of organic matter, either in the shape of farm yard manure or green manure or cotton seed meal alone or together.

Organic matter, exemplified by farm yard manure or green manure, helps the growth of cotton in holding supplies of moisture, and so keeping the soil solution sufficiently dilute and also in encouraging the smooth running of base exchange reactions suited to the requirements of the plant.

Liberal dressings of manures before sowing the crop are undoubtedly necessary; we have seen, that the largest intake of nutrients occurs at the time when bolls form and mature. We have also seen the prominent part which phosphoric acid and lime play in the maturity of the boll. Knowing, as we do, that the application of potash liberates lime, it would be worth while testing how applications of potash and phosphate in a soluble form just before the flowering stage would result.

Direct application of artificial fertilisers has not been very helpful even with irrigated cotton. It is worse still with rainfed cotton as here, the crop growth is governed more by moisture conditions in the soil than by manuring and consequently application of manures will do more harm than good especially in years of scanty and uneven rainfall. The circumstances warrant investigation into methods of indirect manuring. A recent experiment, at Koilpatti by Mr. V. Ramanathan, in which he used. Ammonium Sulphate or Groundnut cake for a cereal crop in a cereal–cotton–cereal rotation shows considerable promise and should be tested on a more extended scale.

From every point of view, our greatest requirement is organic manure in sufficient quantity and of good quality. Research work elsewhere and the recent work of our department has proved beyond doubt the supremely important part which organic manures play in our agriculture. Leaving aside the question of exports—of oil seeds and the consequent loss to the country of oil cake, of fish manure and of bone meal—over which we have no control—we can still think of cattle manure and the composting of vegetable refuse to meet our needs.

Mr. Hilson has laid stress on the necessity of making farm yard manure of good quality and on the importance

of litter. I wish to further emphasise his statement by saying that if litter is used and the manure is allowed to ferment properly in the loose-box system, the total quantity of the manure as well as the important manurial constituents are considerably increased as will be seen below.

	percent increase on account of loose-box system over heap.
Dry matter ...	 62
Nitrogen	 100
Phosphoric anhydride (P_2O_5)	 70
Potash (K_2O)	 155

All these constituents are in a form in which they are easily but steadily available to the crop.

There is also experimental evidence to show that with a properly made loose-box manure the composition of the crop, especially of straw is improved in regard to its phosphate and potash content, which circumstance is beneficial to the nutrition of cattle.

		Straw from heap manure.	Straw from loose-box manure.
Paddy Straw	P_2O_5	0·16	0·23
	K_2O	1·97	2·66
Cholam Straw	P_2O_5	0·10	0·15
	K_2O	2·24	2·19
Cumbu Straw	P_2O_5	0·62	0·84
	K_2O	3·07	3·30

The use of litter in the manufacture of loose-box manure adds to the comfort and cleanliness. That it is so will be seen on inspecting a properly kept and managed loose-box. In addition to these obvious advantages, it is useful in several other ways.

(1) It increases the bulk of the manure.

(2) It renders the manure more porous and therefore, better able to absorb the valuable urine.

(3) It contributes to the production of a large amount of humus which plays a very important part in the absorption and base exchange reactions in the soil.

(4) Its porosity aud its absorptive capacity assist greatly in the fermentation of dung.

That litter is as important as the dung, will be seen from the results of certain recent experiments in which the dung was removed from a loose-box and in its place ground nut cake equivalent in nitrogen to that of the dung was put in. This was compared with complete loose-box manure on a series of crops.

	Complete loose-box manure.	Litter, urine, Ground-nut cake, =nitrogen of dung and ashes of dung.
1924 Chitrai cholam F. No. 60 A.		
Average of 4 repetitions:—		
Grain	1945	1950
Undried straw	10320	11740
1925 Fodder cholam F. No. 50		
Average of two repetitions:—	7760	6400
1927 Ragi F. No. 44.		
Average of 14 repetitions:—		
Grain	2342	2311
Undried straw	20485	20377
Fodder cholam (residual effect).		
Average of 14 repetitions.	23614	23554
1928 Ragi F No. 44.		
Average of 14 repetitions:—		
Grain	1678	1700
Straw	13493	14723

So then litter is an item of great importance in the production of farm yard manure either with or without the intervention of animals.

It is, therefore, necessary that fodder should be in quantities sufficient not only to meet the food requirements of farm animals but also sufficient to provide bedding for the animals.

In order to produce sufficient fodder and straw without if possible, unduly cutting down the area under other money crops, there appears to be one method and that is the intensive method of rapidly converting fertilisers into cattle food. In other words, it is the use of concentrated fertilisers on light dressings of farm yard manure in the

production of cereal and fodder crops. This system is advantageous in three ways :—

(1) The quantity is increased,

(2) the composition of the crop aud consequently its food value is enhanced, and

(3) there is the likelihood of residual effects on the succeeding crop in the rotation.

