

THE CONFERENCE OF EMPIRE METEOROLOGISTS, 1929: AGRICULTURAL SECTION.

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INTRODUCTORY.

THE writer attended the Agricultural Section of the Conference of Empire Meteorologists as agricultural representative of Ceylon. The Conference was held in the large hall of the Civil Service Commission building in Burlington Gardens, London. In addition to the overseas delegates to the Meteorological Conference proper, representatives of the following countries attended the Agricultural Section: New Zealand, Northern Ireland, Egypt, Sudan, Uganda, Gold Coast, Nigeria, Trinidad, Nyasaland, and Ceylon. Mr. A. J. Bamford, Ceylon's Meteorological representative, also attended the sessions of the Agricultural Section. A budget of literature was issued to delegates before and during the conference, no less than 34 papers being given to the members of the Agricultural Section alone. A list of these is given at the end of this account.

JOINT SESSION OF AGRICULTURAL SECTION AND MAIN CONFERENCE.

On Wednesday, August 28th, a joint session of the main conference and the Agricultural Section was held with Dr. G. C. Simpson, Director of the Meteorological Office of the Air Ministry, in the chair.

The first item was a paper entitled "The Empire in Relation to International Meteorology" by Mr. R. G. K. Lempfert of the Meteorological Office. Mr. Lempfert outlined the origin and history of international co-operation in meteorology and showed the importance of the part played by the British Empire in this work. The starting point was the creation in 1903 of an International Meteorological Committee under the name of the "Solar Commission" presided over by the late Sir Norman Lockyer. The "Solar Commission" later became the "Commission for the 'Reseau Mondial,'" Dr. Simpson is now its president and the British Meteorological Office is responsible for the publication of the "Reseau Mondial."

The speaker then dealt with the publication of meteorological data by the Crown Colonies and Protectorates. He explained the improvements that had been gradually effected. The transmission to the Meteorological Office of two hundred reprints of

the meteorological tables published by Colonial Governments had made possible a wide distribution of information among meteorological institutes and observatories.

The publication by the Meteorological Office of the "Observer's Handbook" and the "Observer's Primer" had provided concise instructions for the layout and conduct of a meteorological station.

Dr. Brooks, also of the Meteorological Office, followed with a paper entitled "The Collection, Tabulation and Publication of Climatological Data." The paper dealt with the kinds of observations necessary, the instruments used, the difficulties encountered, the hours of observation, the form of the network of stations required, and the publication of results. Valuable remarks on improving the accuracy of observations were included. The paper concluded with a description of the forms used by the Meteorological Office and specimen forms were attached.

The next paper entitled "The Diurnal Variation of Meteorological Elements" was contributed by Mr. A. Walter, Director, British East African Meteorological Service. Mr. Walter held that sufficient attention had not been paid to diurnal variation in the tropics and that the averaging of hourly values was masking many of the processes of meteorological changes. He cited local instances of this.

The morning session was brought to a conclusion by a paper by Mr. N. P. Chamney, of the Gold Coast Department of Agriculture, entitled "A Preliminary Note on the Rainfall of West Africa." Mr. Chamney drew his data from 14 countries and 342 stations. Periodic curves for all stations with records going back over a fair period had so far failed to show marked periodicity, unless the rhythm of recurrences was a very long one, but a very marked diminution of rainfall was shown to have occurred on the coast between Sierra Leone and Senegal, while a similar diminution was shown at one station in Gambia and two on the Gold Coast. Mr. Chamney attributed this diminution partly to the deforestation resulting from the system of shifting cultivation adopted by the African races. Mr. Chamney also had some interesting remarks to make on the measurement of effective rainfall as opposed to absolute rainfall.

The afternoon session opened with a paper on "Long Range Forecasting" by Sir Gilbert Walker presented by Dr. G. C. Simpson. The paper dealt with the methods so far used to foreshadow seasonal rainfall. These were based on a study of (a) relations with sun spots, (b) strict periodicities, (c) "surges," (d) motion of the belts of high pressure, and (e) relations with previous weather conditions in various parts of the world. After discussing the degree of accuracy required in

correlating data from past records, Sir Gilbert suggested that it would be better to forecast that rainfall would be "in excess" or "in defect" rather than issue such vague forecasts as "normal" or "in excess" in order to avoid misunderstanding or claims of success in a forecast which was really a failure. He preferred the term "foreshadowing" to the more ambitious word "forecasting."

