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EDITORIAL

Manures. The central purpose of agriculture is the feeding of plants so that the plants and their products may benefit mankind. Manures, therefore, play a very important role in agriculture. It is well known that the crop yields in India are very low. The average yield of rice in India is about 825 lb. per acre, but in Spain only one seventh of an acre is required to produce the same quantity. In the Netherlands, 2,700 lb. of wheat is produced per acre against 630 lb. in India. The yield of sugarcane in Hawaii is 56 tons to an acre, but in India the average is only 16 tons. To produce 81 lb. of cotton lint, India must sow an acre of land, whereas in Egypt about one fifth of an acre will suffice. That it is possible at least in some cases to increase the crop yields in India is evident from the fact that the yield of rice has been raised in the Central Farm, Coimbatore from about 2,000 lb. to about 4,000 lb. during the course of the last fifteen years.

From a number of experiments conducted in Madras, it is found in general that farm yard manure, green manure, oil cakes, ammonium sulphate and to a less extent phosphatic fertilizers, influence the yields of crops. The response to the application of cattle manure is marked in dry crops and in some of the garden crops. Green manuring has succeeded well with paddy. Oil cakes have proved useful for sugarcane. Ammonium sulphate has been found beneficial particularly to paddy and sugarcane, and it produces excellent results when it is applied as a top dressing over a basal dose of cattle manure or green manure. Super-phosphate or bonemeal when applied alone has been of practically no value, but when it has been supplemented with organic manures or nitrogenous fertilizers, plants have responded to it. Thus organic manure is a vital need practically in all tracts of our presidency and should be the basic manure. Special deficiencies of nitrogen and phosphoric acid can be made good by other artificials, the application of which is likely to be profitable only in the case of irrigated crops or under conditions where soil moisture is not the limiting factor.

The low prices of farm produce necessitate that manures and fertilizers shall be used critically and with economy. The farmer has to consider what crops will repay any expenditure on fertilizers, and the limits of their profitable use. The cheapening of the manures and the fertilizers would, therefore, be a step in the right direction. Greater supplies of organic

manures are the primary necessity in a tropical country like ours. Apart from the measures for the proper conservation of cattle manure and the manufacture and utilization of poudrette, which are now increasingly adopted, the production of larger quantities of green organic matter demands our earnest attention. Public opinion is now crystallizing in favour of the policy of afforesting waste lands. The planting of trees on road sides and bunds has to be pursued with great vigour. Adequate provision should also be made for the proper care of the trees after they are planted, else the enthusiasm may wane, and the trees might altogether disappear. In many of our districts the paucity of trees is so great that few trees would survive without proper care and watch.

Though the practice of green manuring existed here and there, it is chiefly due to the activity of the agricultural department that this practice is now becoming universal for paddy lands. There is scope for the introduction of superior types and strains of green manures.

It is desirable to make a collection of all the plants that are used in different parts of the world as green manures. Such a collection exists at the Experimental Garden, Buitenzorg in Java. Throughout the world about 375 leguminous species of plants, shrubs and trees are utilized for green leaf and green manuring.

The problem of manuring dry lands has received so little attention even though over seventy per cent. of the area is rain fed. This is no doubt partly due to the fact that when water is the limiting factor, intensive manuring of dry lands becomes unremunerative. In moist climates, nitrogenous fertilizers increase the size of the leaf and the usual consequence is greater yield. Even though the efficiency of the plant as a user of water increases, the plant transpires, on the whole, more water. For dry lands, slow acting bulky organic manures like cattle manure and composts of waste material are more suitable. Green manuring of dry lands is the most difficult proposition in Madras, as it would necessitate foregoing a crop once in three to five years. The size of the average holding in Madras is small, the pressure on land is great, and the risk of the failure of the season is such that the cultivator cannot afford to include in his rotation a green manure crop. His endeavour is to produce a remunerative crop every year so that he can subsist. Near Coimbatore and in Gujerat there is the practice of leaving lands under grass for a few years so that it recuperates, and incidentally some fodder is also obtained. The roots and the stubble increase the humus content of the soil. The discovery of a suitable leguminous fodder for this purpose would be an advantage.

We have not only to face the deficiency of the supplies of organic matter, but we have also to depend to a large extent upon the foreign supplies for artificial nitrogenous fertilizers, the consumption of which is fast increasing. We invite the attention of our readers to the series of articles in this journal on the manufacture of synthetic nitrogenous fertilizers in India.

Dr. Acharya has shown that India imports annually about 80,000 tons of nitrogenous fertilizers valued at Rs. 8 crores, and that there is every justification for taking necessary steps for the manufacture of synthetic nitrogenous fertilizers in this country. The industrialists will no doubt very carefully consider the question of starting plants for the fixation of atmospheric nitrogen. Every important country of the world is endeavouring to be self sufficient in the matter of nitrogen fertilizers.

It is well known that the effectiveness of nitrogenous fertilizers varies according to the crop, season and management. Between one farm and another there is variation, and the variation between region to region is still more. A large number of field trials must, therefore, precede extensive use of artificial fertilizers. In the initial stages, serial experiments embracing a very large number of places seem to be called for. On the basis of these results, it may be possible to fix representative centres for further trials. The results can be also correlated with the climatic and soil conditions. Such experiments have been conducted in U. S. A. on cotton.

In most of the advanced countries, the financing of fertilizer purchases is considered to be a primary function of agricultural banks and co-operative credit societies, and there is even subsidized manuring as in Rhodesia and England. In Spain and Japan they apply for rice, 60 to 80 lb. of nitrogen, and 50 to 60 lb. of phosphoric acid per acre, and the bill for fertilizers exceeds Rs. 50 per acre ; but in South India where soils are only one tenth as fertile as in these two countries, it is normally difficult to expend more than Rs. 10 to 15 per acre towards manures. Credit facilities for the purchase of manures would facilitate larger application of fertilizers, and this is very essential particularly for crops like sugarcane, coconut, arecanut, betel leaf and plantain.

MANUFACTURE OF SYNTHETIC NITROGENOUS FERTILIZERS IN INDIA

Part III. Processes for the Synthesis of Ammonia

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It has been mentioned in Part II of this series that the synthetic process for ammonia was first worked out on a commercial scale in 1913 by Haber and Bosch and plants were erected at Oppau and later at Leuna (Meresburg) in Germany to carry on the process on a large scale. These two factories, between them, are now equipped to fix nearly a million tons of nitrogen per year. The working details of the Haber Process were kept a close secret even after the close of the War, but the principles underlying it were successfully developed into commercial practice independently in other countries, e. g. in America, France, Italy and England. The chief of these modified processes are those of Claude (France), Casale (Italy), Fauser (Italy), Mont Cenis (Germany) and F. N. R. L. (U. S. A.). The main differences between these methods lie in :— (a) the source from which hydrogen is obtained ; (b) the method of separating oxygen from the nitrogen of the air ; (c) method of purifying hydrogen and nitrogen ; (d) nature of catalyst used ; (e) temperature of reaction ; (f) pressure employed ; and (g) method of removing ammonia from the system.

Some of the main technical differences between these methods are shown in Table I.[1]

TABLE I. Comparison of Synthetic Ammonia Processes.

Method.	Pressure atm.	Reported Tem. °C	Reported conversion maximum %	Recirculation of unchanged gases.	Catalyst.
Mont Cenis	100	400	40	Yes	Iron Cyanide Complex.
Haber-Bosch	200	550	8	Yes	Iron granules "promoted"
Fauser	300	500	12·5	Yes	Do.
F. N. R. L.	300	475	30	Yes	Do.
Casale	750	475	40	Yes	Do.
Claude	900	600	40	No	Do.

The world installed capacity for direct synthetic ammonia production was distributed in 1934 among the several processes as follows :— Haber-Bosch 35·2% (mostly in Germany), Casale 14·9 (in France, Italy, U. S. A. and Japan), Fauser 11·9 (in France, Italy and Netherlands), Claude 9·4 (France and U. S. A.), Imperial Chemical Industries 8·5 (England), Mont Cenis 8·0 (Switzerland), Nitrogen Engineering Corporation 6·5 (Norway and U. S. A), General Chemical Co. 6·2 (U. S. A.), F. N. R. L. 2·0 (U. S. A.).

The above processes can be grouped broadly into two classes :— (1) those which work at low or moderate pressures, and (2) those which work at high pressures. To the former class belong the Mont Cenis, Haber-Bosch, Fauser and F. N. R. L. systems ; and to the latter class belong the Casale and Claude processes.

The advantages of working under high pressures are :— (1) the capacity to handle more material in a given reaction space, compared with processes using low pressures (thus " convertors " of about 25 inches diameter and 12 feet height can synthesise 30 tons of ammonia per day in the high pressure system, as compared with the Haber-Bosch " converters " of diameter 4 feet, height 20 feet and walls 7 inches thick. (2) Higher percentage conversion. Thus, the Claude and Casale processes achieve 40% conversion into ammonia, against 8% obtained in the Haber system. The Mont Cenis is, however, an exception, since it obtains the same high degree of conversion even though it works at 100 atmospheres pressure only. This is due to the very active Iron-cyanide complex which is used as the catalyst. (3) The ammonia formed by high pressure synthesis can be directly liquefied as anhydrous ammonia, whereas in the low pressure systems, it has to be absorbed in water to form dilute ammonia and later distilled again.

The disadvantage of working under high pressures is the extra chance of accidents and the necessity for using very durable and highly resistant metal for the conversion chambers. To obtain such resistant material which would work satisfactorily at moderately high temperatures below 500°C is easy nowadays. The case is, however, different when high pressures are combined with high temperatures, as in the Claude process, where pressures of 900 to 1000 atmospheres are combined with temperatures above 600°C. Ordinary types of resistant steel break down under these conditions. The practical application of the Claude process was delayed for a number of years, till a satisfactory type of metal could be manufactured, suitable for the purpose. At present a special alloy of nickel, chromium, tungsten and iron is used and has been found to work satisfactorily.

The use of such special alloys, in addition to increasing the cost of the plant, raises certain important issues, e. g. as to whether it will be possible to prepare such resistant alloys in the necessary quantities in this country in times of need, should the foreign supply be cut off. It would, obviously, be wise to adopt a process which would incorporate the advantages of high pressure synthesis without rendering the use of such super-resistant metal quite necessary.

From this point of view, the Casale Process has many points in it that commend themselves to our favourable consideration. It works at about 475°C and does not require the special resistant alloys needed for the Claude plant. Moreover, the " promoted " iron catalyst can be prepared in this country itself. The method incorporates all the advantages of high pressure synthesis and has been adapted to work on electrolytic hydrogen, for which purpose special types of efficient batteries have been devised.

Before going further into the choice of a final technique, we shall consider in more detail the economics of the different methods of obtaining hydrogen and nitrogen. It has been estimated that as much as 70 to 75% of the total cost of production of synthetic ammonia is involved in the preparation and purification of the 3 : 1 mixtures of hydrogen and nitrogen, required for the purpose. It is, therefore, obviously of importance to consider which of the present methods in vogue are the most economical under the conditions existing in this country.

Of the two components, nitrogen and hydrogen, the cost of production of nitrogen is almost inappreciable, compared with the cost of production of hydrogen. Thus, for fixing one ton of nitrogen, the volume of nitrogen gas theoretically required is about 28,750 c. ft. at N. T. P., which can be produced at a cost less than Rs. 5 including depreciation on machinery; but the cost of production of the necessary amount of hydrogen, say about 90,000 c. ft., may easily go up to Rs. 200 or more.

The important sources for commercial hydrogen are:— (1) Water Gas; (2) Coke Oven Gas; (3) Electrolysis of water; (4) Steam-iron reaction; (5) By-product hydrogen from the production of chlorine, fermentation processes etc.; (6) Natural gas. Of these sources, Nos. 5 and 6 are not available at present in large quantities in India; and method 4 is not cheap, since the reaction between steam and iron comes to an early equilibrium and, moreover, the ferric oxide formed has to be reduced again. Methods, 1, 2 and 3 are the ones generally adopted on the large scale, and the extent to which they have contributed to the supply of hydrogen for the production of synthetic ammonia, is shown in Table II.[3]

TABLE II. Sources of Hydrogen for the production of ammonia.

Source.	1926–27	1933–34
	%	%
1. Water gas	89·0	57·0
2. Coke Oven gas	3·0	25·0
3. Electrolysis of water	6·4	16·0
4. Other sources:— e. g. by-product hydrogen from brine, fermentation etc.	1·6	2·0

Of the sources 1, 2 and 3, source 2 (coke oven gas) is available only in Bihar and Bengal, since there is no coking industry in other provinces of India. Hence, for the other provinces, the alternative is between sources 1 and 3, viz. water-gas or electrolysis of water, as the source of hydrogen.

In the Haber-Bosch process, a mixture of water-gas and producer gas is used. The approximate composition of these gases is shown in Table III.

Water Gas. This is prepared by passing steam into a bed of incandescent coke, the temperature of which is maintained between 1400°C and 1000°C, when the following reaction takes place:— $H_2O + C \rightarrow CO + H_2$. Since the reaction is endothermic and the temperature tends to fall below 1000°C, a blast of air is frequently let in to raise the temperature to 1400°C,

and the carbon dioxide evolved is separately let off. Thus, a portion of the coke is burnt away to carbon-dioxide and only 50 to 60% of it is obtained as carbon monoxide. About 1000 c. ft. of straight water gas are produced for every 40 lbs. of coke (total) consumed.

TABLE III. Composition of Water Gas and Producer Gas.

	Straight Water Gas	Producer Gas
	%	%
Carbon dioxide	3·7	5·2
Ethylene	...	1·0
Oxygen	0·5	0·2
Carbon monoxide	42·3	26·3
Hydrogen	47·9	14·4
Methane	0·6	1·8
Nitrogen	3·4	51·1
Others	1·6	...
	100·0	100·0

Producer Gas. This is obtained by passing a continuous mixture of air (7 volumes) and steam (1 volume) over low grade coal. The amount of steam used per lb. of coal gasified is about 0·4 to 0·5 lb. One pound of bituminous coal yields about 60 c. ft. of gas, semi-bituminous coal about 30 c. ft. and lignite about 28 c. ft.

In the Haber-Bosch method, as already mentioned, a suitable mixture of water-gas ($CO : H_2$ about 1 : 1), producer gas ($N_2 : CO$ about 2 : 1) and additional steam is sent through a hot catalyst of "promoted" ferric oxide, when the carbon-monoxide is converted into an equivalent amount of hydrogen, according to the reaction $CO + H_2O \rightarrow CO_2 + H_2$. The proper (roughly equal) volumes of water gas and producer gas are chosen to give at this stage hydrogen and nitrogen by volume of 3 : 1. The mixture is next passed through an elaborate system of scrubbers and purifiers, which remove most of the other gases and impurities which are likely to poison the catalyst during the synthesis of ammonia.