Here, then, we have a new angle of vision in looking at the economics of manuring cheap cereal crops like cholam, cumbu and ragi. In a balanced scheme of manuring it is not merely the range of profit and loss from the particular crop that is directly manured that counts, but the effect on the crops that follow in rotation and on the farmstead as a whole.

There need be no fear of the production of straw and fodder in excess of the requirements of the numbers of farm animals. The excess can always be converted into valuable manure either by putting it in the loose-box or by fermenting it separately without being fed to animals and convert it into what is called the " Synthetic Farm Yard Manure."

In spite of this, for some time to come, we shall still be producing farm yard manure natural or synthetic less than the demand. Consequently, the question arises, which is better ; to give larger dressings at longer intervals and thus restrict the application to a limited area in a given year or give smaller dressings at shorter intervals and thus give farm yard manure to a more extended area in a given year.

Seeing that very intensive oxidation of organic matter occurs in our soils, the latter method is to be preferred. As an instance in support of this view, we find that in a plot that has not received any manure for 20 years the amount of organic matter is found to be 1.93 per cent on the weight of the soil ; whereas it is only 2.62 per cent on the weight of the soil in a plot that has received 200 tons of farm yard manure in 20 years at the rate of 10 tons per annum.

Our position as to Cotton Pest Control in South India.

By

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(Paper contributed to the symposium on cotton, arranged by the Madras Agricultural Students' Union for its Conference in July 1929).

Introduction:—While the plant Breeder is engaged in evolving strains of Cotton that would give increased yields, and the Agriculturist in devising the best methods of tilth and nurture calculated to provide for them optimum conditions for growth, the Chemist supplies them with plant food best suited for producing the maximum yields. But the cotton plant, like many other crops, is subject to the attacks of various pests and diseases, which often take a heavy toll of the crop, so that the labours of the Breeder, the Chemist and the Agriculturist are liable to be greately wasted thereby. It is the function of the Entomologist and the Mycologist to study the various pests and diseases and devise measures for counteracting their injuring effects in the most economical and efficient way. It is the purpose of this paper to give a short account of the present position of the Entomological Section of this Institute in regard to the control of the major pests of Cotton in South India.

2. *The Important pests of Cotton*:—The list of pests of cotton so far noted in this province is fairly long, but fortunately the really serious pests are not many. Some of them are being mentioned below, grouping them for the sake of convenience according to the damage caused to the cotton plant,

Damage to the Seedlings:—Plants as they germinate may be eaten up and destroyed. In the red soil tracts of the the Deccan Districts, the red Hairy Caterpillar is often responsible for such damage and whole fields may have to be resown. A ground weevil is known to cause similar

damage in the Tinnevelly District, while surface grasshoppers are often responsible for a certain amount of such loss in most districts.

2. Damage to young plants :—Plants are liable to suffer from defoliation by various caterpillars, of which *Cosmophila erosa*, and *Laphygama exigua* are the important ones. They are also subject to attack by various plant lice, such as Aphids, Jassids and Mealybugs at this stage The Spotted bollworm and the Shoot-roller (Phycita infusella) attack the shoots and bring about the effects of topping. This delays boll formation.

3. Damage to Flowers and bolls :—Bollworms, of which 5 different kinds are known to be present in South India, appear when flowers and bolls are formed. The Red Cotton Bug also makes its appearance at this stage on the bolls in some seasons.

4. Damage by Stem-borers :—The Stem weevil is a serious pest in the southern districts of the presidency, viz. Salem, Coimbatore, Madura, Trichinopoly and Tinnevelly, but is not recorded either in Northern Circars or in the Deccan Districts. In the Ceded Districts *Sphenoptera gossypii* the stemborer bettle is sometimes present in serious numbers.

3. *Control Measures* :—A study of the habits and lifehistories of these Insects has to precede the consideration of control measures for them. Much of this has been done now, but in the light of experience that has gradually been accumulating, it is becoming clearer year by year that a close local study of particular pests is necessary in order that practicable remedies may be devised. For, insects have been known to exhibit a great deal of variation in their habits in reaction to different environmental conditions.

Unfortunately, however, the work of the Entomologist is commonly identified with the use of sprayers. Every ill that plants are subject to is expected to be cured by the direct administration of some "medicine." While direct frontal attack is certainly both effective and profitable in particular cases, there are conditions where such methods

are neither practicable nor useful. In the case of crops cultivated on an extensive scale like cotton, spraying, even if efficient, is under present conditions neither practicable nor economical; and a remedy is no remedy unless it is also an economic possibility.

Sometimes spraying in bulk presents side-issues for which we had not bargained. An instance of this kind was experienced two years ago while trying dusting expiriments against the Deccan Grasshopper pest of Cholam in Bellary District. While but few of the hoppers were affected by the dusts of Paris Green and Calcium arsenate used, more than 150 specimens of the common Ladybird were found dead in the small area under experimentation. Since the Ladybird is a potent factor in the control of Aphis, dusting on a large scale would undoubtedly have been followed by an epidemic of plant lice infestation. Such a case has recently been reported from the Southern States of the United States of America, where, as a check on the increase of the Cotton bollweevil, Calcium arsenate is being dusted with the aid of aeroplanes on a large scale. As a result it is stated that an epidemic of plant lice attack has in many instances followed In this case the multiplication of the aphis is supposed to have been caused by the destruction of certain small wasps parasitic on the Aphis.