The next paper by Mr. D. Brunt was entitled "On Forecasting by Periodicity." Mr. Brunt from a prolonged study of European records extending over a hundred years had failed to discover any true periodicity in weather conditions.

Dr. Norman, Director-General of Observatories, India, spoke on seasonal forecasting and emphasised the extreme importance of forecasting the monsoon rainfall in India. He dealt with difficulties and likely avenues of progress. He thought that the primary need was for more data of winds and temperatures in the upper air.

Mr. C. Stewart, Chief Meteorologist, South Africa, said that South Africa, lying between two anticyclones, was peculiarly liable to droughts of great intensity and long duration. The forecasting of such conditions as early as possible was most desirable. There was some indication of a 14-year periodicity in such droughts.

Col. Gold of the Meteorological Office gave an account of a paper by Mr. H. G. Hunt, Commonwealth Meteorologist in Australia, which was to be published in *The Quarterly Journal of the Royal Meteorological Society*.

Mr. Jacob made some interesting remarks on the correlation between winter rainfall and monsoon rainfall in northern India.

Mr. Bamford said that seasonal forecasts for the monsoon had been issued in Ceylon during the last few years, but the practical question was complicated by the fact that as much rain fell in an inter-monsoon month, such as April as in a typical monsoon month, such as June, while the public displayed a strong desire to class all rain as monsoonal. Monsoon rainfall showed a certain amount of periodicity but not sufficient for a definite forecast to be made from periodicity alone. Other factors which showed an appreciable correlation with the rainfall of the following monsoon were the inter-monsoon thunderstorms and the temperatures of February.

Mr. L. J. Sutton discussed the sources of information on which attempts to forecast the Nile Floods were based. He said that the network of stations in the Sudan was insufficient to enable this to be done at present with any degree of certainty. More stations were particularly required in the sparsely-inhabited regions of the south-western Sudan and the Belgian Congo, but facilities were scarce.

Dr. C. C. P. Brooks said that Sir Gilbert Walker's systematic investigations into the relations between numerous action centres in all parts of the world had made long-range forecasts at certain seasons practicable for quite a number of countries.

Sir Napier Shaw thought that there was no guarantee that Sir Gilbert Walker's "centres of action" would remain in action for an indefinite period. It was unsafe to assume continuity of meteorological phenomena. He thought that the detection of periodicity possibly required a special acuteness of sense. He welcomed Dr. Norman's remarks about the correlation between upper winds and the monsoon rainfall in northern India. Consideration of the use of upper air conditions as a guide to surface weather was one of the most encouraging features of the discussion.

This terminated the day's session. During the evening Colonel Sir Henry Lyons, Director of the Science Museum, South Kensington, held a reception at the Science Museum. A large representative historical collection of meteorological instruments was on view in the galleries of the museum and the history and use of these instruments was explained to delegates and their friends.

SESSIONS OF THE AGRICULTURAL SECTION.

On Thursday, August 29th, the separate Sessions of the Agricultural Section of the conference began under the chairmanship of Sir Napier Shaw, F.R.S. The Chairman's refreshing personality and penetrating sense of humour considerably lightened the atmosphere of the subsequent deliberations. In addition to the overseas agricultural representatives the majority of the delegates of the meteorological conference proper attended the sessions of the agricultural section.

A number of representatives of agricultural institutes and organisations in Great Britain also attended and contributed to the conference.

In his opening address, the Chairman gave an interesting historical review of agricultural meteorology which he defined as "What the farmer knows but won't say." He touched on the reform of the calendar and remarked that though the subject appeared to excite but little interest in England, the International Chamber of Commerce had recently for the fourth time reaffirmed a resolution originally passed in 1921 urging the reform of the calendar. He added that when commerce asked for a thing it usually got it.

