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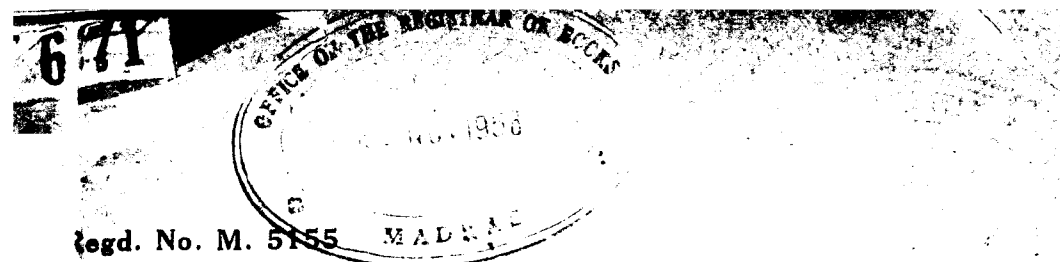
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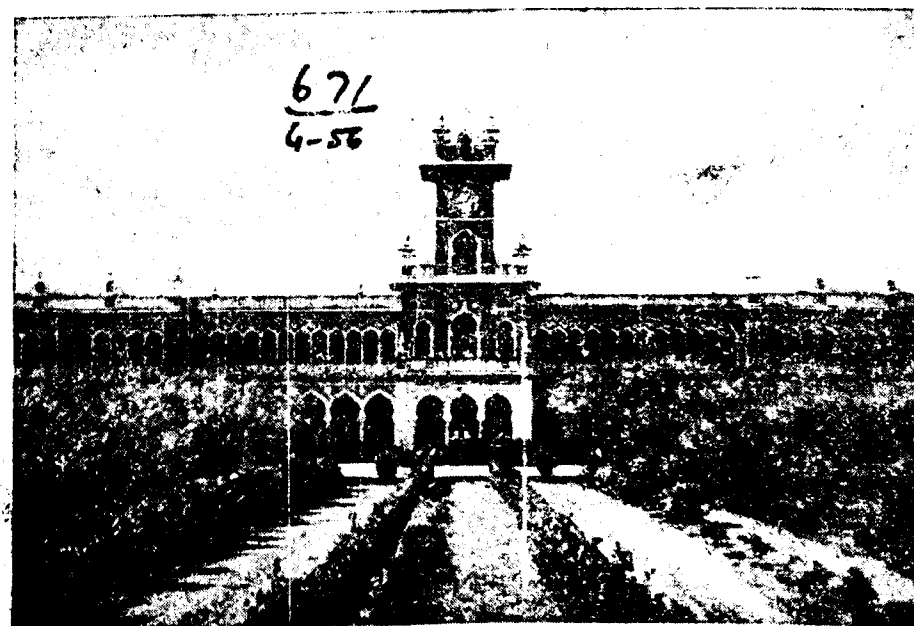
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Announcement

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THE RAMASASTRULU MUNAGALA PRIZE, 1956

1. The prize will be awarded during the College Day and Conference in 1956.
2. The prize will be in the form of a medal and will be awarded to the member of the Union who submits the best account of research or enquiry, carried out by him on any agricultural subject.
3. The subject matter shall not exceed in length twelve foolscap pages, typewritten on one side.
4. Intending competitors should notify the Secretary of the Madras Agricultural Students' Union, with a covering letter giving the full name and address of the competitor. The author's name should not be shown on the paper, but should be entered as a *nom-de-plume*.
5. Four typewritten copies of the paper should be sent.
6. The name of the successful competitor will be announced and the prize awarded at the time of the College Day and Conference.
7. Paper or papers accepted will become the property of the Union, and the Union reserves to itself the right to publish all or any of the papers.
8. All references in the papers to published books, reports or papers by other workers must be acknowledged.