Outbreaks of Aphis and Jassids, which sometimes occur, can be controlled by spraying, as has often been done on the Central Farm in the past, but spraying is not practicable on a large scale; very often such attacks are, perhaps, symptomatic of some defect in the nutritional or physical properties of the soil concerned, and may possibly disappear when these are remedied.

Again, Climatic conditions have a great deal to do in the incidence of pests, and there is much scope for study in this matter and a more definite knowledge is desirable. For instance, the heaviest attack of Stem-weevil at Coimbatore during reeent years, occurred in the season that followed the torrential monsoon rains of 1924, but it is not apparent how exactly the rains helped the increase of the pest. Again, Leaf Caterpillars appear in epidemic form on cotton in years when plants show an excess of vegetative growth owing to heavy rainfall.

The utilisation of natural enemies is a method which would appear to be of distinct promise in certain cases. For instance, in the case of plant lice infestation of young cotton, it may be possible to check it by the introduction in bulk of ladybirds collected by means of hand nets from some other older crops. *Possibilities of such biological control may come to light when each pest is subjected to a more intensive ecological study.*

In other cases, it is possible to avoid insect damage by simply changing the date of sowing. The prevalence of irregular sowings in the same neighbourhood is often a serious factor that favours insect multiplication. While in case a more or less uniform date of sowing is adopted in a locality, the insect even if present will be uniformly distributed among the crops, but where irregular sowings are prevalent, the insect will have opportunities of passing through two or more generations during the same season to the detriment of the late sown and the succeeding crops. If uniformity of sowings can be mad possible, incidence of pests may to a great extent be obviated.

4. ***The Pest Act and Cotton Pest control*** :–While it is certainly desirable that the factor of damage by insects should be entirely eliminated in the interests of the crops, it has to be admitted that absolute protection is an almost impossible feat and, if at all it is made possible, it would be only at a prohibitive cost. However, what is really wanted is protection from heavy loss. If, for instance, by adopting certain remidial measures, losses can be reduced from 50% 5% or even to 10% subject to considerations of economy, the relief obtained would be appreciated by the cultivator.

In the case of bollworms, the relative heaviness of loss would be dependent on the comparative proportions of the insect population to the number of bolls produced. If at the beginning of boll production, large numbers of bollworm moths are present, the crop will start with a heavy handicap and as the crop grows the insect population also increases and great losses will ensue. If, on the other hand, the crop can start with the minimum of infestation, there will be comparatively little damage. The object of the Pest Act

as enforced against Cambodia cotton pests has been to enforce the removal of cotton by a fixed date so as to arrange for a period of at least six weeks when there should be no cotton on the field, in order that the insects may be starved out, before the new crop comes in.

The Cambodia cotton was introduced two decades ago into the Coimbatore District and owing to the suitability of some of its soils to the cultivation of this cotton and also on account of the evident superiority of its *kapas*, this variety became very soon popular. As, however, on account of its robust growth, it was found to be able to stand on the ground continuously for two or three consecutive seasons, the ryots began to keep it as a perennial crop on the same field for two or more years whereas the country cottons are uprooted after one season. It became apparent very soon, however, that the kapas fell off rapidly in quality, and the Tiruppur Cotton, which had won for itself a name and reputation in the Bombay market during the previous 4 or 5 years, was in danger of losing it permanently. At this stage, the question was gone into by the Agricultural Department, and it was found that the cause of such falling off of quality was due in great measure to the facilities unconsciously provided by the ryot for the continued propagation of various cotton pests, especially the bollworms and the stem-weevil by his system of cultivation. Not only did the yields decrease, but also owing to heavy damage by the bollworms the kapas became deteriorated in quality. In seeking to remedy the situation, it was plain that a frontal attack on the pest by way of spraying with chemicals, was impracticable and costly. Since, however, it was more or less evident that the deterioration in the quality of the kapas was due to the continuous keeping of the crop on the same field for several seasons together, it was sought to remedy the situation by making it compulsory on the part of the cultivator to eradicate his crop by a certain fixed time, so as to create a definite "dead" season for cotton, when there should be no Cambodia cotton on the field serving as a food plant to any of the cotton pests. The pest act has been under enforcement in the Coimbatore District since 1919, and in the Salem, Madura, and Trichinopoly Districts since 1921 Till 1923 the date of enforcement was August, 1st;

but from 1924 it was changed to September 1st, in response to popular representation. It may, however, be observed that, in spite of the act being in force, in no year had all fields been cleared of cotton by the date notified; very often it was the second or the third week after the date fixed that the Pest Act Staff could send in their completion report. Consequently, the full period of six weeks, during which it was hoped that it could be arranged to have no growing plant left in the field, was never obtainable in most places. On the whole, it may be stated that the Pest Act has nowhere been given a fair chance to show its beneficial results; notwithstanding all these handicaps, however, there is ample proof that the enforcement has not altogether been without some effect. It has generally been acknowledged that within a year or so of its enforcement the quality of Cambodia cotton at the Thiruppur market showed improvement.