For the fixation of one ton of nitrogen, roughly 30,000 c. ft. of nitrogen gas and thrice that volume of hydrogen are necessary. These correspond, roughly, to a mixture of 70,000 c. ft. water-gas and 60,000 c. ft. of producer gas; and to obtain this mixture are required about $1\frac{1}{2}$ tons of coke, 1 ton of coal and about 10—11 tons of steam. The cost of these materials could be easily calculated from the local prices for coal at any centre. It would not pay to adopt the above method where the price of coal is above Rs. 10 per ton. An advantage of the Water-gas method is that about 100,000 c. ft. of carbon dioxide are obtained as a by-product per ton of nitrogen fixed, which may find some application in the later stages of manufacture, e. g. in adopting the gypsm process for ammonium sulphate or in preparing urea.

Where a cheap source of electricity is available, say at a price lower than Rs. 50 per k. w. yr., it is possible to use the hydrogen obtained by electrolysis of water in the manufacture of synthetic ammonia. Various

special types of cells suitable for the purpose have been designed, e. g. (1) Knowle's multipolar cell and Knowle's column cell (bell type); (2) Pechkranz cell (filter-press type) and (3) Fauser cell (diaphragm type). The Fauser and Pechkranz cells have found much favour in the synthetic ammonia industry. In all these cells, the consumption of current is about 150 k. w. hrs. per 1000 c. ft. of hydrogen obtained which works out to 13,500 k. w. hrs. or about 1·5 – 1·6 k. w yrs. per ton of nitrogen fixed. Where D. C. current is not available, a transformer has to be set up and the total consumption of current may go up to 1·75 k. w. yrs. per ton of nitrogen fixed.

The main disadvantage of the electrolytic method is the high capital cost of the electrolytic system as compared with the Water gas method. On the other hand, the hydrogen obtained by the method of electrolysis is very pure and it is unnecessary to incur the further expenses of purification necessary with water gas. Further, oxygen is obtained as a by-product, which may find a sale and serve to lower the cost of hydrogen. In countries such as Italy, which have no coal, the electrolytic method for hydrogen has been successfully adopted in the manufacture of synthetic ammonia (e. g. in Casale and Fauser processes).

The comparative costs of producing ammonia from the different sources of hydrogen have been discussed by Pollitt,[4] who gives the following data as regards investment and manufacturing charges :—

TABLE IV.

Costs of producing ammonia from different sources of hydrogen (1930-31)

Source of hydrogen.	Investment per metric ton-year of ammonia			Manufacturing cost per metric ton of ammonia as 25% liquor.
	Plant.	Buildings.	Total.	
	$	$	$	$
Electrolytic ...	198	25	223	34—57*
Water gas ...	148	22	170	35
Coke Oven Gas ...	141	19	160	44
Coke Oven Gas† ...	...	...	94	30

* Depending upon local cost for electrical energy.

† From E F. Armstrong, Chemical Trade Journal, November 1931.

Nitrogen Gas. As regards nitrogen gas, it has been obtained (1) by passing air over red-hot coal or copper; (2) by liquefying air and then fractionating it, for which purpose the plants of Linde and Claude are best suited; (3) by burning hydrogen in air; this last method is practical only on a small scale or where hydrogen can be obtained very cheap. In the Fauser process, 10% of the ammonia prepared is mixed with air and passed through platinum gauze, when the residual gas consists mostly of nitrogen.

Of the above methods, Claude's plant for liquefaction of air and subsequent fractional evaporation, has given very satisfactory results at a number of synthetic ammonia factories, and can be recommended for adoption in cases where water-gas is not used.

Derivatives of Ammonia. Though ammonia, as such, finds some application in industry, e. g. in refrigeration plants, most of it is converted into derivatives, e g. ammoniacal fertilizers and urea or oxidized to nitric acid.

Ammonium sulphate is probably the predominant form in which synthetic ammonia appears on the market and almost all of it is used as fertilizer. Where local supplies of sulphur are available, as in Sicily, Japan and U. S. A. or pyrite ores as in Spain and U. S. A., it is convenient to manufacture the necessary sulphuric acid for the preparation of ammonium sulphate. In other countries, e. g. Germany and England, which do not possess sufficient supplies of sulphur or pyrites, but which possess good deposits of gypsum, successful attempts have been made to prepare ammonium sulphate by passing ammonia and carbon dioxide into calcium sulphate, suspended in water. This is a cheap method of preparing ammonium sulphate and the necessary CO_2 is generally obtained as a by-product in the manufacture of water-gas and producer gas used for the synthesis of ammonia.

But the popular preference for ammonium sulphate in fertilizer practice, is only of recent origin, say from the beginning of this century. Before that, the fashion was to use sodium nitrate from Chile. Sodium nitrate suffers from the disadvantage that its continued use renders the soil alkaline and unproductive. On the other hand, ammonium sulphate suffers from the opposite disadvantage, viz. that the continued use of it renders the soil acidic—especially on light soils—due to the accumulation of sulphuric acid.

Serious efforts, through propaganda and demonstrations, are being made by fertilizer companies, both in Europe and in America, to induce the agricultural clientele to use fertilizers other than ammonium sulphate; and it is satisfactory to note that the sale of such fertilizers, e. g. ammonium phosphate, ammonium chloride, urea and various nitrate fertilizers, now exceeds that of ammonium sulphate. Indeed, it is now possible to run a synthetic ammonia plant and to dispose of its products for fertilizer purposes, without being under the necessity to manufacture sulphuric acid or to use gypsum. This is of special significance to India, which does not possess any abundant deposits of sulphur or rich sulphide ores.

Oxidation of Ammonia to Nitric Acid. An important outlet for ammonia lies in its oxidation to nitric acid catalytically, by mixing it with air (11%) and passing it through finely divided platinum gauze; the oxides of nitrogen so formed are further oxidized and absorbed in dilute acid to form 50% Nitric acid.

The dilute acid can be used directly for the manufacture of various fertilizers, e g. ammonium nitrate, calcium nitrate, sodium nitrate, etc. The disadvantage of some of these nitrates, from the fertilizer point of view, is their deliquiscent nature. This has been partially got over by admixing the nitrate with bone-meal, calcium carbonate, gypsum or potassium salts. Thus, we have on the market compound nitrates, such as ammonium sulpho-nitrate, potassium ammonium nitrate, bonemeal ammonium nitrate, calcium ammonium nitrate and trade products such as Nitro-chalk, Calnitro, Leuna saltpeter etc.

Such compound nitrates are now finding increasing sale, since they contain, in addition to nitrogen, other valuable plant nutrients such as potash calcium, phosphoric acid etc.

For purposes of munitions and for the dye-stuff industry, the dilute nitric acid has to be concentrated to 95—98% by addition of concentrated sulphuric acid and redistillation.

Urea. Another fertilizer that is coming into favour is urea, which can be obtained by passing ammonia and CO_2 into an autoclave held at 130° to 140°C. Urea is rich in nitrogen (contains 46·6% N as compared with about 20% in cyanamide and ammonium sulphate) and is easily assimilated by plants. An interesting fertilizer derivative of urea is calcium urea nitrate, in which urea replaces the four molecules of water in calcium nitrate and renders the product much less hygroscopic.

General Review and Conclusions. It is evident from what has been said in this and the earlier parts of this series, that the manufacture of synthetic ammonia offers the best starting point for covering the whole field of nitrogenous fertilizers, e. g. nitrates, ammonium salts, urea etc.; and it is possible to run the plant and market its products, even independently of imported sulphur or gypsum, should it be so necessary.

Of the different processes for the manufacture of synthetic ammonia, those of Casale and Fauser seem to possess several marked advantages over others.

Of the different methods of obtaining hydrogen and nitrogen the water gas and coke oven gas methods are suited to Bihar and Bengal; but in other provinces, the atmospheric liquefaction method for nitrogen and the electrolytic method for hydrogen can be adopted, provided a cheap source of electricity is available which could supply current at Rs. 40 to Rs. 50 per k. w. yr.

It would be advantageous to attach an ammonia oxidation unit to the synthetic ammonia plant and to manufacture compound fertilizers such as calcium ammonium nitrate, ammonium sulpho-nitrate, bonemeal ammonium nitrate etc., in addition to simple compounds such as ammonium sulphate, ammonium phosphate and ammonium chloride. Urea and its derivatives, such as calcium urea nitrate, may also be included in the programme.

A small plant for the manufacture of sulphuric acid from imported sulphur may be added, for the preparation of super-phosphate, ammonium sulphate etc.

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4. Report of Col. G. P. Pollitt before the Second World Power Conf., Berlin. 1930; vide *Chemical Nitrogen*, loc. cit., page 42.

POLLEN STUDY IN RELATION TO BEE PASTURAGE

BY R. RATNAM, B. A.

Introduction. The importance of a full knowledge of bee pasturage is well known to the practical bee-keeper. Almost complete treatises about bee flora exist in all the chief honey producing countries. So far as South India is concerned, the industry is still in its infancy. Except for the records of Ramachandran (1937) and Venkatasubbayya (1938), no detailed information appears to be available and the present study was undertaken to supplement the information provided by them.

But the attempt to ascertain plant sources for honey and pollen has in almost all studies reported in India, mainly been confined to the location of flowers actually visited by bees. This method cannot be deemed satisfactory, for it may be that plant sources growing at a long distance away from the apiary are missed. Also the worker's personal prejudices as to the usefulness or otherwise of a particular source may sometimes vitiate the reliability or completeness of the list of plants arrived at.

The study of the external morphology of pollen grains has always formed a subject of absorbing interest to botanists. Pope (1925) and Wodehouse (1928 and 1935) have studied the morphological features of pollen grains which are characteristic of the several families, the genera and the species of plants. From their observations, it seems possible that such characters as the size and shape of the pollen grains, the number and arrangement of germ pores and furrows, the character of reticulations and of spines, and the texture of the surface can be utilized in ascertaining bee pasturage. The present author is not aware of any work in which the pollen characters have been utilized for ascertaining bee pasturage in India. From the observations made on the pollen carried by the bees, the plants that are visited by them have been located and the seasons and the hours during which such visits are made have also been determined.

Material and Methods. Wodehouse (1935) has extensively used the methyl green glycerine jelly method for classifying pollen. His method has been used in the present study. The method, briefly stated, consists of the following processes. A small amount of pollen is placed on a micro slide and a drop or more of 95 per cent. alcohol is added, and the pollen stirred with a needle. The alcohol removes the oily matter found on the surface of the pollen grains, and also the fluid used by bees for moistening the pollen. The surplus alcohol is drained off by means of a bit of cotton wool and before the slide is completely dry, the required amount of warm methyl green glycerine jelly (previously kept ready) is added. The slide is warmed and covered over with a warm cover slip and examined after two or three days which period is necessary for the pollen grains to be properly stained.

Where absolute shape of the pollen grain is to be determined, the methyl green glycerine jelly method wherein the pollen grain is moistened, is unsatisfactory according to Ferguson and Coolidge (1932). Since it is not the aim of the present investigation to determine the absolute shape and size of the pollen as may be necessary in botanical investigations, and since the pollen from both the sources, viz., directly from the plant and that obtained through the bees, was moistened, the objections held by Ferguson and Coolidge (1932) do not apply to the present study. According to Casteel (1912), Phillips (1926) and Parker (1926) the bee moistens the pollen before transferring its load into the pollen baskets. Since it is practically impossible to obtain dry pollen from the bees, the examination of dry pollen as recommended by Ferguson and Coolidge (1932) is out of question.

The findings which were arrived at through the study of pollen borne by the bees were checked by visiting the plants and observing the bees at work on such plants.

Almost all flowers available in the locality were collected and their pollen grains were mounted as above. Such slides from 64 species formed the keys for identifying the pollen brought by bees.

Species visited by bees. (a) *Pollen species.* Pollen loads brought by bees were collected almost at weekly intervals. To enable the accurate determination of the hour during which each species is visited by bees, pollen was collected from the incoming bees every hour taking at the rate of about four bees per hour picked up at random. The pollen grains were separately packed in paper and taken to the laboratory, and kept mounted for identification noting on the slide the date and hour at which the pollen was collected. These were identified with the help of the key slides and full information as to the hours during which each pollen species was useful to bees has been obtained. Plants like *Tribulus terrestris, Leucaena glauca* and *Psidium guajava* are useful exclusively for pollen. A list of 17 such species has been obtained.

(b) *Nectar species.* The general method of picking bees at random at hourly intervals on particular days not more than a fortnight apart was continued in this case also. Parker (1926) states that pollen grains always adhere to one part or the other of the body of the bees while they gather nectar from flowers. In the case of the bee returning to the hive with nectar, no pollen load is found in the pollen baskets, but some quantity of pollen adheres to some part of the body of the bee. This pollen was removed by placing a bee on a slide and moistening it thoroughly with a few drops of 95 per cent. alcohol. The alcohol washes down the pollen which is left on the slide after the evaporation of alcohol. The slide is then stained with methyl green glycerine jelly as above and examined for the pollen. Only those species which have not been identified as pollen species as per test (a) above are considered as useful exclusively for nectar. Plants like cotton, and *Tamarindus indica* belong to this category and 15 such species have been identified as a result of the present study.

There is, however, difficulty in exactly demarcating the hourly periods during which particular species are useful for nectar. The position may be more clearly illustrated with an example. During the months of December and January, both pumpkin *(Cucurbita maxima)* and cotton were found useful for nectar. While pumpkin is frequented by bees from early morning up to about 10 a. m., cotton flowers are visitied only after 9 a. m. Pollen grains adhering to the body of incoming bees may indicate that pumpkin is visited only till 9 a. m., as the bee which was working till then on this source, may afterwards turn its attention to cotton. Tests carried out after 9 a. m. will reveal the presence of pollen grains from both sources. Hence it is difficult to state at what hour a particular species has ceased to be useful. Conclusions in this regard were, however, arrived at only after actually visiting the species in the field. In the above case, for example, very few bees were seen inside the pumpkin flowers after 10 a. m., and absolutely none at all after 11 a. m. It was concluded, therefore, that pumpkin flowers served as a nectar source for bees, only till about 10 a. m.

(c) *Species useful for both pollen and nectar.* Dual purpose species like *agathi (Sesbania grandiflora)* were identified in the following manner. Using the method (a), the pollen loads brought by bees are identified as those from *Sesbania grandiflora.* A test for the nectar gatherers as per method (b) also shows that *agathi* is the source of the nectar. The point that has now to be considered is whether this test (b) is successful simply because the bee has in a previous trip visited *Sesbania grandiflora.* If the bees had visited another species for nectar, then there would be pollen of that species adhering to its body. The absence of such foreign pollen on a number of bees would prove that *agathi (Sesbania grandiflora)* is both a nectar and pollen source. And this point is further confirmed by field observations.

Only six species were found to serve a dual purpose of furnishing nectar and pollen. If a pollen gatherer collects both nectar and pollen from one and the same species in the same trip, it is likely that the fact regarding nectar utilization would be missed. Since all the species the pollen of which was gathered from the bees were visited by the author in the field, and since every care was taken to observe whether pollen-collecting bees also gather nectar from the flowers of the same species, it is likely that no dual purpose species has been missed. Pollen collectors were not noticed to gather nectar in the same trip. A bee engaged in pollen collecting continued to do that work only. Phillips (1926) cites the work of Bonnier* and states that there are separate pollen carriers and nectar gatherers in the hive.