Sir Napier then proceeded with his paper entitled "Ten Points of a Weekly Calendar." He explained that for meteorology the monthly period of 28, 30 or 31 days had no special value but the cardinal points of the year were the two solstices which are the times of least change, and the two equinoxes which

are the times of the most rapid change in solar radiation. On this basis he drew up a form of weekly calendar divided into four quarters which he named after the four constellations associated with those cardinal points, *Cancer*, *Capricornus*, *Aries* and *Libra*. He placed the odd day on March 26th of the present calendar.

However suitable for agricultural and meteorological purposes such a calendar may be, it is difficult to envisage any extended use of such an arrangement unless adopted as a world calendar.

At the conclusion of his remarks, Sir Napier said that he proposed first of all to elicit the opinion of the conference as to whether it was worth while to try and make the week the recognised intermediate unit between the day and the year for meteorological and agricultural purposes. He suggested the formation of a committee to consider this point. A Committee, consisting of the meteorological delegates from Canada, New Zealand, and India and the agricultural representatives of the Gold Coast and Ceylon was later appointed and met on the following morning. The result of their discussions is to be found in No. 1 of the resolutions given at the end of this paper.

Mr. T. F. Claxton of Hongkong strongly supported the view that the month is not a suitable unit in which to express meteorological means or averages and that the week was the only suitable interval. Mr. G. G. Auchinleck, Director of Agriculture, Gold Coast, supported this opinion from the point of view of the tropical agriculturist dealing principally with perennial crops and gave local instances to support his point. Col. D. C. Bates of New Zealand also spoke and dealt with the religious aspect of a change in the calendar.

Mr. A. Walter, who had himself made considerable use of 5-day periods in presenting meteorological data, spoke in favour of leaving research workers to decide how they were going to combine their data and their observations for themselves rather than of tying them down to some preconceived unit in time. Mr. J. M. Patterson, Director of the Canadian Meteorological Service, pointed out the necessity of daily and even hourly records in studying the relation between crops and weather.

The Chairman pointed out that there was a practice already existing of publishing monthly meteorological means or averages and the point to be considered was whether the week should be adopted instead of the month. At this stage the Chairman introduced two resolutions and a discussion followed, but as these resolutions in their final form are later given in full and are self-explanatory further comment will be omitted.

The next paper, entitled "Agricultural Meteorology in its Plant Physiological Relationships" was given by Professor V. H. Blackman of the Imperial College of Science and Technology. In the absence of Professor Blackman, Dr. Gregory dealt

with the paper in which the intricate relationship of the various climatic factors with plant physiology were discussed. The general conclusion was that "the ordinary meteorological data of temperature and humidity are adequate for plant physiological purposes, though soil temperatures as well as air temperatures are required for the fuller study of the plant's reaction to the climatic factor. With regard to light, what is required is a measure of total radiation or, what would be better still, some measure of lightness and its variation during the day. The plant is certainly affected by light quality as well as light intensity, so that as our knowledge increases, there will be a need for a record at different localities of the energy distribution throughout the spectrum and its changes during the day."

Dr. Gregory further suggested in the course of his remarks that though masses of often unused meteorological data were produced the plant physiological data were often inadequate and not always of the most useful kind. Dr. Laurence Ball, Chief Botanist, Egypt, emphasised the vast differences between climatological conditions in the field and artificial laboratory or pot experiment conditions, and the necessity for conducting researches under actual field conditions. He stressed the importance of recording soil temperatures at various depths. Mr. Chapham combatted Dr. Gregory's attack on precision records and held that such data were far from being useless. In reply to Dr. Ball, Dr. Gregory defended the value of pot experiments and gave an instance in the Sudan in which the results of pot experiments were found to hold good to an amazing extent in the field.

"Climate, Soils and Crops in British Tropical Colonies" by Mr. F. J. Martin of Sierra Leone was the next paper on the agenda. The conclusion of Mr. Martin's paper was that chance rather than climatological conditions had in the past been the chief factor in determining the crops cultivated in the various colonies, though there was a definite correlation between climate and the nature of the soil.