On the Central Farm, Coimbatore, the incidence of Cambolia cotton to attack by pests has been under very close observation since 1920. A field of Combodia is kept under observation during the whole season and weekly records of the degree of infestation of both green and dry bolls made. It has been noted that while the peak of infestation was noted to be about 90% in 1919, it became progressively lower year by year, until in the year 1925 it was only 20% and though it has somewhat increased since then it has not gone much above 30% (barring 44% in 1928 an exceptional case). While in the ryots' fields cotton is removed only at the end of August, it has been the general practice in the Central Farm during the last four or five years to have the cotton crop completely uprooted by the end of May or the beginning of June, but since the area of the Farm is comparatively but a drop in the ocean, considering the huge area of ryots' crops by which it is surrounded, striking results have not been noticeable.

It has to be stated, however, the results so far obtained under the defective enforcement of the Pest Act refer only to one of the pests, viz., the Pink Bollworm *Platyedra gossypiella* for, this insect lives only in the bolls of cotton, and since cotton produces its bolls only about two months

after sowing, it gets a fairly sufficient close period in spite of defective enforcement. But in the case of the Spotted Bollworm–*Earias* spp–and the Stemweevil–*Pempheres affinis*–the length of the dead season is absolutely insufficient. For, while the Pink bollworm functions only as a borer of fairly grown up bolls, and does not, moreover, attack any plants other than cotton, the Spotted bollworm is able not only to breed on numerous other Malvaceous plants, such as Hibiscus and Sida, but also attacks the shoots of young Cotton, on which it has the effect of stopping bringing about a set-back in growth and causing a considerable delay in the production of bolls. Again, the Pink bollworm, attacking as it does the seeds only of the more mature bolls, is a clean feeder which does not discolour or damage the lint, while the Spotted Bollworm is pre-eminently a gross feeder. It usually prefers the younger bolls, and not only are the tender tissues of the developing seed and lint eaten into, soiled and discoloured, but entry of the spores of various moulds is favoured bringing about boll-rot. Altogether, the spotted worm would appear to be the more serious of the two, though the Pink one is, perhaps, the more prolific. The Stem weevil is known to be able to live as an adult for over 5 weeks, and can breed even in young cotton, so that in the case of both this insect and the spotted bollworm, the present type of enforcement is evidently ineffective. There might be some effect if the close season could, instead of it being a mere make believe, be an actual reality and cover at least two months, but it has never been so as a matter of fact. While eradication has tended to extend to at least 2 weeks beyond the date fixed, there has been no provision to restrict the date of sowing, so that the duration of the dead season has been tending to become a vanishing quantity. But prohibition of the time of sowing before a fixed date is not under the present conditions quite feasible since for instance, as in the case of tracts dependent on rainfall the time of sowing must evidently depend on the actual receipt of rain of course, an uncertain factor. Experience on the Cotton Breeding Station, Coimbatore on the other hand, would appear to emphasise the importance of early sowing, for, during the past 2 seasons cotton sown by the first week of September was free from diseases,

such as black-arm, as compared with fields sown a month later, and gave about double their yields. The inference would appear to be that it is not wise to put a time-limit as to the time of sowing, and if it is desired to have a really long "dead period" the only thing to do would be to stop with the first picking and pull all cottons up, so as to prepare the land for a second crop. In fact, in the Avanashi area the more advanced ryots generally pull out their cotton soon after the first picking and prepare the land for raising a cereal; apparently they find it really profitable to do so Statistics carefully taken in the Cotton Station show that the kapas of the second or "kar" picking is mostly of inferior quality, since the plants are during this season specially subject to various pests and diseases, and being dependent on the receipt of good summer showers—always an uncertain factor the yields too are neither as heavy as the first season picking nor by any means certain. In these circumstances, therefore, it looks as if the procedure of the Avanashi ryot is based on hard commonsense and if his action could generally be followed, not only would the principle of providing for a definite "close" period for cotton be given a fair chance to show its results, but the ryot would have substantial advantages therefrom. For, if he gives a careful cultivation to his land, and sows the crop fairly early, he is sure to have a healthier and more vigorous crop, which even during the first picking will give yields that by reason of the superiority in the quality and the quantity of the kapas picked will counterbalance the loss of what may be reasonably expected to be secured in the second picking.