9. The last date for receipt of papers is 15th July 1956.

J. Sakharam Rao,
Secretary.

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Announcement

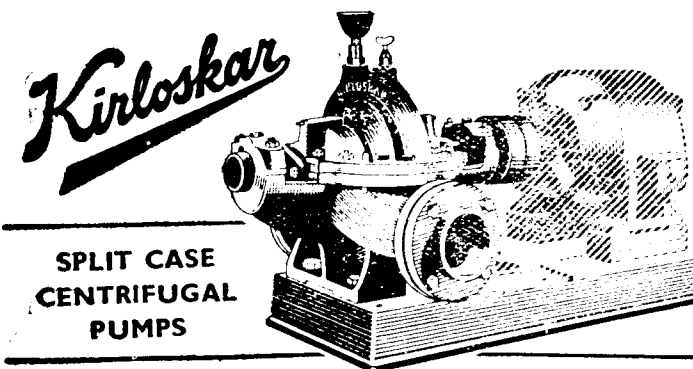
THIRTY-NINTH COLLEGE DAY AND CONFERENCE, 1956

*

The Annual College Day and Conference of the Madras Agricultural Students' Union is to be held this year during the second week of August. The subject for the symposium will be "Modern Trends in Indian Agriculture".

Persons desirous of contributing papers for the symposium are requested to communicate to the secretary.