In the next paper entitled "Weather and Tobacco" Capt. A. J. W. Hornby, Agricultural Chemist of Nyasaland, discussed his experiences of the relation between weather and the growth and quality of tobacco. He showed the differences in optimum meteorological conditions for tobacco found in Kentucky and Nyasaland.

The last paper of the morning session was entitled "Methods for the Photo-electric and Photo-chemical Measurement of Daylight" by Mr. W. R. G. Atkins, Head of the Department of General Physiology, Marine Biological Laboratory, Plymouth, and Mr. H. H. Poole, Chief Scientific Officer of the Royal Dublin Society. This was a long and highly technical paper. Possibly

the most interesting part from the Ceylon point of view was that dealing with woodland illumination, since such measurements are frequently required in rubber experiments. Dr. Walsh and Messrs. Waldran and Tincker contributed to the discussion and emphasised the value and importance of the work carried out by Dr. Atkins and Mr. Poole. Mr. Walter and Dr. Angus also added their experience in experiments in different methods of daylight measurement.

After the luncheon interval Mr. N. V. Taylor, Horticulture Commissioner of the Ministry of Agriculture and Fisheries, read a most interesting paper on "Meteorological Research and Fruit Production." The first and possibly most interesting part dealt with the effects of the weather on fruit production while the second part was devoted to frost damage. The importance of the discovery of the necessity of maintaining the proper carbohydrate-nitrogen ratio and the effect of weather on this ratio were especially emphasised. The influence of a cover crop or a cover of grass on this factor is a point of importance and this aspect of the question, which might well apply to such crops as coconuts, would repay study in Ceylon.

The next paper on the agenda by Mr. J. Turnbull of the Ministry of Agriculture and Fisheries bore the same title as Mr. Taylor's. Mr. Turnbull's paper emphasised the great need for the co-operation of the meteorologist and the horticulturist in a joint study of the many complex factors involved.

Mr. Bagnall said that his work was to give advice to fruit growers in Kent. He was also engaged in a fruit soil survey of a comparatively small area. He laid stress on the number of other factors influencing the growth of fruit trees besides meteorological conditions. The problem was a very complex one and he thought that in the large Kent fruit area it would be necessary to ask the meteorologists to multiply their observation stations before much further progress could be made.

Mr. H. Goude, Horticultural Superintendent, Norfolk, spoke next. His first remarks were on the effects of wind in frosty weather and wind protection. He then spoke of Bruckner's theory predicting a cycle of eighteen hot summers and severe winters followed by eighteen wet summers and mild winters. He spoke of the effect of this in Norfolk on Cox's Orange Pippin, a variety which flourished in warm summers but failed when wet summers and mild winters were experienced.

Mr. A. H. Lees of the Long Ashton Fruit Research Station contributed some remarks which helped to demonstrate the extreme complexity of the interrelation between weather conditions and fruit crops. It was also clear that the choice of the best variety to suit local conditions was a matter of great importance.

Sir Napier Shaw in commenting on Mr. Bagnall's remarks held that if additional meteorological observations were required it behoved those interested to make them. "The air is free," he said. "If you want twenty observations, make them; if you want a hundred observations, make them, but do not complain to a Meteorological Conference if you have not got them because it is your part to provide them for the district in which you are interested."

With reference to Mr. Goude's remarks on cycles, Sir Napier said that Dr. Bruckner's was a 35-year cycle and was based on observations covering some centuries. He thought that the cycle had a good deal to be said for it, but he would not for a moment advise anyone to put all his money on a fruit crop next year on the supposition that Dr. Bruckner's experience was going to be repeated exactly according to schedule.

Mr. T. Wallace, of Long Ashton, again emphasised the importance of selecting the right variety of fruit tree for local conditions. He also suggested that investigators in attempting to find out the effect of nutrients on the quality and growth of plants had neglected the meteorological side of the question since relationships between the nutrients and the tree appeared to be fundamentally affected by meteorological conditions.