5. *Suggestions for Future Work* :—Although much of the pioneer work is now over, and a fairly comprehensive knowledge of the general conditions governing the increase of cotton pests has been obtained, there is still a great deal of ground to be covered before cheap, efficient and practicable methods of control for all the pests can be evolved. Each individual insect pest can yet bear a much more close and intensive study, not only from the purely entomological point of view, but also from that of the Botanist, the Chemist and the Breeder. An instance in point is the Cotton Stem weevil, on which very interes-

ting light has been thrown by the recent work of the Cotton Specialist and the Agricultural Chemist at Coimbatore. If further attention could be focussed on it from all points of view, I am quite hopeful that some practical results will be obtained before long.

Owing to the demands for emergent attention from other crop pests it has not been possible, during the past four or five years, to set apart hands for the intensive study of cotton pests. All that has been possible to do is the continuation of the weekly observations regarding bollworm attack on the Central Farm year by year, in order to check the actual effect of the enforcement of the pest act. In case hands can be set apart from the Cotton Commitee's funds for entomological work at Coimbatore, as contemplated a few years ago, and an intensive study of the various pests undertaken, I am full of hope that results of value will soon emerge.

The Diseases of Cotton in the Madras Presidency

By

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[Paper contributed to the symposium on cotton arranged by the Madras Agricultural Students' Union for its conference in July 1929].

PART I.

It is a matter of common experience that crops subjected to extensive and intensive culture are among those which are victims to the largest number of pests and diseases. The truth of this statement is in a large measure attributable to the great amount of attention bestowed by the scientist to the health of the plant by virtue of which all the pests and diseases which occur on the crop are recorded and studied At the same time the fact cannot be denied that man's intervention in the natural development of plants and his unscrupulous exploitation of their resources renders them more susceptible to the inroads of insects, fungi, bacteria, etc.

The Entomologist who preceded me has given us a very interesting, though pathetic, account of the heavy losses caused by insect pests-indigenous and imported-to which the cotton crop is subject in our presidency. It is seldom that the plant pathologist lags behind the Entomologist in reciting a similar tale of woe, but in the case of cotton it is the peculiar good fortune of the pathologist to be so privileged. The number of cotton diseases occurring in India are not as numerous as the intensive study of the crop in the past would warrant, and those which are of economic importance to the cotton grower in South India are fewer still. As a result of this remarkable scarcity of important cotton diseases in our province, research on cotton diseases has not in the past loomed large in the

mycologist's annual programme of work. The only disease on which some intensive work has been done in Madras during recent years, is a seedling blight and boll-rot of the Herbaceums an account of which is given in part II of this paper.

Before I venture to enumerate and give an account of the diseases of cotton which are of some importance to us in South India, it would be worth while to analyse the causes that have led to the comparative freedom from diseases which the cotton crop in our presidency enjoys.

Firstly, it is an almost universal practice in this province to rotate cotton with a cereal like cholam or cumbu. This is a very commendable agricultural practice which satisfies the first principle of plant sanitation and hence has a very far reaching effect in the control of diseases. I do not for a moment attribute this practice of crop rotation to any acute development of the pathological sense among the agricultural classes, since its observance is merely the outcome of an economic necessity. The owner of a small holding in a cotton tract is obliged to raise at least one cereal crop which provides food for himself and fodder for his cattle, while his cotton functions as a remunerative money crop which provides him the where withal to purchase his other necessaries of life.

Secondly, the climatic conditions under which cotton is grown are ordinarily unsuitable for the promiscuous development of fungi and bacteria. Cotton is essentially a dry weather crop. Sowing is done during August-September in the northern districts and October-November in the southern districts so that the period of growth falls in a dry season characterised by low humidity relieved only by an occasional shower of rain.

Thirdly, the cotton plant, though a perennial in its wild state, is usually cultivated as an annual. The major crop is borne during the first six months and it is seldom remunerative to keep the crop going in order to produce a second and subsequent flushes. If the plants are pulled out immediately after the first crop is harvested, there is an interval between one crop and another during which the land either lies fallow or is sown to some other crop. In

either case, the parasites are necessarily starved out for want of their favourite host plant. It may however be mentioned in this connection, that there is a growing tendency in some cotton tracts, to prolong the duration of the crop with a view to produce a second flush. The interval between two crops of cotton is thus reduced to as low as a month or even less, with obvious evil results. The Cotton PestAct primarily designed against two insect pests did go a long way to discourage this baneful practice being carried to the extreme. But the relaxation of the act in recent years is a retrograde step in as much as it unduly shortens the off-period between two cotton seasons with the result that pests and diseases are assisted in bridging the gulf between two seasons.

Fourthly, the practice of pulling out the crop by the root, collecting the stalks and utilising them for fuel fulfils the requirements of another important axiom of plant sanitation. Here again we have an instance where an economic necessity has turned out to be a virtue of far reaching consequence and perhaps with few parallels in any system of agriculture. The practice now slowly gaining ground in some places, of composting the pulled out cotton stalks, is one which deserves special encouragement. This process not only supplies a valuable bulky organic manure which returns to the soil practically all the ingredients taken out of it, but also aids in clearing the field of the diseased material and possibly helps their destruction by the heat evolved in the chemical changes occurring in the pit.