J. SAKHARAM RAO,
Secretary,
The Madras Agricultural Students' Union.



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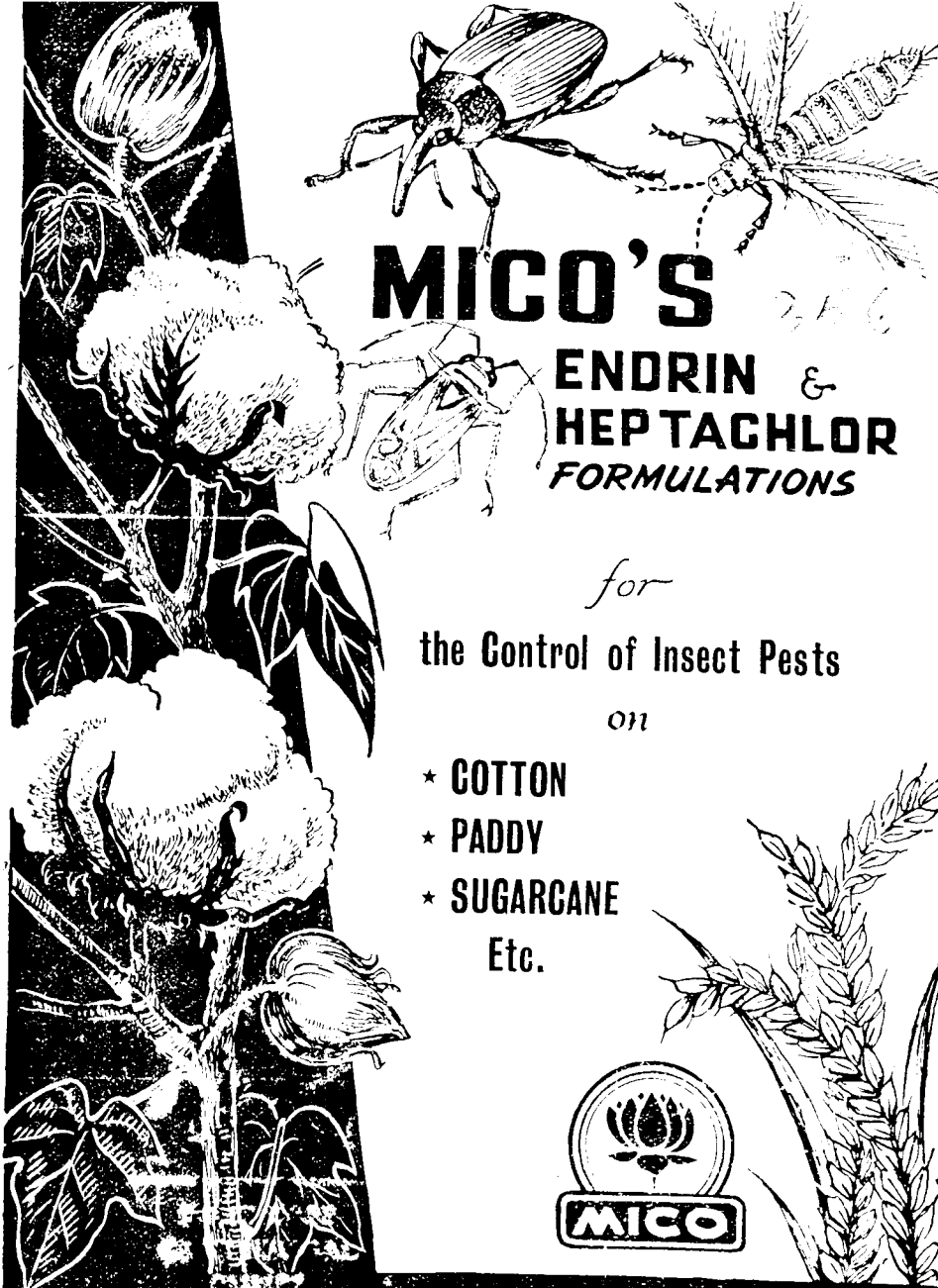
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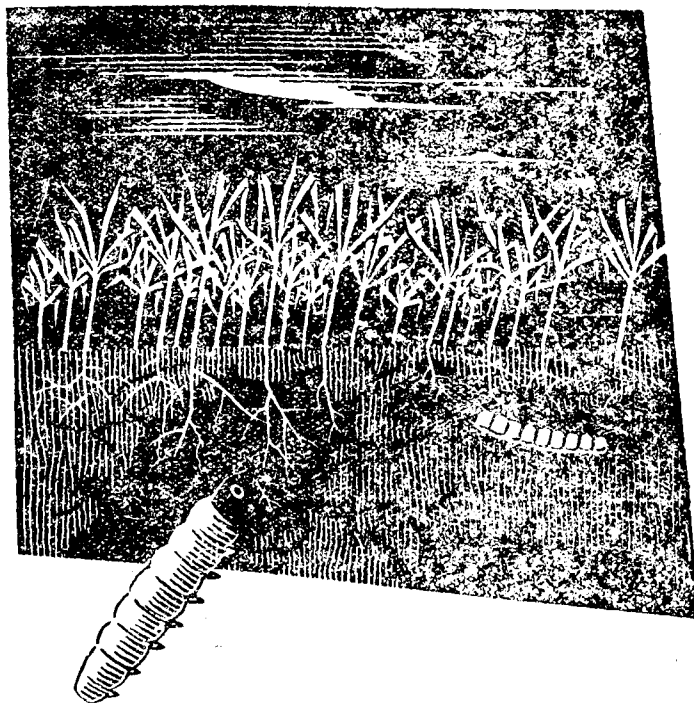
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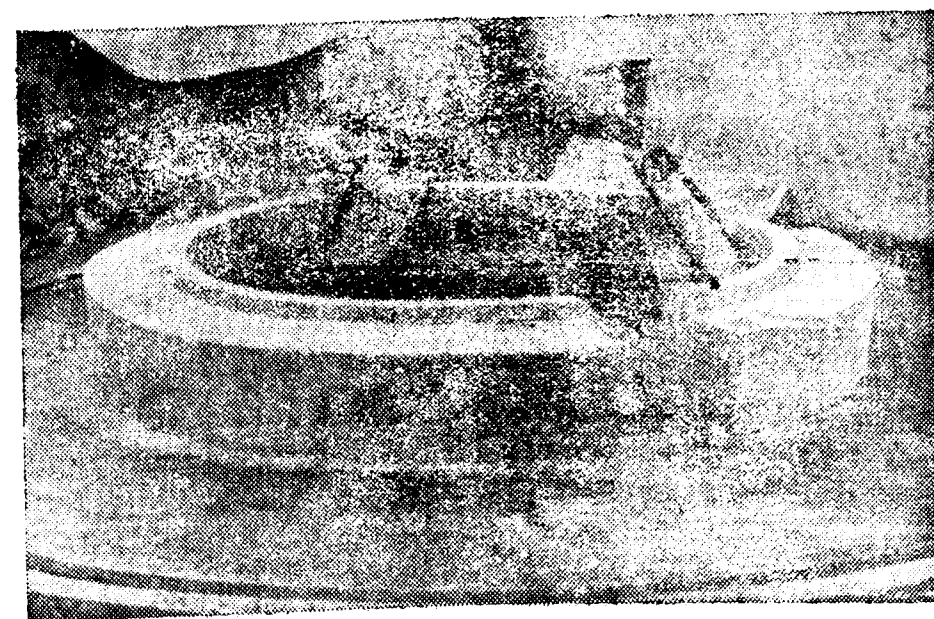
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The Madras Agricultural Journal

SPECIAL CONFERENCE NUMBER

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June 1956

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Editorial

"BETTER but than never" and we are therefore glad to publish in this month's issue the papers presented for the symposium on "What next in Agricultural Research and Extension" during the last College Day and Conference, in August 1955. For this, the Union has to be thankful for the generous grant of Rs. 1,000- sanctioned by the Government of Madras, towards the cost of printing all the papers in a single issue of the Madras Agricultural Journal.