On Friday, August 30, the morning session opened with a paper entitled "The Relation of Animal Numbers to Climate" by Mr. C. S. Elston of the Department of Zoology and Comparative Anatomy, University Museum, Oxford. Mr. Elston discussed the periodic fluctuations in numbers of different animals such as rabbits, rats, mice, lemmings and various fur-bearing animals. It was pointed out that some of these fluctuations were of great economic importance and the study of wild animal numbers was becoming an important branch of animal ecology and one which required the help of meteorology.

Two papers followed on the relation of weather conditions and insects—"Weather and Climate in their Relation to Insects" by Mr. B. P. Uvarov, Senior Assistant, Imperial Bureau of Entomology, and "The Relations of Entomology to Meteorology" by Mr. J. J. de Gryse of the Entomological Branch, Department of Agriculture, Canada.

Mr. Uvarov's paper dealt with the complex interrelation between climatic conditions and the development and activity of insects. He said there were a vast number of entomological problems which could not be solved without the meteorologist and hoped that a close co-operation between the two sciences would rapidly develop.

Mr. de Gryse's paper gave similar information on Canadian conditions. He stressed the importance of extreme precision of observation in order to obtain reliable results. Very small

changes of temperature had a decided effect on the rate of development and behaviour of insects.

The last paper of the morning session was "The Relation of Weather to Plant Diseases" by Mr. C. E. Foister, Plant Pathological Division, Department of Agriculture for Scotland.

Mr. Foister's paper gave numerous examples of the important influence of temperature and humidity in fungoid diseases. The influence of light and the carrying of spores by wind were also discussed. Finally, he spoke of the practicability of forecasting outbreaks of certain diseases from a study of meteorological conditions. In this connection he mentioned the question of the interpretation of the results of observations. "Having secured meteorological data and those of disease intensity, the problem of correlation will become acute. Will the meteorologist or the plant pathologist or either of them be competent to carry out such correlation or will the task require a specialist "superman" in the form of a statistician? This is a problem which overclouds many branches of agricultural science today.

The first paper of the afternoon session was entitled "Crop Forecasting and the Use of Meteorological Data in its Improvement" by Mr. J. O. Irwin of Rothamsted Experiment Station. The first part of Mr. Irwin's paper consisted of a review of the methods of forecasting at present in use in England and Wales, the United States and India, and of the scientific work done on the relation between weather and crops and on crop forecasting from weather. In the second part he discussed the value of crop forecasts. The subject of the third part was the future improvement of data.

In his conclusions, Mr. Irwin said that it seemed almost certain that official methods of crop forecasting could be improved by forecasts based on weather, though satisfactory forecasts could not in all cases be obtained on the basis of weather only. Very considerable improvements would have to be made in crop data and to a less extent in meteorological data before the method could reach its maximum fruition.

Mr. S. M. Jacob, Government Statistician, Nigeria, followed with a paper entitled "Crop and Weather Data in India and their Statistical Treatment." Mr. Jacob divided his subject into what he named *Agronomic Meteorology*, that is, the study of weather conditions which induce the cultivator to plough and sow land or to refrain from ploughing or sowing it or affect his capacity for doing these things, and *Agricultural Meteorology* which has to deal with the problem of the reactions of the plant after sowing to the weather conditions. He held that, while conditions in India were fairly favourable for the study of agricultural meteorology, for the solution of the problems of agronomic meteorology

the data provided by Northern India were unsurpassed in the whole world for the space and time they covered and for their accuracy and continuity.

A considerable discussion centred round these two papers. Amongst other speakers was Dr. R. A. Fisher who suggested that the results of his correlations between weather and wheat yields on the Broadbank field at Rothamsted should be applied to crop forecasting in Hertfordshire. Mr. H. C. Vigor of the Ministry of Agriculture strongly countered this suggestion. He said that, however interesting experimentally, agriculturally the Broadbank wheat was a monstrosity and no amount of "cooking in Dr. Fisher's mathematical kitchen" would make the figures obtained therefrom applicable to normal conditions. Dr. Fisher also said that although meteorological observations from a network of stations were available, he wondered if the meteorologist could tell him what the conditions were at any given point between two such stations.