Fifthly, we have under cultivation several species and varieties of cotton which exhibit among themseves a wide range of variation in their susceptibility to particular diseases As for example, I may mention the total immunity of Cambodia (*G. hirsutum*) and Karunganny (*G. indicum*) to the seedling blight and boll disease caused by *Colletotrichum sp.* while Uppam (G. herbaceum) is extremely susceptible to the disease.

Lastly, the discontinuous geographical distribution of the cotton tracts of the presidency, the suitability of different varieties for different areas and the differences in soils and seasons are bound to remain effective barriers in the natural spread of the diseases from one tract to another.

From a review of the several reasons adduced above, it is apparent that barring a few notable lapses, there obtains in our system of cotton culture several agricultural practices which are highly commendable from the Plant Pathologist's point of view. As I already stated, many of these practices are the products of certain economic factors inextricably associated with the rural life of our ryot population. Whether they can be classed as the result of accident or of a well planned design handed down from generation, the cumulative effect of the several beneficial practices is a comparative freedom of the cotton crop from epidemics which other tropical crops of similar importance seldom enjoy. Conversely, we are reminded that the adoption of rational agricultural practices constitutes a sounder insurance against diseases than the maintenance of disease gangs and spraying outfits and of the truth of the old maxim "Prevention is better than cure."

PART II.

In the second part of this paper, I shall attempt to give a short account of the chief diseases of the cotton crop in this presidency.

(1) *Wilt* By far the most important cotton disease in India is "Wilt". There are two wilts of cotton known in India. The wilt familiar to the north and central Indian cultivator is practically unknown in Madras This disease which is associated with a Fusarium and is allied to the American wilt, has been the subject of some acute controversy among two schools of mycological workers in the north. Whatever be the real cause of this disease, it causes a considerable amount of loss in central and western India, but we in the south are fortunately free from its depradations, and our only concern is to hold a vigilant look out for preventing its importation into our province. The other wilt which is of common occurrence in our cotton fields is caused by *Rhizoctonia bataticola*, a fungus which has a cosmopolitan host range, included in which are groundnuts, castor, cow pea, black gram, jute, etc. The disease is of common occurrence in the Cambodia crop, but stray cases have been noticed on Uppam and Karunganni also. Cotton is susceptible to this wilt first in the seedling stage when it

is capable of killing the seedlings outright It assumes serious proportions only under unfavourable conditions, e. g., water logging caused by poor drainage. Plants which survive this stage remain practically free during the active growth of the plant until the major portion of the crop is harvested, when the weakening caused by heavy cropping renders them again susceptible to the disease. Unlike the north Indian wilt, the loss from this disease has never been known to reach alarming proportions. Good cultivation, rotation of crops and attention paid to the proper drainage of the fields are known to keep this disease under control.

(2) *Angular leaf-spot 'Black arm' and 'Stem flattening*. Another disease which is sometimes a serious menace to cotton cultivation in some parts of the presidency is the 'Black arm' and 'Stem flattening' It is caused by a bacterium *(Pseudomonas malvacearum)* which produces lesions on the leaves, branches and the main stem. On the leaves it produces angular leaf spots but the loss from this form of the disease is negligible. On the primaries and secondaries the organism causes a condition known as 'Black arm' which causes the breaking of the branches and the consequent loss of crop. An organism indistinguishable from the 'Black arm' bacterium causes a peculiar disease in South India, known as stem-flattening. It occurs on the main stem ordinarily below the point of primary branching. The disease begins to appear about 3 months after sowing. The first visible symptom is a black band round the stem. The bark usually remains intact, but occasionally splits lengthwise in the discoloured area. The next stage is the gradual flattening of the stem. The leaves now ture pale or red in some cases The plant sheds its leaves and begins to show signs of wilting.

Nothing more than a cursory study of this disease has been possible in South India. The disease begins sporadically during abnormally heavy rains and during such periods the damage is considerable. Being of bacterial origin this is one of the important diseases awaiting investigation by a pathological Bacteriologist.

(3) *'Seedling blight' and 'Boll-rot'*. A disease which has come into prominence in some parts of the Coimbatore

district is the 'Seedling blight' and 'Boll-rot' caused by a species of Colletotrichum. Though this disease resembles the well-known 'Anthracnose' caused by *Glomerella* (*Colletotrichum*) *Gossippi*, it differs from the latter in several important details. The disease appears during two stages of the crop First it occurs in the seedling stage when it attacks the cotyledons and the hypocotyle, in the latter case causing damping off Seedlings which servive the attack exhibit a condition known as 'Sore-shin' which is but a healed up canker of the phloem of the tender stem. It is essentially a wet weather disease and when normal sunny weather returns, those plants which survive the attack completely throw off the disease The next stage in which the crop becomes susceptible to attack is the fruiting stage when bolls in all stages of development may be attacked On the bolls, the disease appears on the exposed surface starting either at the apex or the base. The first sign of infection is the formation of a small pinkish brown irregularly circular spot. As the infection progresses, the discoloured area extends, becoming dark grey in colour with the formation of several concentric rings of black pwstules. When young bolls are attacked, they cease to grow, get hardened and fail to burst. The lint inside gets lumped up and is stained yellow. When partially mature bolls are attacked, they burst normally, but the lint is rendered brittle and does not protrude from the locks. Black pustules which are the acervuli of the fungus develop on the kapas and within the lint also Seeds formed within infected bolls are generally poorly developed and show poor germination. Recent researches into the life history of this fungus have shown that the fungus is capable of hibernating within the seed coats of apparently healthy seeds.