Out of 64 species collected to serve as a key for the identification of pollen, only 38 have been found to be utilised by bees. The others are not at all visited by them.

Attraction of bees to floral colours. Von Frisch (1937) states that bees do not distinguish fine shades of colour and are in a sense colour-blind

* Bonnier, Gaston. 1906, *Sur la division du travail chez les abeilles. Comptes rendus hebdomadaires des seances de l' academie des sciences,* CXLIII, pp. 941–946.

particularly to red blossoms to which bees are, however, attracted on account of the reflection of ultra-violet rays. In Table I the colours of the various flowers are grouped :—

TABLE I

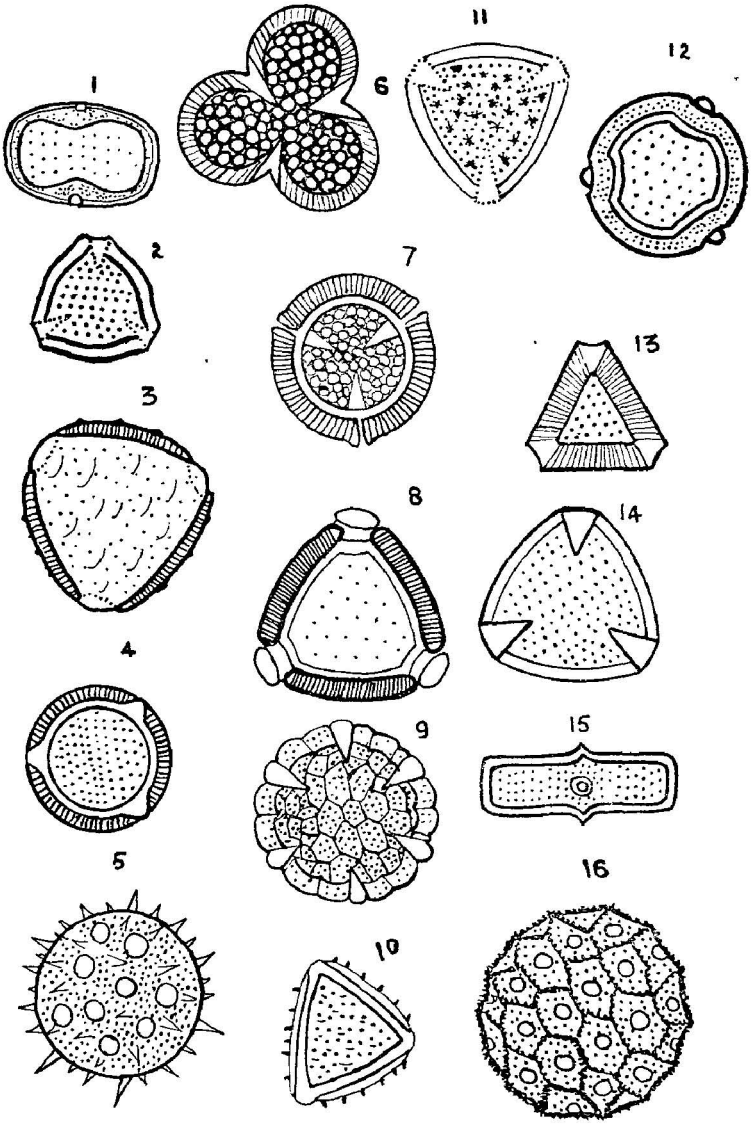
Number of species grouped as per floral colours.

Flower colour.	Key slides		Bee flora	
	Number	Percentage of total	Number	Percentage of total
White	27	42	17	44
Yellow	21	32	15	39
Total	48	74	32	83
Red	3	5	2	5
Blue	3	5	1	3
Pink	3	5	1	3
Rose	2	3	1	3
Green	2	3	...	...
Orange	2	3	...	...
Grey	1	2	1	3
Grand Total	64	100	38	100

In assessing the colours of such flowers as *Tamarindus indica* which have two or more colours on their calyx and corolla, the predominant colour, viz., yellow, has only been taken into consideration.

From Table I it will be seen that out of 64 species which formed the keys, 74 per cent. have white and yellow flowers. Out of the 38 species utilised by bees, 83 per cent. possess yellow and white flowers. In the locality under study, therefore, the flora appears to consist of a large population of white and yellow flowered species and it is seen that out of 48 such species, as many as 32, or 67 per cent. are utilized by bees. But of the remaining 16 species having colours other than yellow and white, only 38 per cent. (6 species) are made use of by the bees. It looks as though bees show a particular preference to yellow and white colours. This point, however, requires further study.

It is relevant at this stage to mention a few observations made in regard to the colour sense in bees. Many bees working on the yellow flowers of *Tribulus terrestris* were seen to alight on similar coloured (though of a different shade) flowers of *Cleome viscosa* apparently by mistake, and then perhaps after detecting the scent, immediately leave the latter without collecting any pollen. Similar observations were made on bees visiting the white and two-lipped flowers of *Justicia tranquebariensis* and the flowers in heads of *Lagasca mollis*. These observations go to show that bees do not recognise shades of colours. They also suggest that even shapes of flowers are missed.



Explanation of Figures.

The diagrams are freehand drawings of pollen grains mounted in methyl green glycerine jelly. They are not drawn to scale and in some cases are slightly diagrammatic for purposes of clarity in print.

1. *Justicia tranquebariensis.*
2. *Trichodesma indicum.*
3. *Cereus peruvianus (?).*
4. *Cleome viscosa.*
5. *Ipomoea carnea.*
6. *Euphorbia heterophylla.*
7. *Ricinus communis.*
8. *Calophyllum inophyllum.*
9. *Ocimum canum.*
10. *Dolichos biflorus.*
11. *Sesbania grandiflora.*
12. *Moringa olifera.*
13. *Psidium guajava.*
14. *Argemone mexicana.*
15. *Coriandrum sativum.*
16. *Tribulus terrestris.*

Shape of the flower in relation to the method of pollen collection. Now considering the shape of the flower, Parker (1926) classifies flowers which are useful to bees into four groups, viz., open type, tubular type, closed type, and spike type. This classification, of course, does not strictly conform to the method generally followed by botanists in describing the shape of flowers. For example, the flowers which are said to be tubular and funnel shaped by botanists have all been classed under the tubular type by Parker (1926). In discussing the utility of flowers for nectar and pollen, it is convenient to group them under various types, and it seems feasible to adopt Parker's method of classification.

In the present study, the Ipomoeas and some of the cucurbitaceous plants can be classed under the tubular type, and they are useful chiefly as nectar sources. The papilionaceous and the labiate flowers such as *Leucas aspera, Ocimum canum* and *Dolichos biflorus* belong to the closed type and they are useful chiefly for nectar although *Sesbania grandiflora* and *Ocimum canum* are also equally useful for pollen. These observations generally confirm Parker's (1926).

Flowers belonging to the open and spike types are generally pollen species only. *Psidium guajava* and *Leucaena glauca,* for example, belong to the open type while *Sorghum vulgare* and *Pennisetum typhoides* belong to the spike type. The method of collecting pollen from these types vary. In gathering pollen from flowers of the open type, the bees bite the anthers with their mandibles and pull them towards their bodies with their forelegs while at the same time they run rapidly over the flowers packing the pollen in the pollen baskets. A slightly different method of gathering pollen from *Cereus (peruvianus ?)* which belongs to the tubular type has been noticed. In these flowers the bees first get to the bottom and walk upwards along each filament of the stamens towards the tip where the anthers are fixed. Here the bees bite the anthers and at intervals suspend themselves in the air for a few seconds collecting the pollen grains in the pollen baskets. On the spike type of flowers, the bees were seen to run over them from bottom to top and then rise in the air packing the pollen into the pollen baskets. The above observations appear to be generally in conformity with Parker's (1926).

Flowering periods. The present study was commenced in August 1937 and extended almost to the end of July 1938 and so covers a period of about 12 months. During this period, pollen study was carried out almost at weekly intervals except during six weeks. Even on these six occasions the interval between two days of study did not exceed a fortnight. It is well known that the flush of flowers of almost all South Indian flora lasts for more than a fornight and it may, therefore, be taken that this investigation covers almost all flora available in the vicinity of the apiary.

In Table II the number of species in flower during the respective months is summarised.

TABLE II

Number of species in flower during the respective months

Months	No. of species		
	Nectar	Pollen	Dual purpose
January ...	11	4	3
February ...	6	1	2
March ...	3	1	2
April ...	5	5	5
May ...	5	5	5
June ...	4	3	2
July ...	4	1	1
August ...	3	2	1
September ...	3	6	2
October ...	8	12	2
November ...	10	13	3
December ...	11	11	3
Total No. of species	15	17	6

It will be seen from Table II that during October to January the largest number of species are in flower. Again in April-May there is a second season. There appears to be a dearth of pasturage during March and June-September. Particularly the month of August seems to be a very "dry" month. Such species as *Cocos nucifera, Tridax procumbens* and *Antigonon leptopus* are in flower almost throughout the year. But no pollen species are in bloom all round the year. Other species like *Moringa oleifera,* cotton and *Psidium guajava* are in flower during two seasons in the year. Such species, however, are only few. In fact out of 15 nectar species only three, and out of 17 pollen species only four, have two flowering seasons.

Bees were examined for pollen at hourly intervals so as to obtain information as to the hours from which or up to which particular species were visited by bees for one purpose or another. The information so obtained has been presented in Table IV. In Table III the total number of species which are utilised by the bees for pollen or for nectar at the various hours of the day when such species are in flower is furnished.

TABLE III

Number of species visited by bees at various hours of the day.

Hour	No. of species		
	Nectar	Pollen	Dual purpose
5 a. m. ...	4	4	3
6 ,, ...	5	6	4
7 ,, ...	6	9	5
8 ,, ...	8	13	6
9 ,, ...	12	15	6
10 ,, ...	13	16	6
11 ,, ...	13	14	3
12 ,, ...	11	12	3
1 p. m. ...	10	6	3
2 ,, ...	10	3	2
3 ,, ...	8	1	2
4 ,, ...	7	...	3
5 ,, ...	4	...	2
6 ,, ...	3	...	2
7 ,, ...	3	...	2
Total No. of species	15	17	6

TABLE IV. SPECIES OF PLANTS VISITED BY BEES

References: w—white; y—yellow; p—pink; b—blue; r—rose; rd—red; g—grey; c—closed type; o—open type; t—tubular type; s—spike type; ×—nectar; –pollen; × nectar and pollen.

Name of Plant	Floral colour	Flower type	Months of flowering: January	February	March	April	May	June	July	August	September	October	November	December	Time of visit (a. m. / p. m.): 5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Nectar Species																													
1. *Justicia tranquebariensis*	w	c	×									×	×	×					×	×	×	×	×	×	×	×			
2. *Tridax procumbens*	y	t	×	×	×	×	×	×	×	×	×	×	×	×						×	×	×	×	×	×				
3. *Ipomoea batatas*	w	t	×	×													×	×	×	×	×								
4. *Benincasa cerifera*	y	t	×									×	×	×					×	×	×	×							
5. *Cucurbita maxima*	y	t	×									×	×	×		×	×	×	×	×	×								
6. *Euphorbia heterophylla*	r	t	×	×										×					×	×	×	×							
7. *Leucas aspera*	w	c	×									×	×	×							×	×	×	×	×	×			
8. *Gossypium sp*	y	t	×	×			×	×						×						×	×	×	×	×	×	×			
9. *Moringa oleifera*	w	o	×	×	×				×	×						×	×	×	×	×	×	×	×	×	×	×	×	×	×
10. *Antigonon leptopus*	r	o	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×
11. *Coriandrum sativum*	w	o	×										×	×					×	×	×	×	×	×					
12. *Tamarindus indica*	y	o				×	×	×	×							×	×	×	×	×	×	×	×	×	×	×	×	×	×
13. *Merremia dissecta*	w	t				×	×	×			×	×	×							×	×	×	×						
14. *Ipomoea purpurea*	b	t										×	×	×						×	×	×	×						
15. *Dolichos biflorus*	y	c											×	×						×	×	×	×	×	×				
Pollen species																													
16. *Ocimum canum*	w	c	–								–	–	–	–						–	–	–	–	–	–				
17. *Leucaena glauca*	w	o	–				–	–	–			–	–	–	–	–	–	–	–	–	–	–	–	–	–				
18. *Psidium guajava*	w	o	–			–	–					–	–	–	–	–	–	–	–	–	–	–	–	–	–				
19. *Argemone mexicana*	y	o	–	–								–	–	–							–	–	–	–					
20. *Calophyllum inophyllum*	w	o			–	–					–	–	–	–				–	–	–	–	–							
21. *Cereus peruvianus (?)*	w	o				–	–					–	–			–	–	–	–	–									
22. *Peltophorum ferrugineum*	y	o				–	–	–											–	–	–	–	–	–	–	–			
23. *Poinciana regia*	rd	o				–	–	–												–	–	–	–	–	–				
24. *Tribulus terrestris*	y	o										–	–	–						–	–	–	–						
25. *Saccharum officinarum*	w	o										–	–	–						–	–	–	–						
26. *Trichodesma indicum*	p	o											–	–						–	–	–							
27. *Cleome viscosa*	y	o											–	–							–	–	–	–	–				
28. *Lagasca mollis*	w	o											–	–						–	–	–	–	–					
29. *Ricinus communis*	w	o											–	–						–	–	–	–						
30. *Tragus biflorus*	w	s											–							–	–	–							
31. *Sorghum vulgare*	y	s											–	–		–	–	–	–	–	–								
32. *Pennisetum typhoides*	g	s											–	–					–	–	–	–							
Pollen and nectar species																													
3. *Ipomoea carnea*	w	t	×			×	×	×				×	×	×	×				×	×	×	×	×						
34. *Sesbania grandiflora*	w	c	×	×										×	×	×	×		×	×	×							×	×	×
35. *Cocos nucifera*	y	o	×	×	×	×	×	×	×	×	×	×	×	×			–	–	×	×	×	×	×	×	×				
36. *Cucumis sativus*	y	t				×	×	×											×	×	×	×	×	×					
37. *Odina wodier*	y	o					×	×								×	×	×	×	×	×								
38. *Opuntia dillenii*	y	o					×	×								×	×	×	×	×	×	×	×	×	×	×	×	×	×

It will be seen from table III that the greatest number of species are visited by bees between 9 and 10 a. m. either for nectar or for pollen. The number of species that are so visited increases as the day advances from 5 a. m. to about 10 a. m. and then steadily falls. Out of a total of 15 nectar species only three are visited by bees throughout the day and out of six species serving a dual purpose only one is similarly utilised. There is not a single pollen species from which pollen is collected by bees throughout the day. Invariably most of the pollen species are not visited by bees in the afternoon. Although pollen is available in the flowers after certain hours, bees were observed not to gather them after those hours. This may perhaps be due to some changes in the pollen grains themselves on account of environmental factors. What exactly those factors are, it is at present unknown.