A discussion then developed on "Microclimates" which resulted in the drafting of a resolution.

The last paper was entitled "Weather and Wheat Yields at Lincoln College, New Zealand," by Dr. E. Kidson, Director of Meteorological Services, New Zealand.

In the absence of Dr. Kidson this paper was taken as read.

Before the close of the Conference, Dr. G. C. Simpson summed up the position and attitude of official meteorology to the various questions raised at the conference. He said that the Meteorological Office welcomed any request for assistance and would do their utmost to meet it. It must, however, be understood that meteorology was concerned with the air; if agricultural research workers required such observations as the temperature or humidity in a growing crop or at various depths in the soil it was their business to make such observations.

VISITS.

On Saturday, August 31st, arrangements were made to convey delegates to the Royal Horticultural Society's Gardens at Wisley, and to the Lord Wandsworth Agricultural College at Long Sutton, Hampshire. At Wisley, after a tour of the fruit experimental plots and the gardens, the party was entertained to lunch by the Royal Horticultural Society.

At Long Sutton the party was taken round the beautiful new buildings of the Lord Wandsworth Agricultural College and the plots where cereal variety trials are being carried out in connection with the Ministry of Agriculture's Crop Precision Scheme. Tea brought an interesting visit to a conclusion.

On Monday, September 2nd, a visit to Rothamsted was made.

FINAL MEETING OF THE AGRICULTURAL SECTION.

On Wednesday, September 4th, a final meeting was held for the purpose of adopting the various resolutions submitted to the Conference for incorporation in a draft report.

The resolutions are given below:—

I. THE WEEK AS A UNIT.

In the opinion of the Conference the month is too long a period for the purpose of summarising, for publication, statistics of agricultural meteorology and the week should be adopted for this purpose.

II. INSTRUCTION IN METEOROLOGY AND AGRICULTURAL METEOROLOGY

(I). In view of the fact that technical information regarding weather has become a part of common life and the information is of little value to those who have no knowledge of the meaning and implication of the technical terms used, the Governments of the several countries should be invited to take into consideration the desirability of making suitable provision for instruction in the physics of the atmosphere and the geography of weather in their national systems of education.

(II). Instruction in the methods and results of agricultural meteorological research should form a more important part of the curriculum than is the case at present at University Departments of Agriculture, Agricultural Colleges, and Farm Schools.

III. EXPERIMENTAL AND DEMONSTRATIONAL WORK IN AGRICULTURE.

Experimental and demonstrational work, particularly that on cultivation operations, manuring, and varieties of crops, should be accompanied by adequate meteorological observations, since such experimental and demonstrational work loses much of its value unless the results are discussed in the light of the meteorological conditions experienced during the course of the work.

IV. CLEARING STATION FOR INFORMATION ON AGRICULTURAL METEOROLOGY.

The Conference considered the question of the establishment of a clearing station for information on methods and results of agricultural meteorological work. The following existing bureaux already, or will shortly, centralise information regarding the problems of the agricultural meteorological research workers so far as their respective sciences are concerned, viz., the Imperial Bureaux of Soil Science, Animal Nutrition, Animal Health, Animal Genetics, Entomology, Mycology, Plant Genetics (both general and herbage crops), Agricultural Parasitology and Fruit Production. The bulk of agricultural meteorological research work is probably covered by these Bureaux.

At the same time, it would be very convenient if all the information on the subject could be focussed at some one centre. Such centralisation of information with subsequent distribution would be useful both to the agricultural meteorological research worker and also to the worker in pure meteorology.

With a view to obtaining experience which will prove useful as a guide to the Imperial Agricultural Research Conference of 1932 in considering the question, the Conference would be glad if the Ministry of Agriculture and Fisheries could develop the work it is already doing in this connection, and could obtain from the existing Bureaux, and from other sources, information on the methods and results of agricultural meteorological research, and could issue this information regularly to workers in agricultural science and pure meteorological science throughout the Empire.

This recommendation should not be taken as in any way pre-judging the issue for the Imperial Agricultural Research Conference of 1932.