Climatic factors. As in the case of the seedling blight caused by the same fungus, the progress of the disease is governed by high ranges of humidity and synchronises with humid damp weather. The disease appears in epidemic form during prolonged rainy weather the damage depending on the extent of the period during which wet weather prevails. With the return of normal sunny weather, the fungus stops development and fresh attacks cease to occur.

Control. The disease is strictly confined to the Herbaceum cotton, and at present it is known to occur only in parts of Coimbatore district. As the disease is carried though seed, the selection of seed forms an important preventive measure. If the disease appears during the seedling stage and weather conditions are favourable to its spread, one or two sprays of Bordeaux mixture will keep it in check. The same operation may be carried out with satisfactory results in the fruiting stage also.

Minor diseases—(1) Macrosporium sp. Among the minor diseases which have not merited serious attention so far, the chief is a leaf spot caused by Macrosporium. The fungus appears on the cotyledons of seedlings and should favourable weather conditions exist, it spreads to the foliage leaves causing their shedding. The disease has been observed on Cambodia, Uppam and Karunganny. Spraying with Bordeaux mixture has been tried against this diseas with success.

(2) *Ramularia areola* Another disease which is occasionally come across is Ramularia leaf spot. The disease was till recently observed only in the northern area, but it was recently reported on Cambodia in the Central Farm. It occurs chiefly on the old leaves as the plant reaches maturity and as yet, has never been found to produce any appreciable damage, to necessitate any treatment.

(3) *Rust (Kuehneola desmium)*. This is another fungus recorded on cotton in South India also, but beyond its merely academical interest, it has never been recognised as a disease of the cotton crop in this country. It occurs on the leaves and green stem and has a partiality for the unacclimatised exotics and the perennial tree cottons while the annuals are practically free from it.

Before I conclude this paper I wish to take this opportunity to make an appeal to all the agricultural officers who are working in the cotton tracts to make it a special point to collect and send as much information as possible regarding any cotton diseases occurring within their jurisdiction and to assure them that all information so furnished to the Mycologist will be of immense value in supplementig our present knowledge of cotton diseases and in keeping a vigilant look out on the progress of those diseases in this presidency.

Students' Corner.

GENERAL.—The second and third year students entertained the new students at a tea-party in the last week of July, when most of the members of the teaching staff including the Principal were present. Several of the senior students and members of the staff addressed the new students.

GAMES.—It is gratifying to note that among the newly admitted students this year, there are many highly proficient in games. No less than five have been taken in the foot-ball team. There are several good acquisitions to the Hockey and Cricket teams also. Two days have been made compulsory games days in the week, and the tutors are now taking greater interest in their wards as the students are divided into batches according to their tutors for attending to games on these days

FOOT-BALL —Our College team competed for the Abraham Memorial Foot-ball Tournament in the second week of this month, and met in the first round the Medical School team Though both teams were well matched our team won by one goal. In the finals our team met the London Mission High School team our old rivals on the 12th, and our team consisting of really good players, failed to press hard effectively due to lack of sufficient practice. The school team did not appear to be as strong as it was last year, when it yielded the cup to us and all the same the match ended in a draw. It was replayed on the next day when a more brisk game was witnessed, but as ill-luck would have it, we lost narrowly by one to two, the deciding goal being scored in the last minute.

CRICKET —The matches in connection with the local Cricket tournament commenced this month the games being played under the points system. Our college played with the Stanes High School in the first instance, but fared badly. In the second match with the Gymkhana team, better luck prevailing, our team scored brilliantly 245 for only four wickets down Mani made more than a century and Thomas unusually more than half a century. The Gymkhana were able to make up just over 200, mainly due to Baskara Rao, for five wickets.

Departmental Notifications.