Discussion. The pollen study of ascertaining bee pasturage which has not so far been attempted in India, indicates that this method is a very useful approach for collecting the list of bee flora of each locality. The method gives the clue as to where exactly to look for the bees in the field. The usefulness of this method is demonstrated by the fact that 20 species hitherto not reported in India were discovered as being useful. It is here that the personal prejudices of the workers as to the usefulness or otherwise of particular species are eliminated and the results arrived at are checked by visiting the plant sources in the field. By this method a confirmation as to the utilization of the species by the bees for one purpose or another is readily obtained with information as to the time of visit by bees. Such weeds as *Leucas aspera, Tribulus terrestris* and *Ocimum canum* were (at least by the present author) least suspected pasturage crops, and a study of pollen grains has definitely indicated that even weeds which are ordinarily eradicated by agriculturists as being a nuisance, have their own status in providing bee pasturage.

Generally there are two seasons in the year when plants are in bloom when the apiculturist can expect a surplus crop of honey. One season commences from November and continues up to the end of January while the other season commences in March and lasts only for about two months. The former season comprises a large number of annuals like cotton and the cucurbitaceous plants, while in the latter season chiefly *Tamarindus indica* and the second crop of flowers in cotton are useful. Most of the species are visited by bees in the forenoon only.

That the proximity of flowers facilitates the performance of a larger number of trips by bees in a given interval of time is easily recognised. This is no mean advantage for the apiculturist in getting a surplus crop of honey. While records about the range of flight of some of the European bees indicate that bees visit flowers situated even two miles away from the apiary (Eckert, 1933), Ramachandran (1937) reports that in South India the range of flight of Indian bees is only about three furlongs. The present study, however, indicates that bees fly a distance of even six furlongs provided a good pasturage, for example, *Cucumis sativus*, is available. Although

the range of flight may be extensive, it should be emphasized that the location of nectar species situated far away from the apiary is uneconomic. Of the 38 species recorded in the present study, excepting one (*Cucumis sativus*) all else were situated within a radius of 500 yards from the apiary.

The species of plants now found useful to bees may be classified as in Table V.

TABLE V

Status of the species in the field of agriculture.

Class	Nectar species		Pollen species		Dual purpose	
	Number	Percentage of total	Number	Percentage of total	Number	Percentage of total
Weeds ...	4	27	7	41	1	17
Cultivated :—						
Ornamental plants	3	20	2	13	1	17
Economic plants	6	40	4	23	1	17
Trees	2	13	4	23	3	49
Total	15	100	17	100	6	100

From Table V it will be seen that of the nectar species 40 per cent. are cultivated plants of economic importance while weeds and trees contribute 27 and 13 per cent. respectively. On the other hand cultivated plants are less useful for pollen, and the largest share (41 per cent.) of the pollen species is provided by weeds only. Next in importance, the cultivated plants contribute a total of about 36 per cent. of the pollen species followed by trees. Forty-nine per cent. of the species serving a dual purpose are trees.

Mention may be made of the most important species useful for bees:—

Nectar species: *Tamarindus indica*, cotton, *Cucumis sativus*
Pollen species: *Sorghum vulgare, Pennisetum typhoides, Psidium guajava, Cereus peruvianus (?)*

The above species have made themselves important by sheer numbers, that is by the availability of a large population of flowers over a compact area of field. Most of these are cultivated plants. It may be concluded, therefore, that relatively speaking, cultivated plants are more economic from the apiculturist's point of view than wild weeds. It is by no means the intention to under-estimate the value of some weeds. Especially in November—January season a large majority of the pollen species comprise of weeds only and but for them, there would have been a dearth of pasturage during these months.

Summary and Conclusions. In respect of information so far available in India as to bee pasturage, the method of ascertaining species has been confined to locating in the field the flowers actually visited by bees. Key pollen slides from known plants growing in the locality under study have been prepared in methyl green glycerine jelly, and the pollen actually

brought by bees, and the pollen adhering to the body of nectar gatherers have been identified. A list of 38 species useful for nectar, for pollen, and for both has been obtained and as many as 20 plants in the list are reported for the first time in India. Analyzing the colour of the flowers visited by bees, it is observed that a majority of bee flora possess white and yellow flowers. The shape of the flowers in relation to their utility by bees is indicated, and the method of collecting pollen from the various floral types is discussed. There are two seasons in the year during which plants come to bloom, one in October-January and the other in April-May, the former comprising mostly of weeds and annuals, and the latter of perennials. A majority of flowers are visited by bees in the forenoons only. Although pollen is available after certain hours, bees are found not to gather them, and why this is so, it is not at present definitely known.

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APPENDIX

EXTERNAL MORPHOLOGY OF THE POLLEN GRAINS OF THE BEE FLORA

Note :— The description of pollen grains relate to specimens mounted in methyl green glycerine jelly. In the case of spinous pollen grains, the diameters of the grains furnished exclude the length of the spines. For the sake of convenience in reference the species are grouped according to their families and arranged alphabetically.

Acanthaceae.

1. *Justicia tranquebariensis*, L. f. (Fig. 1)—Egg shaped with poles more flattened. 34·5—20·7 μ. Smooth and clear with one furrow.

Anacardiaceae.

2. *Odina wodier*, Roxb.—Yellow. Spheroidal. 20—21μ. Exine 3·5μ. Surface smooth and clear. Three furrows each containing one germ pore. Furrows gape widely in stained specimens giving almost a triangular appearance.

Boraginaceae.

3. *Trichodesma indicum*, R. Br. (Fig. 2)—Small and generally spheroidal. 20—21μ. Three spindle shaped furrows.

Cactaceae.

4. *Opuntia dillenii*, Haw.—Yellowish white. Spheroidal. 120μ. Seven to nine pores, dia. 25μ. Surface finely pitted.

Reported previously by Ramachandran (1937).

5. *Cereus (peruvianus ?)* (Fig. 3).—White. Spheroidal. 69μ. Three spindle shaped furrows. Surface finely frothy. Exine thin and striated.

Previously reported by Ratnam (1938). There is some doubt regarding the nomenclature of this plan Confirmation is being made.

Capparidaceae.

6 *Cleome viscosa*, L. (Fig. 4).—Yellow. Spheroidal. 27—30μ. Furrows wide and spindle shaped. Exine striated and rather thick. Surface smooth and clear.

Compositae.

7. *Lagasca mollis*, Cav.—Whitish. Spheroidal. 24—31μ. Spines 3μ long and do not take in stain. Surface clear. Reported previously as a pollen source by Ramachandran (1937).

8. *Tridax procumbens*, L.—Spheroidal and spinous. 24—28μ. Spines 3·5—5μ long and distributed about 4μ apart and do not take in stain. A few large pores about 6μ in diameter. Exine faintly striated.

Convolvulaceae

9. *Ipomoea batatas*, L.—Spinulose (Gamble, 1923). Spheroidal 120μ. Spines 10μ long and 10μ apart, and do not take in stain.

10. *Ipomaea carnea*, Jacq. (Fig. 5).—White. Spheroidal. 75μ. Spinous. No uniformity in distribution of spines. A few spines appear a little hooked at the tip. Spines do not take in stain.

11. *Ipomoea purpurea* Roth.—Exactly like *I. carnea*. 116μ.

12. *Merremia dissecta*, Hall. f.—Spheroidal. 83μ. Exine striated and 6—8μ thick. Surface finely frothy. Three furrows spindle shaped. No furrows.

Cucurbitaceae.

13. *Benincasa cerifera*,—Savi.—Nearly spheroidal. 65μ. Surface finely reticulate.

14. *Cucumis sativus*, L.—Yellow. Spheroidal. 42—45·5μ. Surface smooth and clear. Three furrows.

15. *Cucurbita maxima*, Duch.—Spheroidal. 158μ. Spinous. Spines 7—10μ long. Distribution of spines not regular. Seven to nine pores diameter 25—35μ.

Ramachandran (1937) refers to cucurbitaceous plants as being useful for bees.

Euphorbiaceae.

16. *Euphorbia heterophylla*, L. (Fig. 6).—Mounted specimens three lobed. 31—35μ. Exine stout and striated. Surface possesses elaborate sculpturing.

Georgia (1914) states that honey gathered from the flowers of this plant is "acrid" and emetic and unfit for use. This does not seem to obtain confirmation under South Indian conditions.

17. *Ricinus communis*, L. (Fig. 7).—Spheroidal or nearly so. 28μ. Exine 3·5μ. Three furrows separate the exine which have knob-like ends. Finely reticulate surface.

Graminae.

18. *Tragus biflorus*, Schult.—Light yellow. Spherical. 24—30μ. Surface granular. Single germ pore diameter 3μ.

19. *Sorghum vulgare*, Pers.—Yellow. 45—48μ. Spheroidal. Single germ pore 3·5μ diameter. Surface smooth and finely granular. Exine slightly striated

Previously reported by Ramachandran (1937).

20. *Pennisetum typhoides*, Stapf & Hubbard—Grey. Mounted grains examined within a week after mounting do not appear perfectly spheroidal. Diameter varies from 41·4—34·5μ. Surface coarsely granular.

Previously reported by Ramachandran (1937).

21. *Saccharum officinarum*, L.—Spheroidal. 31—34·5μ. Surface smooth and lightly granular. Exine thin and striated.

Guttiferae.

22. *Calophyllum inophyllum*, L. (Fig. 8).—Bright yellow. Spheroidal. 38μ. Exine 3·5μ and striated. Surface smooth and clear.

Labiatae.

23. *Leucas aspera*, Spr.—Spindle shaped. Polar diameter 21—24μ. Surface smooth and clear. Three furrows.

24. *Ocimum canum*, Sims (Fig 9).—Spheroidal. 55—60μ Six furrows. Surface characteristically reticulate.

Leguminosae.

25. *Peltophorum ferrugineum*, Benth.—Spheroidal. 48μ. Reticulate almost amounting to pitted appearance. Three furrows.

Previously reported by Ramachandran (1937).

26. *Poinciana regia*, Boger.—Spheroidal. 48—55μ. Three furrows. Exine 6·5μ and striated. Surface clear and reticulate.

Previously reported by Ramachandran (1937).

27. *Tamarindus indica*, L.—Spheroidal. 34·5μ. Exine 2μ. Surface smooth, Three furrows.

Previously reported by Ramachandran (1937) and Ratnam (1938).

28. *Leucaena glauca*, Benth,—Almost spheroidal. 41—43μ. Surface smooth. exine thick. Faintly frothy. Three furrows.

29. *Dolichos biflorus*, L. (Fig. 10).—Egg shaped with one pole rather pointed. The length from pole to pole varies rather widely in mounted grains from 60–85μ and width from 45—60μ. Three furrows. Fine bristles scattered over the surface.

30. *Sesbania grandiflora*, Pers. (Fig. 11).—Spheroidal. 34·5μ. Surface smooth and slightly granular.

Malvaceae.

31. *Gossypium indicum and G. hirsutum.*—Spheroidal or nearly so. Spinous. 95—97μ. Spines 7μ long and take in stain.

Previously reported by Ramachandran (1937) and Ratnam (1938). Banerji (1929) has studied in detail the pollen of the various *Gossypium* species.

Moringaceae.

32. *Moringa oleifera*, Lam. (Fig. 12).—Spheroidal. 30—38μ. Three furrows each containing a germ pore. Surface clear and smooth.

Reported previously by Ramachandran (1937).

Myrtaceae.

33. *Psidium guajava*, L. (Fig. 13).—Very small. From the polar view almost exactly triangular. Width 12—16μ. Surface smooth and clear. Exine striated. Three linear furrows.

Previously reported by Ramachandran (1937) and Ratnam (1938).

Palmaceae.

34. *Cocos nucifera*, Linn.—Mounted specimens irregularly round with flattened margin at one portion, having one furrow. 35—41μ. Surface smooth and exine thick.

Ramachandran (1937) states that this is a useful pollen source during May and June. Narayana (1937) and Patel (1938) have reported that coconut flowers are always visited by bees.

Papaveraceae.

35. *Argemone mexicana*, L. (Fig. 14).—Spheroidal. 34·5μ. Exine thin. Surface smooth and clear. Three furrows gape widely.

Polygonaceae.

36. *Antigonon leptopus*, Hk & A.—Almost spheroidal. 52μ. Texture granular. Surface characteristically pitted.

Ramachandran (1937), Ratnam (1938) and Venkatasubbayya (1938) have all reported about this plant previously.

Umbelliferae.

37. *Coriandrum sativum*, L. (Fig. 15).—Egg shaped with flattened poles. Length 32μ and width 10·5μ. At the equatorial region, the exine has a ridge running all round. Surface clear and smooth.

Ramachandran (1937) states that Coriander is also suspected to be a pasturage crop but that its status is not known.

Zygophyliaceae.

38. *Tribulus terrestris*, L. (Fig. 16).—Spheroidal. 40—45μ. No furrows. Surface characteristic with fine reticulations. The lacunae are not divided by solid continuous ridges, but only coil-like partitions which under the lower powers of the microscope appear like a chain of dot-like structures. Lacunae are clear and contain germ pores.

SOME ASPECTS OF THE CONTROL OF *KOLEROGA* OR *MAHALI* DISEASE OF THE ARECA PALM

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Mahali or *Koleroga* disease of arecanuts is the most serious disease of areca palms in Malabar and South Kanara of the Madras Presidency. There are about 80,000 acres under Areca in the former and 20,000 acres in the latter district. In addition to these localities the disease is also prevalent in the North Kanara district of Bombay and in the states of Mysore, Cochin and Travancore. The disease first attracted the attention of the Mysore Mycologist Dr. Coleman who investigated it and published his results in the form of a bulletin in the year 1910*. It was shown that the disease could be effectively controlled by proper spraying. Our province had just then realised the necessity for a mycologist of its own and appointed Mr. McRae as the Madras Mycologist in 1910. Some time after he took up his post, he found the disease widely prevalent in certain arecanut areas in Malabar. He conducted spraying trials and demonstrated to the areca growers of Malabar that the disease could be effectively controlled. The propaganda was so successful that areca growers in Malabar were soon conversant with the measures advocated by the department. Since then the demand for the chemicals necessary for the spraying has fostered a trade in these articles so that stocks are obtainable in many of the petty shops in areca areas of Malabar.

History of the disease in South Kanara. Sporadic outbreaks of *Koleroga* were reported from time to time from South Kanara especially from the ghat areas bordering Mysore. A few spraying trials beginning from as early as 1913 were conducted in this district so that the ryots of the locality might see for themselves the success of the measures adopted. In spite of vigorous propaganda by the department, especially in the years 1934 and 1935 when 116,150 and 385,000 trees were sprayed under the supervision of departmental officers, the areca growers here were tardy in taking up the measures advocated. This could be attributed to the following causes:

(1) The disease had not appeared there in epidemic form involving large areas causing heavy loss.