V. FRUIT: WEATHER AND SOIL SURVEYS: FROST DAMAGE AND VARIETAL SUSCEPTIBILITY.

Surveys should be initiated or extended, in the different parts of the Empire, to determine:—

- (I) The effect of varying weather conditions on the growth, cropping, and resistance to diseases and pests of fruit grown on soils of various types; and
- (II) The positions, under various conditions, in which it is inadvisable to plant fruit owing to risk of frost damage.

Further research should be carried out to determine the degree of susceptibility to frost damage of the chief commercial varieties of fruit and to discover the characters which confer resistance to frost.

VI. VARIATIONS IN NUMBERS OF WILD ANIMALS.

In the opinion of the Conference the economic importance of fluctuations in the numbers of wild animals, such as mice and rabbits, justifies the prosecution of research to ascertain the causes of these fluctuations, and in such research it appears essential that there shall be close co-operation between the meteorological and the biological research worker in order to ascertain how far these fluctuations are due to climatic causes.

VII. METEOROLOGICAL OBSERVATIONS OF LOCAL CLIMATES.

The Conference are of opinion that the standard records of meteorological components form the base-line to which all investigations on agricultural meteorology must necessarily be related.

But the local climate or weather in the immediate vicinity of the plant or insect in an agricultural crop or elsewhere may be markedly different from that shown on the meteorological screen,

and while the Conference recognise that the records of such local meteorology must be made by the individual investigator for individual purposes they nevertheless are of opinion that meteorologists could render valuable service to agriculture by assisting agriculturists to devise standard methods for adoption in the systematic recording of these local climates, and by studying the results as meteorological data.

Such recording requires appropriate instruments and screens for measuring the meteorological components among various crops in various horizontal strata above and below ground in order to record the environment of the root system.

The standard records should be systematically extended, as opportunity offers, to measure, *e.g.*, the intensity and quality of radiation and the moisture content of soil.

VIII. INSECT PESTS AND PLANT DISEASES:

(a) *Forecasts, Spraying Advice, Description of Intensity Attack.*

The Conference emphasise the value to practical agriculturists of forecasts of seasonal appearance of insect pests and plant diseases and their mass outbreaks, and recommend that research directed to the discovery of the relations between the various meteorological factors and insect activities and plant diseases should be energetically pursued with a view to providing bases for such forecasts.

The Conference note that entomologists and mycologists are investigating methods for determining and describing the intensity of attack of insect and fungus pests on crops and express the hope that it will be possible for standard methods to be established.

(b) *Insect Investigations.*

Investigations should be carried out on the following subjects:—

(I) The application of the climograph method to studies in the distribution, seasonal cycles of development, and periodical fluctuations in the numbers of insects.

(II) The effect of atmospheric motion on the distribution of insects.

(III) The insect fauna of the upper atmosphere.

(IV) The influence of coloration of insects on their thermal economy.

(V) The effects of atmospheric pressure on insect activities and development.

(VI) The part played by light in the development of insects.

The development of work along these several lines is dependent upon the co-operation of research meteorologists with entomologists capable of dealing with the physiology of insects.

(c) Plant Disease Investigations.

An investigation should be carried out by plant pathologists in close co-operation with meteorologists to determine the distribution of fungus spores by the wind.

The Conference emphasise the need for close co-operation between phenological mycologists and research workers engaged in investigations on the relation of weather to healthy crop growth and yield.

For the purpose of correlation of weather condition with plant diseases, the Conference consider it to be very desirable that continuous records from self-recording instruments should be available. It is particularly important that records should be taken of night temperatures.

IX. CROP FORECASTING.

The Conference have noted with satisfaction the progress that has been made in the use of statistics of weather in forecasting crop yields and express the opinion that it is desirable that further investigations should be made into the possibility of improving forecasts of crop yields by this means.

IMPRESSIONS AND CONCLUSIONS.

No visitor to the Conference could fail to be impressed with the great importance of meteorological observations in all branches of agricultural science. At the same time it is realised that owing to the large number of factors involved the drawing of conclusions from such observations is a very complex matter. Observations of less than twenty years are considered inadequate as a basis for long range forecasting and similar problems, and in some cases a period of twenty years is considered insufficient.