GAZETTED:—

Mr. R. D. Anstead, Director of Agriculture, leave on average pay from 1-9-29 for 6 months and 20 days and in continuation leave on half average pay up to and inclusive of 1-6-1931. Mr. G. R. Hilson to officiate as Director Mr. D. Munro, Deputy Director of Agriculture leave on average pay for 8 months from 23-9-29 and leave on half-average pay for one month in continuation. Mr. M. Ananthan, Assistant Paddy Specialist Pattambi leave on average pay for 2 months from date of relief. Mr. C. R. Srinivasa Ayyangar, Assistant Paddy Specialist, extension of leave on half average pay for 21 days from 3-8-29. Mr. R. Chockalingam Pillai, Assistant Cotton Specialist, leave on average pay for 15 days from 10-7-29. Mr. B. Ramayya, Deputy Director of Agriculture, Guntur, leave on average pay for one month from 9-9-29. Mr. V. Ramanatha Ayyar Assistant Cotton Specialist, to officiate as Cotton Specialist in a temporary post created in the Madras Agricultural service from date of taking charge. Mr. V. K. Subramanya Mudaliyar. assistant, to act as Assistant Cotton Specialist. Koilpatti from date of taking charge.

NON-GAZETTED :—Appointments, promotions, transfers etc.—

The candidates named below are appointed in the agricultural section as Upper subordinate on probation from 19th August 1929:—Mr. G. Ranganathaswami to Samalkota; Messrs A. H. Subramanya Sarma and K. H Subramanyam. Live-Stock section Hosur; Messrs P. Govindakuttikurup and K. Raman Menon to Curator's office, Ooty; Messrs M. P. Narasimha Rao and J. Suryanarayana to II circle Guntur; Messrs K. Sanjiva Shetty and M. Jivan Rao to III circle Bellary; Messrs P. Venkatasubramanyam and C. Annamalai to IV circle St. Thomas Mount Mr. T. N. Balasubramanyam to V circle Trichinopoly; Messrs M. Kalimuttu and A. Ramados to VI circle Madura; and Mr. S. Ramaswami to VIII circle Coimbatore Mr. T. S. Sundaram to be temporary Upper subordinate in the VIII circle Coimbatore and Mr. M. Somayya to officiate as Upper subordinate III circle Bellary;

The candidates named below are appointed as Upper subordinates in the Science section on probation from 19th August 1929:— Mr. P Seshadri Sarma to Millets Specialist's section; Mr. K. Kunhikannan Nambiyar to Paddy Specialist's section; Messrs T. V. Rangaswami, S. Sundaram and M. Ramayya Shetti to Cotton Specialist's section; and Mr. P. S. Krishnamurthi to Entomologist's section Messrs T. K. Mukundan and N. K. Thomas to be temporary Assistants in the Entomologist's section from 19 August 1929.

The following provisionally substantive promotions are ordered in the Upper subordinate service Science section with effect from 17th July Mr. T. S. Ramasubramanyam to II grade; Mr. G. Ganapathi Ayyar to III grade and Mr. C. V. Sundaram Ayyar to IV grade. Mr. G. L. Narasimha Rao assistant demonstrator from III to II circle Mr. S. S. Katchapeswara Ayyar from VIII circle to District work in the Nilghiris district from date of relief; Mr. K. Krishnan demonstrator Trichi is posted to Perambalur.

Leave etc :—III Circle :-Mr. P. V. Ramana Assistant demonstrator Markapur, leave on average pay for 8 days from 24-8-29; Mr. G. L. Narasimha Rao assistant demonstrator, Kurnool leave on average pay for 1½ months from 27-8-29.

VII Circle :—Mr. T. Gopalan Nayar demonstrator, leave on average pay for 10 days from 5-8-29.

VIII Circle :—Mr. K. Avadanayakam Pillai, demonstrator, leave on average pay for 8 days from 10-8-29.

Live Stock :—Mr. F.L.J. Lobo assistant Manager extension of leave on average pay for 5 days and leave on half-average pay for 2 months and 25 days.

G. E's section .—M. E. R. Gopala Menon assistant leave on average pay 2 months and 15 days from 15-8-29 Mr. M. S. Kylasam Assistant leave on average pay for 15 days from 19-8-29.

P. S's. section :—Leave of one month granted to Mr. Saravayya Assistant Maruteru is cancelled.

The Ramasastrulu-Munagala Prize 1930.

1. The Prize will be awarded in July 1930,

2. The Prize will be in the form of a Medal and will be awarded to the member of the Union who submits the best account, of original research or enquiry, carried out by him on any agricultural subject.

3. The subject matter shall not exceed in length twelve fools-cap pages type-written on one side.

4. Intending competitors should notify the Secretary of the Madras Agricultural Students' Union not later than the 15th May the subject of the paper which they propose to submit and the paper should be sent in so as to reach the Secretary, Madras Agricultural Students' Union not later than the 1st June 1930, with a covering letter showing full name and address of the sender. The authors. name should not be shown on the paper which should be entered under a *nom-de-plume.*

5. Four type written copies of the essays should be sent in.

6. The name of the successful competitor will be announced and the prize awarded at the time of the Conference,

7. The Union reserves to itself the right of publishing all or any of thepapers.

8. All references in the paper to published books, reports or papers by other workers must be acknowledged.

9. Papers submitted will become the property of the Union.

Any further particulars may be obtained from the Secretary Madras Agricultural Students' Union, Lawley Rd. P. O. Coimbatore