(2) The rainfall in S. Kanara is much heavier than in Malabar being about 150 inches in the coastal areas and over 200 inches in the Malnad areas. In the year 1931, in one of these latter areas, the rainfall in the

* Coleman, L. C.—Mycological Series, Bulletin No. 2, Department of Agriculture, Mysore State, 1910.

south west monsoon alone was 200 inches, August contributing 95 inches · though the average for this month is only about 25 inches.

(3) The climbers available in South Kanara had not the same training as their brethren in Malabar and found it difficult to climb up the slippery palms for the second spraying recommended to be given in July.

Such was the situation in South Kanara when in June 1936, the disease broke out in a very serious form and spread rapidly. Just before the outbreak of this epidemic, little did these ryots realise that they were on the verge of disaster. The disease was so serious and widespread and came upon them when they were least prepared to meet the situation. Many were without sprayers and could not get them when needed. Those who were able to get sprayers and spray their gardens were able to save their crop, the amount saved depending on the time of spraying. Those who gave the first spraying before the appearance of the disease followed by a second spraying in July—August were able to save the whole crop, while those who conducted spraying only after the first appearance of the disease were able to save only 50 to 75% of the crop. It was a very pathetic sight to see the total loss of crop in some of the unsprayed gardens in centres like Hathyadka.

While the disease had caused a general calamity among the areca growers, it served at least one good purpose. It taught such of those growers who were aware of spraying on the need for preparedness and prompt action. Those hitherto ignorant of the treatment or looked on it with indifference or suspicion learnt to their cost the existence of an effective remedy, which they had not availed of Since this catastrophe, there has been an all round awakening and a general willingness to follow departmental advice. During the year 1937, about 80% of the areca plantings were sprayed.

It will thus be seen that the difficulties were not insurmountable. The climbers are now better trained and are able to manipulate the sprayers well. New types of sprayers have come into the market. In one type, a delivery hose of about 60 feet is attached so that the climber has simply to carry the nozzle up the tree for spraying Climbers here prefer this to the one gallon sprayer which is carried on the back. In former years, the climbers had to go right up to the top to spray the bunches as the spray was delivered in the form of a mist and travelled only a short distance. Now nozzles with jet spray travelling over comparatively long distances are available. The climbers therefore need climb only a short way especially during rainy weather. The spraying done by the areca growers in South Kanara is only by this method. Though there is wastage of 30 to 50 per cent. of the mixture, it enables them to spray their trees more easily a second time during the break in the heavy rains and in a much shorter time.

The adhesive hitherto recommended for the Bordeaux mixture was resin dissolved in washing soda. As long as there was only one spraying necessary as in most parts of Malabar there was no complaint against this mixture

except its cost. However, when the need for a second spraying arose, the areca cultivators found it difficult to prepare the resin adhesive within the limited time at their disposal during the short breaks in the heavy monsoon. As early as 1921—22, the mycological section of the Madras Agricultural Department had found during the coffee spraying experiments in Coorg that casein was a good adhesive for Bordeaux mixture. During the years 1934 and 1935, vegetable oils were tried as spreaders to Bordeaux mixture for the control of Koleroga and were found satisfactory.

Spraying experiments in South Kanara. Such was the state of our knowledge when in 1936, the disease broke out in a virulent form in very many parts of South Kanara. Some of the growers had taken to spraying with resin mixture, some with casein mixture and many with oil mixture, this being the easiest to prepare and the cheapest. Though all these adhesives were generally found to be successful in the control of the disease, when the question about the relative merits of these adhesives arose, well analysed experimental data for pronouncing any definite opinion were lacking.

Two series of experiments were laid out in two different places in South Kanara.

A tabular statement is given as Appendix I showing the treatments tried, the percentage of nut fall caused by *mahali*. The object of these experiments was to get definite evidence on the following points :

(1) Whether one spraying just when the disease makes its appearance in the locality is able to control the disease as effectively as two sprays, one just before the monsoon and the other six weeks later.

(2) Whether 1% Bordeaux with adhesives controlled the disease as effectively as 2% Bordeaux with adhesives.

(3) To determine the relative merits of resin, casein, oil and fish-oil-resin soap as adhesives to Bordeaux mixture.

(4) Whether 2% Bordeaux mixture without adhesives controlled the disease as effectively as 2% Bordeaux mixture with adhesives.

(5) Whether cuprous oxide was as effective as Bordeaux mixture.

Weekly records of nut-fall were maintained from the time of the first spraying to the end of the harvest and fallen nuts were examined and classified as due to *Mahali* and other causes. A summary of the statistical analysis of the results obtained is furnished separately as Appendix I.

The following inferences are drawn from the results obtained :

(1) The control plots show the heaviest infection.

(2) Cuprous oxide is a poor substitute for Bordeaux mixture.

(3) Two sprays with Bordeaux mixture controls the disease better than a single spray.

(4) 2% Bordeaux mixture is more efficient than 1% mixture in the single spraying series.

(5) Oil or casein in combination with 2% and 1% strengths of Bordeaux mixture effectively controls the disease.

(6) Oil and casein are found to give better control than resin.

(7) 2% plain Bordeaux without adhesive is found to give as good a control as 2% Bordeaux with oil or casein.

A comparative statement of the cost of chemicals required for one spraying of an acre of areca garden with 2% Bordeaux mixture with the important adhesives tried is given as Appendix II.

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APPENDIX I.

Treatment effects on infection per plant in Vittal and Kandigai.

Serial No.	Treatment combinations.		Number of sprays.	Percentage of infection per tree.	No. of units. (1 unit = 10 trees.
	Mixtures used.	Adhesive per 100 gallons.			
1.	Bordeaux mixture 1%	Resin soda (8 lbs. + 4 lbs.)	2	5·8*	2
2.	,,	Casein (2 lbs)	2	2·5*	3
3.	,,	Coconut oil (½ gallon)	2	0·7*	3
4.	Bordeaux mixture 2%	Resin soda (8 lbs. + 4 lbs.)	2	5·4*	4
5.	,,	Casin (2 lbs.)	2	8·8	3
6.	,,	Coconut oil (½ gallon)	2	2·9*	3
7.	Bordeaux mixture 1%	Resin soda (8 lbs. + 4 lbs)	1	32·0	4
8.	,,	Casein (2 lbs.)	1	12·5	3
9.	,,	Coconut oil (½ gallon)	1	17.0	2
10.	Bordeaux mixture 2%	Resin soda (8 lbs. + 4 lbs.)	1	6·2*	2
11.	,,	Casein (2 lbs.)	1	3·3*	3
12.	,,	Coconut oil (½ gallon)	1	2·2*	1
13.	,,	Fish oil resin soap (10 lbs.)	2	7·0*	3
14.	Cuprous oxide 1%	Casein (2 lbs.)	2	14·6	4
15.	Bordeaux mixture 2%	Niger oil (½ gallon)	2	2·5*	3
16.	,,	Without adhesive	2	2·8*	3
17.	Control	No spraying	–	34·9	3

* Effective treatments not significantly different from each other. A block of 17 units was rejected as there was no disease in that block.

Note:— For the double spraying series the first spraying was given between the 23rd and 30th May and the second spraying between the 23rd and 30th July 1937. For the single spraying series, the spraying was given between the 3rd and 8th July 1937. The monsoon in 1937 was particularly late as it commenced only on the 10th June.

Analysis of variance of Treatment effects on mahali infection in Vittal and Kandigai experiments.

Variations due to	Degree of freedom	Sum of squares	Mean square
Between treatments	16	5, 26, 99·89	3293·7
Remainder	28	2, 31, 72·36	,,
Between plots	44	7, 58, 72·25	,,
Within plots	445	13, 63 75·39	306·48
Total	489	21, 22, 47·64	

$P < \cdot 01$

The treatment effects are significant.

Main effects of treatment.			Infection per plant.
Bordeaux mixture	1%	13	Significant.
	2%	5·1	
Adhesives	Resin	14·5	Significant.
	Casein	6·8	
	Oil	5·2	Not significant,
Number of sprayings	Single	14·9	Significant.
	Double	4·3	

APPENDIX II

Comparative cost of chemicals and adhesives required for spraying 500 tress. (50 gallons of 2% Bordeaux mixture.)

Resin Bordeaux.		Rs.	Oil Bordeaux.		Rs.
Copper sulphate	10 lbs.	1 14 0	Copper sulphate	10 lbs.	1 14 0
Lime	10 „	0 5 0	Lime	10 „	0 5 0
Resin	4 „	0 12 0	Niger oil	8 oz.	0 1 0
Soda	2 „	0 4 0			
	Total.	3 3 0			2 4 0

Casein Bordeaux.			Plain Bordeaux.		
Copper sulphate	10 lbs.	1 14 0	Copper sulphate	10 lbs.	1 14 0
Lime	10 „	0 5 0	Lime	10 „	0 5 0
Casein	1 lb.	0 4 0			
	Total.	2 7 0			2 3 0

EXTRACTS

Soil Erosion-Bunding Classes. In 1813 Jefferson wrote of his farm in Virginia "our country is hilly and we have been in the habit of plowing in straight rows, whether up or down hill..... and our soil was rapidly running into the rivers. We now plow horizontally, following the curvature of the hills and hollows on head level. Every furrow thus acts as a reservoir to receive and retain the water, all of which goes to the benefit of the growing plant instead of running off into the stream." A few careful cultivators appreciated the damage due to erosion but Americans as a class were indifferent. There was always virgin land available. Limit was reached. A century and a quarter later, it was noticed that "while the United States formerly produced a thousand million bushels of wheat in a single year, and had substantial surplus for export, now that was being imported from Canada, President Roosevelt set up a Commission to warn the country that the public estate would entirely disappear in another hundred years, unless nation-wide conservation steps were taken early." Some of the findings of the Commission were staggering as under.

1. Forest Resources are reduced by half.

2. One billion acres of land has lost, by erosion or wind from one to three fourths of the top soil.

3. One hundred million acres of the finest agricultural land will never again be tilled.

4. Three million tons of solid material are washed out of fields and pastures every year by water erosion. Morris L. Cooks, sometime chairman of the National Resources Board, sums up: "Just as with bodily diseases such as cancer

or tuberculosis which can be cured only in the early stages, so it is with soil built up through the ages. Once depleted beyond a certain point, they are incapable of restoration except by nature's slow process which are measured not in tens, but in thousands of years..... I believe that at our present rate of soil erosion this country of ours has left to it less than a century of virile existence..."

The President has acted quickly and vast organizations have been set up to assist nature in restoring the balance.

Soil erosion has had its effect on the destiny of every agricultural people whose rise and fall history records. The ancient Mayens Civilization -China— the fall of the Roman Empire are a few instances that have been affected in some way by this menace.

Gullying can be invited either by careless management of cultivated soil or on grassland by overgrazing which bares the surface. Streams will begin to flow during the rains and acquire sufficient velocity to cut into the soil. The gullying started in how-ever small a way, if it is not checked, develops year to year, into extensive wide and deep cuts. In a recent book "Rich Land, Poor Land" is described a great crater in Georgia, U. S. A., 200 feet deep, that has arisen from a simple gully. "Do you know what started him? A trickle of water running off a farmer's barn 40 years ago. Just one damn little trickle, and now a third of the country's gone—forty thousand acres". Deep ravines are formed along the banks of several rivers in Gujarat.

In our province the soil erosion problem had attracted the attention of the Department in 1916, as would be seen by the Director of Agriculture's general remarks (1916—17). "Another important matter is the question of controlling the surface wash on undulating land and the prevention of excessive erosion which is taking place yearly". Even before the Royal Commission of Agriculture in India, officers of the various departments and the public witnesses have pleaded for the prevention of soil erosion. Mr. Gordon, as a witness before the Commission speaking for the Bijapur District considered bunding and levelling as a most important piece of work.....and believed it would affect a very large area, and stated that he was held up by want of funds and technical advice.

We have now a bunding officer for each of the three divisions, i. e Poona, Nasik and Dharwar. Good schemes have come into being with the help of this limited staff. The present Government have seriously taken up this problem and have sanctioned the liberal sum of Rs. 40,000 for the training of the cultivators in the art of the prevention of the soil erosion. Bunding classes have been commenced at different centres and the keenness of the cultivators is manifested by their enthusiasm. After this short training they would be able to tackle the simple cases for themselves. The classes have been successful to bring the problem prominently before them and make them "Bunding minded."—*Poona Agricultural College Magazine*, July 1938.

American cotton and World markets by Dudley Windel, Economist, Liverpool, England. "Since last August the World situation has deteriorated considerably in both a political and economical sense.

Economically there has been a sharp recession; commodity prices have fallen severely and industrial activity has moved steadily downwards since last summer. The textile trades have felt the full force of the depression; mill consumption has contracted appreciably compared with a year ago."

"Something appears to be fundamentally wrong in our present economic system that prevents the distribution of the plenty which industrial power production and scientific agriculture can today create.

Features of the 1937--38 season. "Added to the July, 1937, world carryover of 6,250,000 bales, the harvest of 18,500,000 bales gave a total available supply for 1937-38 season of 24,750,000 bales as against 19,400,000 bales in 1936-37 and 26,200,000 bales in 1932-33. World consumption last season, however, was probably only around 11,000,000 bales as against 13,100,000 bales in 1936-37 and 14,400,000 bales in 1932-33. This left an end-of-season world carryover of about 13,750,000 bales, as against 6,200,000 bales in July 1937, and 13,300,000 bales in July 1931.

The falling off in consumption last season compared with the 1936-37 season was due very largely to a reduction of about 2,000,000 bales in United States domestic use, European and Oriental consumption showing no important change, Although southern exports to Great Britain were around 400,000 bales larger. Lancashire's consumption was about the same as the 1936-37 figure of 1,?50,000 bales and end-of-seasons stocks in British mills and ports were consequently correspondingly higher. Southern exports to the continent were about 450,000 bales larger, but, as continental consumption did not increase to any appreciable extent, mill and port stocks at the end of July were also heavier than in July 1937. Southern exports to Japan declined severely but mill consumption did not fall to the same extent ; mill and port stocks at the beginning of the season were fairly large and these were drawn upon to make good the deficiency in imports. Stocks at the end of the season, however, were virtually exhausted. Exports to India were about 150,000 bales larger than in 1936-37. Total Southern exports during the past season were only slightly more than in the previous season—increased shipments to Europe being approximately off-set by decreased shipments to the Orient."

Why Southern Exports failed to expand. "During the 1937-38 season U. S. A. consumed domestically about 5,700,000 bales and exported about 5,800,000 bales, making a total of 11,500,000 bales. These figures compare with 7,768,000 and 5,511,000 bales respectively in the 1936-37 season. The failure of her exports to expand appreciably following the record 1937 production and the more favourable price relationship of American cotton to competitive Foreign cottons was due to several causes: Firstly, the general recession in trade reduced the mill demand for all kinds of cottons; secondly, the economic difficulties of Japan resulting from the conflict with China forced her heavily to curtail all cotton imports; thirdly, European countries such as Germany, Italy, Poland, Rumania, etc., continued their policy of economic nationalism, substituting home-made synthetic fibres for raw cotton as far as possible and buying foreign cottons on a barter basis because a lack of dollar exchange precluded them from materially increasing their purchases of American cotton.