A great deal of the meteorological information required by agriculturists or agricultural research workers is frequently available from meteorological stations or would be provided if asked for, but it is thought that the fullest use is not always made of information that is already available even from routine observations. As an example of special information being provided by request the Colombo Observatory has made correlations by weeks between weather conditions and the incidence of plague and malaria at the instance of different medical authorities.

A great deal of the information required however would be more specialised and such as would not be ordinarily obtainable from a meteorological station. Provision for such observations must be made by the workers concerned though meteorologists would frequently be able and willing to render valuable assistance by advice and the loan of instruments. Such assistance has

been frequently rendered by the Colombo Observatory to the Experiment Station, Peradeniya. One was struck by the difference in the degree of attention paid to meteorological matters by Colonial Departments of Agriculture; thus in the Gold Coast meteorological matters are the special charge of an officer of the Department of Agriculture and a considerable amount of valuable work has been carried out. In some countries comparatively little attention appears to have been paid to this subject.

A point on which emphasis was laid was the desirability of growing in every large experiment station plots of the main crops of the country cultivated in the normal manner and maintaining careful records of these plots concurrently with the necessary meteorological observations, in order that correlations between growth and crops and weather conditions might be made. To be of any value such correlations would naturally have to be made over a large number of years.

The Conference once more impressed on one the value of a personal interchange of views between workers in different parts of the Empire.

List of papers issued to the Agricultural Section of the Conference of Empire Meteorologists, 1929.

GENERAL CLIMATOLOGY AND SEASONAL FORECASTING.

1. The Empire in Relation to International Meteorology.—R. G. K. Lempfert.
2. The Collection, Tabulation and Publication of Climatological Data.—C. E. P. Brooks.
3. The Diurnal Variation of Meteorological Elements.—A. Walter.
4. A Preliminary Note on the Rainfall of West Africa.—N. P. Chamney.
5. On Long Range Forecasting.—Sir Gilbert Walker.
6. On Forecasting by Periodicity.—D. Brunt.

AGRICULTURAL SECTION.

1. Agricultural Meteorology: A brief historical review.—Sir Napier Shaw.
2. Ten Points of a Weekly Calendar.—Sir Napier Shaw.
3. Agricultural Meteorology in its Plant Physiological Relationships.—V. H. Blackman.
4. Methods for the Photo-Electric and Photo-Chemical Measurement of Daylight.—W. R. G. Atkins and H. H. Poole.
5. Meteorological Research and Fruit Production.—A. V. Taylor.
6. The Relation of Animal Numbers to Climate.—C. S. Elton.

7. Weather and Climate in their Relation to Insects.—
B. P. Uvarov.
8. The Relation of Weather to Plant Diseases.—C. E.
Foister.
9. Meteorological Research and Fruit Production.—J.
Turnbull.
10. Note on the Relation between Weather and Crops.—A
Walter.
11. Climate, Soils and Crops in British Tropical Countries.—
F. J. Martin.
12. Weather and Tobacco.—A. J. W. Hornby.
13. The Relations of Entomology to Meteorology.—J. J. de
Gryse.
14. Crop Forecasting and the Use of Meteorological Data in
its Improvement.—J. O. Irwin.
15. Crop and Weather Data in India and their Statistical
Treatment.—S. M. Jacob.
16. Weather and Wheat Yields at Lincoln College, New
Zealand.—E. Kidson.

**SURVEYS BY COUNTRIES OF THE ORGANISATION OF
AGRICULTURAL METEOROLOGICAL WORK.**

1. Agricultural Meteorological Work in Great Britain.
2. Agricultural Meteorology in New Zealand.
3. " " " The Sudan.
4. " " " The Gold Coast.
5. " " " Canada.
6. " " " The United States.
7. " " " Germany.
8. " " " France.

MISCELLANEOUS.

1. British Agricultural Meteorological Scheme: Observer's
Handbook.
2. Crop Variety Trials carried out at Long Sutton under the
Testing Scheme.
3. List of Exhibits.