Competition from foreign cottons. "World production of foreign cottons during the past season reached the huge figure of around 18,000,000 bales in spite of a poor harvest in China which suffered badly from war and weather damage. Brazil, Egypt and Russia produced record crops and average yields were obtained in India, Africa and most of the smaller cotton growing countries. World consumption of foreign cotton, however, declined severely due partly to increased competitions from American cotton in Europe and partly to the heavy reduction in consumption by China and Japan. The end-of-season world carryover of foreign cottons was probably between 9,500,000 and 10,000,000 bales as against 7,000,000 bales in July 1937, the increase being composed mainly of Indian, Egyptian and South American cottons.

Future Export prospects. The outlook is not promising unless there is a marked change for the better in general world political and economic conditions., At present, international trade in goods and commodities is being seriously impeded by all sorts of devices—tariffs, quotas, exchange restrictions. Fear of

war is influencing most nations to develop economic self-sufficiency to a maximum. Industrialization is spreading rapidly to former purely agricultural countries. Huge expenditures on rearmament are making it impossible for debtor nations to import their normal raw material requirements. Increased agricultural and industrial productivity has created a glut of raw materials and goods and prices have fallen to levels at which the huge burden of bonded debt is crippling fresh enterprise While millions of people are suffering from poverty and unsatisfied want, men and machines are idle, and the production of material wealth has to be restricted and surpluses destroyed.

The situation in Lancashire. Exports of yarn and cloth during the first half of the year were the smallest recorded for this period in any of the post-war years. More machinery is inactive today than at the nadir of the 1931–32 slump. Trade with India has dwindled to retail proportions owing to the impossibility of competing with the Indian domestic mills over a prohibitive import tariff. Business with Egypt has been seriously affected by the recent decision of the Egyptian Government to make big increases in import duties on foreign textiles. The slump in cocoa prices has caused a sharp contraction in the West African demand for textiles. Continental trade is greatly restricted by exchange restrictions and the Argentine offtake has decreased owing to the poor 1937 harvests, Columbia heavily reducing her imports in order to foster a domestic textile industry. The Sino-Japanese war has brought trade with China to a standstill. In the unprotected overseas markets Japanese competition continues with unabated severity. The Dominions and Crown colonies alone have maintained their purchases on a satisfactory scale.

This combination of unfavourable factors has resulted in heavy curtailment of raw cotton consumption in Lancashire.

In recent seasons, Lancashire has exported about 1,900,000 square yards of cotton piece goods and about 150,000,000 pounds of cotton yarn.

It is problematical if exports can be maintained in future seasons even at this level.

On present prospects, Lancashire will need about 1,000,000 bales of the American new crop during the current season and imports are unlikely to be much above this figure unless there is a marked recovery in international trade. Last season imports of American cotton totalled about 1,700,000 bales but of this only about 1,300,000 bales were consumed or reexported.

The Continental situation. "Situation last season started with promise but ended disappointingly.

Aggregate continental stocks of American cotton at the end of the season were about 250,000 to 300,000 bales larger than on July, 31, 1937. Total mill consumption at around 2,700,000 bales was only slightly larger than in the 1936–37 season. During the latter half of the past season textile trade in France, Belgium, Holland and Switzerland suffered a severe deterioration partly owing to the increase in political tension and partly owing to the recession in international trade generally. Mill activity in Germany and Italy held relatively stable, but both countries continued their policy of substituting home made synthetic fibres for raw cotton and developing barter trade as a means of securing essential imports of the latter.

The total continental consumption of American cotton last season was about 1,600,000 bales less than in the 1929–30 season, but consumption of foreign cotton was about 1,400,000 bales larger. The decline in American consumption has been due mainly to the substitution of Russian, East Indian, South American cottons, and to increased use of rayon staple fibre.

If present economic trends continue, it is doubtful if Great Britain and the Continent combined will be able to import more than 3,500,000 bales American cotton during the current season. The U. S. A. must realize that she can sell cotton freely to Europe only if she is prepared to accept competitive world prices and also take European manufactured goods in return. A high Washington loan against the 1938 crop would have no other effect than to increase the attractiveness of South American, Indian and other Foreign growths.

American cotton policy. To retain U. S. A. export markets for raw cotton she should produce relatively higher yields per acre than her foreign competitors by more scientific methods of cultivation. A Government export subsidy would be preferable to the present policy of fixed-price loans which result only in growing domestic surpluses. Large Washington loan stocks exert a depressing psychological effect on prices even if the cotton is withheld from the market. Also, it would appear imperative that Washington should make bilateral trade agreements with customer countries willing to exchange manufactured goods for her cotton. Unless U. S. A. buys, it is economically impossible for her to sell, especially as she is now a World creditor country. (Extracted from "*American Cotton Grower*" Harvest Edition 1938).

Gleanings.

Plant Hormones in Agriculture. Hormone dust promises to speed agriculture in field and garden, as the result of investigations of the Canadian National Research Council. Synthetic chemicals that grow roots on seeds and slips of plants many days before they otherwise would sprout are now ground into talc and other inert dusts for easier and more effective application.

Experiments of Dr. N. H. Grace are being extended this year to large field trials of actual grain production in various parts of Canada.

The use of chemical stimulants, plant hormones, is not new. For the past few years scientists and gardeners have been using naphthylacetic acid, indolylacetic acid and indolylbuttyric acid, all synthetically made from coal-tar and other substances, for getting roots started faster and more vigorously. Roots can even be made to grow where they would not normally appear.

The Canadian improvement is in the manner of application. Instead of putting the hormone chemicals in water and applying them that way, they are distributed in fine dust. It is easier to roll the seeds in the dust and stick the cuttings in fine powder. Wheat on the western plains may be able to get its roots in the soil faster and more surely if the seed wheat is dusted with hormones. In some cases this may mean the difference between getting a crop and not getting it. Winds are likely to blow the young sprouting seeds out of the ground if the roots do not anchor them speedily. Since the treatment causes the roots to "dig in" promptly, wheat so treated may withstand wind and drought at an earlier time after seeding.

Farmers already dust their seed with poison to kill fungus, and it is only necessary to add the hormone to the dust previously used. Demand in reducing the cost of these synthetic chemicals, and naphthylacetic acid costs about 10$ per pound. Seed for several thousand acres can be treated with a pound. Thus the treatment costs only about half a cent an acre.

Pioneers in plant hormone research were Drs. P. W. Zimmerman and A. E. Hitchcock, of the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., who in 1935 showed that some 16 new chemical substances would grow root "whiskers" upon plants, even in the most fantastic places, such as upon the flowers. They applied their chemicals as solutions in water or as salves.

Extraordinarily small amounts of the chemicals are needed. For instance, naphthylacetic acid is effective in a water solution containing one part per hundred million, and a single pound of it would make ten train loads, with each train of 100 tank cars, and every car containing 12,500 American gallons.

(Watson Davis in the *Supplement to Science*, page 7, Vol. 88, No. 2276, dated August 12, 1938).

Deep ploughing. For eight years experiments have been carried out at Cambridge to test the desirability and efficiency of the common forms of cultivation. The experiments were made on complete farming rotations of crops including wheat, sugarbeet, oats, beans and clover grown both on heavy and light types of land. Normal ploughing was compared with special very deep form of cultivation costing about twice as much as ploughing. No increase in yield was found to result from this special treatment. Thus the prediction of better rooting and consequently of higher yields was falsified. It follows that in cotton growing countries it would be very unwise to adopt the practice of deeper cultivation without rigorous experiments.

(Extracted from the *Annual Report for 1938 of the Administrative Council of Empire cotton growing corporation).*

Agricultural Jottings.

(From the Director of Agriculture, Madras).

TREATMENT OF JONNA SEED WITH SULPHUR DUST AGAINST SMUT

All dryland ryots are well aware of the fact that smut ("Katuka thegulu" in Telugu) is a serious disease of Jonna and that it reduces the yield and causes great loss to the crop. There is a simple and cheap remedy by which this loss could be avoided. It consists of treating the jonna seed with sulphur dust before sowing. Packets of fine sulphur could be had at Re. 0—1—6 per packet from the Depots of the local Agricultural Demonstrators. One packet is enough to treat nearly 30 lbs. of seed to sow 3 to 4 acres. The required quantity of jonna seed may be placed in a mud pot or vessel and sulphur added. Then the vessel should be thoroughly shaken so that all seeds get coated with the sulphur. The seed is then ready for sowing. The following is a recent experience of a prominent ryot of West Godavari district, M. R. Ry. Alapati Bulli Guravayya Garu as given by him :

"One of the Problems for us was to check the disease known as "Katuka thegulu" of Jonna which is an important food crop of my village. In the sowing season sulphur packets were brought and distributed free of cost to the ryots. But very few of us were willing in the first instance to try this remedy and had our own doubts. Somehow or other on the persuasions of the Agricultural Demonstrator myself and my friends treated the seed sufficient for about 100 acres belonging to more than a dozen of us, and sowed the crop. When the harvesting season approached, we made it a point to go round the fields and inspect the crop to find out how far the remedy was really effective. To our great surprise we found not even a single diseased earhead. We then doubted whether this absence of the disease was due to the season. For this purpose we also went round and inspected the crop of our friends who had not treated the seed. We found about 50% of the earheads affected by this disease in the untreated fields. We came to know that this is really a cheap and an effective remedy and began to persuade our friends to take up this treatment. In the subsequent season more than 500 acres were treated and in 1937, 600 acres were treated in this locality. We are indeed very thankful to the Agricultural Department to have given us the remedy for an important disease and we hope we shall have the advantage of having more of such help".

EPILACHNA ON BRINJAL AND ITS CONTROL IN ANAKAPALLI AREA

Anakapalle in Vizagapatam district is an important vegetable growing centre. Of the vegetables grown, brinjal occupies a prominent place, and this crop when grown on old village sites proves very delicious and profitable.

2. The crop is grown in the locality to an exent of about 150 acres in the two main seasons. The common pest on this crop is the Epilachna. (Telugu—Atchintala Purugu). The beetles and grubs of this pest scrape away the green matter from the leaves and ultimately kill the plants. From a distance the infested crop can be distinguished from its reddish unhealthy appearance. On approaching an attacked plant we find the scraped portions of leaves forming some patches of characteristic appearance, and the whole plant putting up an unhealthy form. The affected leaves also show the presence of grubs unless they are forced to seek shelter on the stems either for pupation or to avoid the hot sun. The loss on account of this pest is very heavy especially when the crop is in its early stages, as the plants are not allowed to grow and come to bearing. On account of the set back received the plants may even die. On a modest estimate it can be stated that the average loss on account of this pest to a crop of brinjal is about Rs. 100 per acre.

3. The pest appears in all stages of the crop from nursery down to the main crop. Under favourable conditions the pest spreads very rapidly. The general practice of the ryot is to sprinkle a few handfuls of ashes on the affected leaves, and the stems, but it is in no way effective.

4. After some successful demonstrations the Agricultural Department started a regular campaign against this pest in the Anakapalli area, and during this year about 20 acres of this vegetable crop were sprayed with calcium arsenate to dislodge the pest from the infested fields and also prevent its further spread to other fields. Calcium arsenate serves as a stomach poison to the grubs as well as beetles, and when it is taken into the stomach of the insect along with the leaf on which it is sprayed, it acts as a poison and kills the insect. The dose of calcium arsenate used is 1 ounce with another ounce of lime in 2 gallons of water. In few cases the spraying may have to be repeated twice. About 72 gallons of fluid with $2\frac{3}{4}$ lbs. of calcium arsenate is required to treat an acre The cost of insecticide to treat an acre comes to about Rs. 2—8—0. Labour required for spraying comes to 3 men at Rs. 0—4—0 each, total Rs. 0—12—0; but for all practical purposes labour need not be taken into consideration as the ryot and his family attend to the spraying work. The spraying of calcium arsenate is so effective that the grubs of the pest are killed and the pest is completely wiped out in 2 or 3 days, as a consequence of which the shoots of the treated plants come up with renewed vigour and bring about a striking contrast with the previous decaying crop. The Anakapalli ryots are very well impressed with spraying and volunteer to get their brinjal crops sprayed by the Department paying the cost of the insecticide required for treatment.

THE SINDWAHE FURNACE AND TURMERIC BOILING AT CUMBUM (KURNOOL DISTRICT)

The Sindwahe Furnace is an improvement over the local furnace, employed in boiling down cane juice for the manufacture of jaggery. This furnace has become very popular with many cane growers. A full description of the furnace and the advantages it possesses over other furnaces is given in the departmental leaflet No. 29, which can be had free on application to the Agricultural Demonstrator stationed in almost all the taluks of the Presidency. The furnace was introduced two years back at Cumbum to reduce the cost of the manufacture of jaggery by using megasse and cane trash as fuel in place of costly firewood

required to be used for the local furnace. The ryots are saving nearly Rs. 18 per acre by the use of this furnace. In those days of low prices of agricultural commodities any reduction in the cost of cultivation must be welcome. The Sindwahe furnace is now constructed by the ryots themselves without departmental help.

This furnace was used for boiling turmeric rhizomes also. Recently a certain ryot boiled the produce of 1·5 acres—(turmeric rhizomes) and the fuel used by him was only the dried leaf of the turmeric crop from the above area plus one and a half cartloads of groundnut husk costing Rs. 0—12—0 only. Boiling over the local furnace would require 2 cart loads of firewood costing nearly Rs. 10. The saving effected by the improved furnace in the use of fuel works out to Rs. 6—3—0 per acre, which is by no means a small income to the ryots, in these days of fall in prices. It is hoped that more ryots will adopt this useful practice.

Crop and Trade Reports.

Paddy—1938-39—Intermediate Monthly Report. The harvest of first crop paddy has either concluded or is concluding in parts of the Central districts, the South and the West Coast. The yield is reported to be normal in Tanjore and the West Coast and generally below the normal in the other districts. The standing crop is reported to have been affected to some extent by drought in parts of Vizagapatam, Kurnool, Cuddapah, the Carnatic, Chittoor, Salem, Coimbatore, Tanjore and Ramnad and by the attack of insects in parts of Vizagapatam and Kurnool. The condition of the crop is reported to be generally satisfactory in the other districts.

2. The wholesale price of paddy, second sort per imperial maund of 82⅔ lbs. as reported from important markets on 7th November 1938 was Rs. 2—11—0 in Madura, Rs. 2—8—0 in Virudhunagar, Rs. 2—6—0 in Trichinopoly and Tinnevelly, Rs. 2—5—0 in Vizianagaram, Bezwada, Masulipatam and Guntur, Rs. 2—4—0 in Ellore, Rs. 2—3—0 in Rajahmundry and Chittoor, Rs. 2—2—0 in Cocanada, Anantapur, Hindupur and Vellore, Rs. 2—1—0 in Kumbakonam, Rs 2 in Cuddalore, Rs. 1—15—0 in Nagapatam, Rs. 1—13—0 in Mangalore and Rs. 1—11—0 in Conjeevaram. When compared with the prices published in the last report, i. e. those which prevailed on 10th October 1938, these prices reveal a fall of 18 per cent. in Mangalore, 5 per cent. in Hindupur, 3 per cent. in Vizianagaram and Anantapur and one per cent. in Ellore and a rise of 4 per cent. in Masulipatam, 3 per cent. in Bezwada, Trichinopoly and Tinnevelly and one per cent. in Rajahmundry, the prices remaining stationary in the other markets.

Sugarcane—1938—Intermediate condition report. The condition of the sugarcane crop is generally satisfactory in all districts except South Kanara where the crop has been damaged by floods in parts. The yield is expected to be normal outside South Kanara if future seasonal conditions are favourable.

2. The wholesale price of jaggery per imperial maund of 82⅔ lbs. (equivalent to 3,200 tolas) as reported from important markets on 8th November 1938 was Rs. 9—14—0 in Adoni, Rs. 8—9—0 in Chittoor, Rs. 8—1—0 in Vellore, Rs. 7—10—0 in Trichinopoly, Rs. 6—14—0 in Vizagapatam, Rs. 6—7—0 in Cuddalore and Mangalore, Rs. 6—0—0 in Rajahmundry, Rs. 5—12—0 in Cocanada, Rs. 5—6—0 in Erode, Rs. 5—4—0 in Vizianagaram and Salem and Rs. 4—15—0 in Bellary. When compared with the prices published in the last report, i. e., those which prevailed on 10th October 1938, these prices reveal a rise of about 23 per cent. in Trichinopoly, 12 per cent. in Cuddalore, 10 per cent. in Bellary, 6 per cent. in Salem, 5 per cent. in Vizagapatam and 3 per cent. in Cocanada and a fall of 6 per

cent. in Mangalore, 5 per cent. in Vizianagaram and 4 per cent. in Chittoor, the prices remaining stationary in Rajahmundry, Adoni, Vellore and Erode.

Cotton—1938-39—Second Forecast Report. The average of the areas under cotton in the Madras Province during the five years ending 1936--37 has represented 9 6 per cent of the total area under cotton in India.

2. The area under cotton up to the 25th September 1938 is estimated at 833,200 acres. When compared with the area of 656,700 acres estimated for the corresponding period of last year, it reveals an increase of 26·9 per cent. The increase in area is marked in Bellary where it is estimated to have risen from 190,000 acres to 325,000 acres.

3. The area in the Central districts and the South relates partly to the last year's crop and partly to the current year's sowings which have commenced in parts.

4. The condition of the standing crop is generally satisfactory.

5. The wholesale price of cotton lint per imperial maund of 82-2/7 lb. as reported from important markets on 4th October 1938 was about Rs. 13—13—0 for Cocanadas, Rs. 16--7—0 for Red Northerns, Rs. 14—4—0 for White Northerns, Rs. 11—4—0 for Westerns (Mungari crop), Rs. 13—2—0 for Westerns (Jowari crop), Rs. 21—10—0 for Coimbatore Cambodia, Rs. 16—0—0 for Southern Cambodia, Rs. 19—7—0 for Coimbatore Karunganni, Rs. 15--7—0 for Tinnevelly Karunganni, Rs. 14—2—0 for Tinnevellies and Rs. 15—4—0 for Nadam cotton. When compared with the prices published in the last report, i.e., those which prevailed on 5th September 1938, the prices reveal a fall of five per cent in the case of Southern Cambodia and Tinnevelly Karunganni, four per cent in the case of Tinnevellies, three per cent in the case of Coimbatore Karunganni, two per cent. in the case of Coimbatore Cambodia and one per cent in the case of Westerns (Mungari) and a rise of one per cent in the case of Cocanadas, the prices of Northerns (Red and White varieties), Westerns (Jowari) and Nadam remaining stationary.

6. Figures by districts are given below :—

(Area in hundreds of acres, i.e., 00 being omitted)

District and tract.	Estimate of the area sown up to the end of			Increase (+) or decrease (-) of the area in column (3) as compared with the area in column (4)
	July 1938	September 1938	September 1937	
(1)	(2)	(3)	(4)	(5)
	Acs.	Acs.	Acs.	Acs.
Madura ...	34,0	41,0	43 0	- 2,0
Ramnad ...	10,0	12,0	14,0	- 2,0
Tinnevelly ...	12,0	12,0	14,0	- 2,0
Chingleput ...	...	...	...	...
South Arcot ...	4,0	5,0	7,0	- 2,0
Chittoor ...	...	1	1	...
North Arcot ...	3	7	8	- 1
Salem ...	29,0	35,0	44,0	- 9,0
Coimbatore ...	33,0	53,0	62,0	- 9.0
Trichinopoly ...	12,5	14,0	15,0	- 1,0
Tanjore ...	...	...	...	...
Malabar ...	1	2	2	...
South Kanara ...	2	2	2	...
Total, mainly Cambodia including Nadam and Bourbon.	135,1	173,2	200,3	- 27,1

Kurnool ...	47,0	148,0	105,0	+ 43,0
Bellary ...	75,0	325,0	190,0	+135,0
Anantapur ...	4,5	55,0	67,0	- 12,0
Cuddapah ...	6	37,0	8,0	+ 29,0
Total, Northerns and Westerns.	127,1	565,0	370,0	+195,0
Vizagapatam (Golgonda taluk)	1,8	2,0	2,0	...
East Godavari ...	5	2,7	2,3	+ 4
West Godavari ...	5	5	7	- 2
Kistna ...	1,0	1,3	4	+ 9
Guntur ..	12.0	67,0	55,0	+ 12,0
Nellore ...	1	15,0	19,0	- 4,0
Total, Cocanadas	15,9	88,5	79,4	+ 9,1
Vizagapatam (except Golgonda taluk)	6,2	6,5	7,0	- 5
Grand Total	284,3	833,2	656,7	+176,5

Cotton—1938-39—Intermediate Monthly Report. In parts of the Central districts and the South, the sowings of cotton are reported to have been delayed for want of sufficient rains in October and consequently the area under the crop is expected to be generally below the normal in these tracts. The condition of the standing crop is generally fair except in Coimbatore where the early sown crop of Cambodia is reported to have been stunted in growth owing to drought and insect attack.

2. In the Deccan, the condition of the crop (both mungari and hingari) is on the whole satisfactory. Pickings of the mungari or early sown crop have commenced in parts of the districts of Kurnool and Bellary. The yield is expected to be normal.

3. The local cotton trade is not generally active at this time of the year. The wholesale price of cotton lint per imperial maund of 82⅔ lb. as reported from important markets on 7th November 1938 was about Rs. 13—13—0 for Cocanadas, Rs. 16-7-0 for red Northerns, Rs. 14-4-0 for white Northerns, Rs. 11-3-0 for Westerns (Mungari crop) Rs. 13—1—0 for Westerns (Jowari crop), Rs. 22—5—0 for Coimbatore Cambodia, Rs. 16—12—0 for Southern Cambodia, Rs. 19—12—0 for Coimbatore Karunganni, Rs. 15—8—0 for Tinnevelly Karunganni, Rs. 14—5—0 for Tinnevellies and Rs. 16—6—0 for Nadam cotton. When compared with the prices published in the last report, i. e., those which prevailed on 4th October 1938, these prices reveal a fall of one per cent. in the case of Westerns (Mungari and Jowari) and a rise of eight per cent. in the case of Nadam cotton, five per cent. in the case of Southern Cambodia, three per cent. in the case of Coimbatore Cambodia, two per cent. in the case of Coimbatore Karunganni one per cent. in the case of Tinnevellies, the prices of Cocanadas, Northerns (red and white varieties) and Tinnevelly Karunganni remaining stationary.

Groundnut—1938—Intermediate condition report. The condition of the winter crop of groundnut is generally satisfactory in East Godavari, West Godavari, Kistna, Guntur, Bellary, Anantapur, Nellore, Coimbatore and Malabar. Elsewhere the crop has been affected by the hairy caterpillar in parts of Salem, Trichinopoly and Madura and by drought in the remaining districts.

2. The wholesale price of groundnut (shelled) per imperial maund of 82⅔ lbs. (equivalent to 3,200 tolas) as reported from important markets on 7th November 1938 was Rs. 3—15—0 in Cuddalore, Rs. 3—12—0 in Anantapur, Rs. 3—10—0 in Vizagapatam and Guntur, Rs. 3—9—0 in Vizianagaram, Rs. 3—5—0 in Vellore,

Rs. 3-3-0 in Coimbatore, Rs. 3—2—0 in Cuddapah, Rs. 2—15—0 in Nandyal, Bellary and Tadpatri, Rs. 2—14—0 in Adoni and Rs. 2—13—0 in Hindupur. When compared with the prices published in the last report i. e., those which prevailed on 10th October 1938, these prices reveal a rise of 20 per cent. in Anantapur and 2 per cent. in Coimbatore and a fall of 6 per cent. in Hindupur and Tadpatri, 5 per cant. in Guntur and Cuddalore, 3 per cent. in Vizagapatam and Vizianagaram and 2 per cent. in Adoni, the prices remaining stationary in Bellary and Vellore.

Gingelly—1938-39—Intermediate condition report. The gingelly crop has been affected to some extent by drought in parts of Vizagapatam, Bellary, Chingleput Chittoor, North Arcot, Salem, Coimbatore, Trichinopoly, Madura, Ramnad, Tinnevelly, Malabar and South Kanara. The yield is expected to be normal outside these districts.

2. The wholesale price of gingelly per imperial maund of 82⅔ lbs. (equivalent to 3,200 tolas) as reported from important markets on 7th November 1938 was Rs. 6—9—0 in Trichinopoly, Rs. 6—2—0 in Tinnevelly, Rs. 6—1—0 in Salem, Rs. 5—15—0 in Cuddalore, Rs. 5—9—0 in Tuticorin, Rs. 5—6—0 in Cocanada, Rs. 5—5—0 in Rajahmundry, Rs. 5—2—0 in Vizianagaram, Rs. 5—1—0 in Ellore and Rs. 4—12—0 in Vizagapatam. When compared with the prices published in the last report, i. e., those which prevailed on 10th October 1938, these prices reveal a rise of about 4 per cent. in Cuddalore and Tinnevelly, 3 per cent. in Vizagapatam and Vizianagaram, 2 per cent. in Trichinopoly and Tuticorin and one per cent. in Rajahmundry and a fall of 9 per cent. in Ellore, the prices remaining stationary in Cocanada and Salem. (*Director of Industries, Madras*).

Cotton Raw in the Madras Presidency. The receipts of loose cotton at presses and spinning mills in the Madras Presidency from 1st February 1938 to 18th November 1938 amounted to 486,002 bales of 400 lb. lint as against an estimate of 505,200 bales of the total crop of 1937-38. The receipts in the corresponding period of the previous year were 492,572 bales. 406,195 bales mainly of pressed cotton were received at spinning mills and 90,116 bales were exported by sea while 67,909 bales were imported by sea mainly from Karachi and Bombay.

(*Director of Agriculture, Madras*).

College News and Notes.

Students' Corner. *Students' club.* That "the introduction of compulsory Hindi in our schools is a necessary step for achieving national unity" was the subject of a debate held on the 2nd November 1938 in the Freeman Hall under the Presidency of Mr. R. C. Broadfoot, Principal. K. S. Sankaran the mover opened the debate with an interesting and fluent speech. This was suitably opposed by S. K. Joshi. Several speakers including the members of the staff participated in the discussion. The proposition when put to vote was carried by a large majority.

On the 14th November 1938 a debate was held in the Freeman Hall in which four institutions viz., our College, the Government Arts College, the Theosophical Society and the Literary Association, Coimbatore participated. Miss Southgate was the speaker and Mrs. Coelho, the Observer. Initiating the debate "that the abolition of all religions would be a constructive step taken towards humanity's progress", Mr. Louis Royal brought out that religion was the root cause of all human atrocities. Mr. D. Narayana Rao, in opposing, dwelt on the influence of religion on man's life. The subject was discussed threadbare by the several speakers, and on being put to vote lost by an overwhelming majority.

The Hon'ble Minister for Local Self-Government, Sri. B. Gopal Reddi, addressed the students at 11 a. m. on 15--11—'38 at a meeting held in the Freeman

Hall with Mr. R. C. Broadfoot. Principal, in the chair. He asked the students to identify themselves with the life of the villagers with whom they have to deal and wanted them to think always in terms of their duties to the villagers. Finally he stressed on the importance of the spirit with which the villager has to be approached.

The Hon'ble Minister for Rural Development, Sri. V. I. Munuswamy Pillai was also kind enough to address the students at 10 a. m. on 19—11—'38. The meeting was held at the Freeman Hall under the presidency of Mr. R. C. Broadfoot. The Hon'ble Minister advised the students to concentrate on their studies, he asked them to bear in mind the various responsibilities which they will be called upon to shoulder in a free India, in increasing the productivity of the land.

Cricket. On 23—10—'38 a friendly match was played between C. Ramaswami's XI and H. Shiva Rao's XI. C. Ramaswami's XI batting first scored 197 (Ramaswami 103 retired, Adeni 25 not out; Subrahmanyam 6 for 51 and Shetty 3 for 24). Shiva Rao's XI replied with 124 (Babu 50, Shiva Rao 25, Nagaraja Rao 23; Hegde 6 for 22, Kothandaraman 4 for 63).

The Agricultural College beat the Maharajah's College, Ernakulam, in the Inter-collegiate Zone Finals at Ernakulam on 29-10-'38. The Maharajah's College Team scored 77 (Srinivasan 5 for 22, Dinker Rao 2 for 10 and Shetty 2 for 11). The visitors scored 80 and won the match (Nataraj 5 for 21).

A friendly match played with Princes Club, Ernakulam on 30-10-'38 resulted in a draw. Princes Club 135 (Kocha 57, Kunhunni 22, and Ravi Varma 20; Srinivasan 3 for 41, Dinkar Rao 2 for 40, and C. Ramaswami 2 for 5). Agricultural College 99 for 5 (C. Ramaswami 33 including four sixers; R. R. Varma 2 for 16 and Kocha 2 for 37).

Interclass Cricket Tournament for the Victory Cup between the third and the first year classes was played on 4-11-'38. The third year team entering first scored 141 (Menon 44, Nagaraja Rao 32, Dinkar Rao 24, Adeni 20; Srinivasan 5 for 62 and Govindarajan 3 for 11). The first year team were all skittled out for a total of 23 runs (Dinkar Rao 2 for 5, Shetty 3 for 5, Menon 2 for 3).

The match between second and third year classes was played on 12-11-'38, third year team having an easy victory. The second year team was out for 59 (Dinkar Rao 2 for 17, Shetty 4 for 17, Jayaraman 2 for 3). Third year 74 for no loss (Menon 44 not out).

A friendly match between the students and officers played on 5-11-'38 ended in a draw. Students 200 for 7 and declared (Dinker Rao 94, Nagaraja Rao 49; Kothandaraman 4 for 59 and C. Ramaswami 2 for 42). Officers 52 for 3 (Babu 22 not out; Hegde 2 for 7).

Inter-Collegiate quarter finals match was played with the Maharajah's College, Pudukottah on 16th and 17th November 1938 on the Agricultural College grounds. The Agricultural College piled up a huge total of 338, Shetty narrowly missing his century by 3 runs. Dinkar Rao was on top form claiming 13 wickets for 44 runs. Our College won the match by an innings and 216 runs. Agricultural College 338 (Shetty 97, Menon 75, Adeni 44, Dinker Rao 31; Srinivasa Gopal 4 for 94, Muthiah 3 for 71 and Jagannath 2 for 80). Maharajah's College 60 (Muthiah 21; Dinker Rao 7 for 18) and 62 (Dinker Rao 6 for 26 and Srinivasan 1 for 6).

Rajah's Club, Sivaganga who were on a visit to Coimbatore played a friendly match with the Agricultural College on 19-11-'38. The match ended in a draw. Agricultural College 192 (Srinivasan 65, Ramaswami 33, Shiva Rao 26 and Kothandaraman 23; Kannabiraman 2 for 74, Doraippan 4 for 35 and Natarajan 2 for 16). Sivaganga 78 for 6 (Venkataraman 36; Dinker Rao 2 for 16 and Kothandaraman 4 for 25).

Hockey. The quarter finals of the inter-collegiate tournament was played between the St. Alosius College, Mangalore and Agricultural College. The latter won by 4 goals to one; scoring honours were shared by Keshava Reddy (3) and Govindarajan (1).

Visitors. The Hon. Sri. T. Prakasam, Minister for Revenue, with his Parliamentary Secretary went round the Agricultural College and the Institute on 25-10-'38.

Sri. Belli Gowder, M.L.A., Honorary Visitor of the Agricultural College also visited the College on 4-11-'38.

On 15-11-'38 the Hon. Sri. Gopal Reddy, Minister for Local Self Government accompanied by his Parliamentary Secretary paid a visit to the College and Research Institute.

And on 19-11-'38 the Hon. V. I. Munuswamy Pillai, Minister for Agriculture and Rural Development went round the Central Farm, and the Institute.

Weather Review—OCTOBER 1938.

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	3·2	−4·8	32·2	South	Negapatam	9·9	−0·6	36·2
	Calingapatam	7·0	−1·0	38·7		Aduthurai *	7·1	−0·7	22·8
	Vizagapatam	6·7	−0·4	38·8		Madura	1·9	−5·9	21·2
	Anakapalli*	4·4	−3·4	42·6		Pamban	3·8	−5·2	18·8
	Samalkota*					Koilpatti*	3·3	−4·0	27·2
	Maruteru*	1·4	−7·3	38·7		Palamkottah	5·0	−1·8	21·1
	Cocanada	5·9	−2·0	45·4					
	Masulipatam	4·7	−3·4	31·7					
	Guntur*	0·8	−5·1	33·3	West Coast	Trivandrum	3·7	−6·9	51·0
Ceded Dists.	Kurnool	0·8	−2·7	23·5		Cochin	5·4	−7·8	80·9
	Nandyal*					Calicut	8·5	−1·7	131·3
	Hagari *	0·1	−3·6	22·9		Pattambi *	6·8	−5·8	86·1
	Siruguppa*	Nil.	−4·2	28 6		Taliparamba *			
	Bellary	0·2	−3·7	23·4		Kasargode *	7·0	−2·2	138·1
	Anantapur	0·2	−3·5	29·3		Nileshwar*	6·9	−1·9	145·6
	Rentachintala	1·6	...	28·9		Mangalore	2·9	−4·6	141 7
	Cuddapah	0·7	−4·3	33·4					
	Anantharaju-pet *	0·4	−6·3	22·5	Mysore and Coorg	Chitaldrug	0·7	−3·5	21·2
						Bangalore	1·1	−4·6	31·4
Carnatic	Nellore	5·7	−2·7	29·5		Mysore	1·4	−4·9	18·6
	Madras	7·9	−3·8	23·9		Mercara	8·0	−0·7	133·3
	Palur *	6 9	−3·5	36·6					
	Tindivanam *	2·3	−7·2	26·7					
	Cuddalore	9·4	−1·6	27·9	Hills	Kodaikanal	5·8	−3·9	43·5
Central	Vellore	0·8	−5·5	30·4		Coonoor			
	Salem	0·7	−6·0	28·9		Ootacamund *	2·1	−1·6	39·8
	Coimbatore	2 5	−3·9	11·1		Nanjanad *	2·8	−4·4	32·6
	Coimbatore A. C. & R. I.*	3·0	−2·7	11·4					
	Trichinopoly	3 2	−3·7	20·4					

* Meteorological Stations of the Madras Agricultural Department.

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

Weather Review for October 1938. During the first half of the month thunderstorms have been fairly widespread in the northern half of the Peninsula and the West Coast and local in Malabar, Berar, the East Central Provinces, Bengal and Orissa, while a few falls have been recorded from the West Central Provinces and the Madras Deccan. From the 26th onwards the North East Monsoon caused widespread thunder showers over the Madras Presidency.

A depression appeared in the Central Bay on the 6th, and becoming a severe storm crossed the Orrissa Ganjam Coast on the 10th and finally disappeared over Central India by the 13th.

Rainfall was general in Konkan, the Bombay Deccan, Hyderabad and local in Malabar and the North Madras Coast, while a few falls have been recorded in the Madras Deccan during the first half of the month ; while the onset of the North East Monsoon on the 26th of the month caused heavy showers in South East Madras and the South. The rainfall however was in defect all over the country.

Skies have been moderately to heavily clouded and the humidity has been generally in excess in the Konkan, the Bombay Deccan, Hyderabad and the North Madras.

The maximum temperatures have been below normal and the minimum temperatures above normal.

Chief amounts of rainfall.

Kodaikanal	1·0″ on the 17rh.
Cuddalore	1·6″ on the 18th & 4·6″ on 31st.
Coimbatore	1·1″ on 25th.
Masulipatam	4·4″ on 28th.
Nellore	3·4″ on 29th.
Negapatam	3·9″ on 31st.

Weather Report for Research Institute Observatory.

Report No. 10/38.

Absolute maximum in shade	...	90·0°F.
Absolute minimum in shade	...	60·7°F.
Mean maximum in shade	...	88·4°F.
Departure from normal	...	+0·6°F.
Mean minimum in shade	...	69·1°F.
Departure from normal	...	−1·1°F.
Total rainfall	...	3·02″
Departure from normal	...	−2·73
Heaviest fall in 24 hours	...	1·62″ on 29th.
Total number of rainy days	...	4.
Mean daily wind velocity	...	3 M. P. H.
Mean humidity at 8 hours	...	72%.
Departure from normal	...	−6·9%.

Summary. The monsoon was active during the 1st and last weeks of the month with a complete lull in the middle. The rainfall was practically received during the last week of the month. The total rainfall was 3·02″ of which 1·62″ was received on the 28th. The rainfall was largely in defect. The mean maximum temperature was slightly above normal while the mean minimum temperature and the mean humidity were in defect.

P. V. R. & F. L. D.

Departmental Notifications.

Transfers.

Name of officers.	From	To
Sri. N. Kesava Ayyangar,	Asst. in Cotton, Hagari (on leave)	Asst. in Cotton, Coimbatore.
„ C. K. Ramachandran,	Offg. Asst. in Cotton, Coimbatore	Offg. Cotton Asst., Hagari.
„ K. Meenakshisundaram,	Offg. Asst. in Cotton, Hagari	Offg. F. M., D. F. S., Hagari.
„ B. N. Padmanabha Ayyar,	Offg. F. M , D. F. S., Hagari	A. D., II Circle.
„ S. Kuppuswami Ayyangar,	A. D., Sriperumbudur	A. D. Puttur.
„ A. Muhammad Ali Sahib,	A. D., Puttur	A. D., Sriperumbudur.
„ T. Narayana Rao,	(On leave)	Asst. Millets, A. R. S., Guntur.
„ B. L. Narasimhamurthy,	Offg. Millets Asst.,	Asst., in Millets, A. R. S , Anakapalle.
„ R. Subbiah Pillai,	Millets Asst., A. R. S., Koilpatti.	Millets Asst., A. R. S., Palur.
„ J. S. C. Antony,	Asst. A. D.. Tinnevelly,	A. D., Groundnut, Warehouse, Cuddalore.
„ K. Kuppamuthu,	A. D., Warehouse, Cuddalore,	F. M., A. R. S., Palur.
„ K. S. Krishnamurthi Iyer,	A. D., Cuddalore,	A. D., Dindigul.
„ M. K. Swaminatha Ayyar,	A. D., Dindigul,	A. D., Devakottai.
„ S. V. Parthasarathy,	A. D., Nellore,	A. D., Adoni.
„ V. G. Venkataramana Rao,	A. D., Kandukur,	A. D., Palamaner.
„ V. Ratnaji Rao,	A. D., Nayudupet,	A. D., Sullurpet, New Sub-circle.
„ K. Rangachari,	A. D., Kavali,	A. D., Venkatagiri, New Sub-circle.
„ K. Ambikacharan,	A. D., Tirukoilur,	A. D., Rapur, New Sub-circle.
„ A. R. Subramania Ayyar,	Asst. A. D., Ramnad,	A. D., Udayagiri, New Sub-circle.
„ A. K. Ganesha Ayyar,	A. D. (on leave),	A. D., Ramnad.
„ M. Rama Reddy,	A. D. (on leave),	A. D., Anantapur.
„ M. Ratnavelu,	A. D., Tiruchengode,	A. D., Attur.
„ N. Narayana Ayyar.	A. D., Attur,	A. D., Tiruchengode.
„ G. K. Subramania Ayyar,	Asst. A. D. (on leave),	A. D., Hosur.
„ C. S. Sankaranarayana Ayyar,	A. D., Hosur,	A. D., Arkonam.
„ N. Krishna Pillai,	A. D., Cheyyar,	A. D., Tirupathur.
„ U. Muhammad Abass,	A. D., Tiruppur,	A. D., Cheyyar.
„ G. Venkataraman,	A. D., Gurzala,	A. D., Baptla.
„ K. K. Subramania Ayyar,	A. D., Srivaikuntam,	A. D., Devakottai.
„ J. S. C. Anthony,	Asst. A. D., Devakottai,	A. D., Srivaikuntam.

Leave.

Name of officers.	Period of leave.
Sri. S. Muthuswami, A. D., Tirukoilur.	L. a. p. for 1 month from the date of relief.
„ C. Ekambaram, F. M., A. R. S. Gudiyatam.	L. a. p. for 1 month from 24-10-'38.
Janab Mohammad Basheer, Offg. Asst. Entomology, Coimbatore.	L. a. p. for 10 days from 26-10-'38.
Sri. W. L. Srinivasa Rao, Asst. A. D., Kollegal.	L. a. p. for 19 days from 13-10-'38 and for 7 days from 9-11-'38.
Dr. R. Sankara Ayyar, Cotton Asst. Coimbatore.	Extension of leave without allowance for 8 months from 1-11-'38.
Sri. P. V. Hariharan, Millets Asst. A. R. S. Palur (on leave).	Extension of l. a. p. on m. c. for 2 months from 11-10-'38.
„ A. K. Ganesha Ayyar, A. D. (on leave).	Extension of l. a. p. on m. c. for 6 weeks from 4-10-'38.
„ M. C. Menon, A. D., Coondapoor.	L. a. p. for 1 month from 15-10-'38.
„ K. Venkataswami, Probationary, A. D., Kavali (on leave).	Extension of 1 month's earned leave from 4-11-'38.
„ N. Krishna Pillai, A. D., Cheyyar	Extension of l. a. p. for 1 month from 28-10-'38.
„ A. M. Muthayya Nattar, A. D., Pollachi (on leave)	Extension of l. a. p. on m. c. for 26 days from 1-11-'38.
„ P. S. Suryanarayana Ayyar, Asst., A. D. in Mycology, Cuddalore.	L. a. p. for 1 month and 26 days from 28-10-'38.
„ V. Viswanathan, Asst., A. D., Arkonam.	L. a. p. for 1½ months from 9-10-'38.
„ K. V. Reddy Naidu, A. D. (on leave).	Extraordinary leave on loss of pay for 2 months from 31-10-'38.
K. Soopi Haji Sahib, Asst. A. D., Badagara.	Extension of l. a. p. for 1 month and 23 days from 27-10-'38.
Sri P. Gopalaratnam, Senior Cotton Asst., A. R. S. Guntur.	L. a. p. for 1 month from 24-10-'38.
„ R. Balasubramania Ayyar, Cotton Asst. A. R. S. Guntur.	Extension of l. a. p. on m. c. for 2 months from 22-10-'38.
„ V. S. Rangacharlu, F. M., A. R. S. Guntur.	Earned leave for 25 days on l. a. p. and Extraordinary leave on loss of pay for 1 month from 24-10-'38.
„ C. Krishnan Nayar, Asst. in Mycology (on leave).	Extension of l. a. p. on m. c. for 3 months from 27-10-'38.
„ B. G. Narayana Menon, Offg. F. M., Nileswar.	L. a. p. for 30 days from 19-10-'38.
„ K. Vasudeva Shenoi, A. D., Coondapoor.	Extension of l. a. p. for 1 month from 16-11-'38.
„ T. R. Narayana Ayyar, Millets Asst., Coimbatore.	L. a. p. on m. c. for 4 months from 1-11-'38.
„ M. K. Padmanabhan, Asst., A. R. S. Pattambi.	L. a. p. for 7 days from 7-11-'38.
„ B. N. Padmanabha Ayyar, F. M., D. F. S. Hagari.	L. a. p. for 2 months from 20-10-'38.
„ P. Vishnusomayajulu, Asst., Mycology, Coimbatore.	L. a. p. for 1 month and 17 days from 7-11-'38.

Sri. B. Suryanarayana Murthy, F. M., A. R. S. Guntur.	L. a. p. for 25 days from 31-10-'38.
„ T. Paramanandam, A. D., Madanapalle.	Extension of l. a. p. for 15 days from 10-11-'38.
„ M. B. V. Narasinga Rao, Asst. in Paddy, A. R. S. Maruteru.	L. a. p. for 15 days from 10-11-'38.
„ P. S. Narayanaswami Ayyar, Temporary, Asst. in Entomology, Coimbatore.	L. a. p. for 1 month and 23 days from 1-11-'38.
„ K. Kunhikannan Nambiar, Asst., A. R. S. Pattambi.	L. a. p. for 12 days from 7-11-'36.
„ M. C. Menon, A. D., Badagara.	Extension of l. a. p. for 1 month from 15-11-'38.
„ U. Achyutha Wariar, Asst. in Millets, Coimbatore.	Extension of l. a. p. on m. c. for 3 months from 22-10-'38.
„ P. Govindakutty Kurup, Manager, Pomological Station, Coonoor.	L. a. p. for 28 days from 25-11-'38.