A perusal of the papers would show that in spite of a time-lag of over ten months, none of the papers has lost its topicality, because all the problems mentioned then still exist and the methods of tackling them are also as appropriate now as in August 1955. The first paper by Dr. K. C. Naik gives a critical and masterly survey of the present position in regard to agricultural research, with valuable suggestions for improving the efficiency still further. The second

paper by Sri S. N. Venkataraman is an equally helpful survey in respect of extension work and indicates the lines along which further progress is possible. In the next paper, a brief outline is given of some of the more spectacular of the recent advances in agricultural research, indicating their possibilities for the future. A similar review is made in the next paper on the use of fertilizers. The paper on actinomycetes is an interesting one, as it relates to a field which is virtually untrodden by Indian workers, in spite of its great practical potentialities. Some constructive suggestions are made in the paper by Sri Ibrahim Ali to increase the utility of plant protection work and this is followed by a series of papers on crops, such as Paddy, Millets, Cotton, Oilseeds, Sugarcane and Fruits. The future possibilities of soil research and weather forecasts form the theme of the next two papers and in conclusion some practical suggestions are given in the last two papers, for improving agricultural extension, to take the results of research as it were, right to the very doorstep of every farmer.



What Next in Agricultural Research?

by Dr. K. C. NAIK,

B. Ag. (Bom.), M. Sc., Ph. D. (Bristol),
Head-quarters Deputy Director of
Agriculture (Research), Madras*

A retrospect of the work done in the field of agricultural research in this State for nearly six decades is bound to present us with a store-house rich with experiences of successes and failures, hopes and frustrations. The monumental "Memoirs of the Madras Agricultural Department" published recently, as well as the "Basic Records of Experimental Work" also compiled recently in each research centre in this State, constitute not merely valuable records of the past achievements, but also a medium to detect many a void or imperfection in our agricultural knowledge and practices. At a time when nationwide attention is being focussed on the outlines of the Second Five-Year Plan, the availability of these factual accounts of the track covered and of the sign-posts for the future is of invaluable benefit to keep us off from paths that may end in a blind alley.

From the administrative angle certain policies have been recently adopted and measures taken in this State, which are also expected to have a profound bearing on the course and content of our agricultural research work in future. The net effect of these has been that the purely administrative and routine duties of our research workers have been eliminated, so that our research personnel are no longer tied down to their office tables and are free to devote their full energies and talents to the work for which alone they were chosen and intended. With the clearing of the deck we have virtually set the stage, therefore, to mingle our efforts with those of others in the country for the next spurt towards the national goal.

The basis of all agricultural research is rooted in the conception that the prevailing crops and cropping practices are capable of considerable improvement. The fact that agricultural crops and cropping practices are not the same in all parts of the country, stands to interdict the use of steam-roller methods either in the research programme or objectives. We have had experience in this State of the projects and trials of horse-drawn implements imported

* Now Principal, Agricultural College and Research Institute, Coimbatore.

from Great Britain, electro-culture methods borrowed from Uttar Pradesh, introduction of milk-yielding trees, etc., which had to be abandoned or had to run their weary course, to confirm the view that borrowed ideas or hypotheses do not always transplant well in a new environment.

The trend towards co-ordinated research is a noticeable development after the establishment of the Indian Council of Agricultural Research and the various Commodity Committees. In the Indian Council of Agricultural Research, the scientific committees are composed only of representatives of technical personnel, and these are charged with the preliminary scrutiny of research projects as well as the detailed scrutiny of technical programmes and reports, while in the Commodity Committees the technical or technological or agricultural research sub-committees are generally made up of both non-officials and technical personnel. It is possible that the association of non-official elements in these Scientific Committees may help the former to gather an idea of the work under way, but it is a moot point if their co-operation is essential in the scrutiny of these technical programmes and reports, to judge the soundness of the technique, appropriateness of the analysis of data or the validity of inferences in the progress reports.

The promotion of research through Central and Regional Research Stations being one of the primary objectives of these Commodity Committees, a substantial fillip has been given in recent years to the establishment of a network of research centres by these Commodity Committees either on their own initiative and resources or with the collaboration elicited from the State Governments. While all these are apparently to the benefit of the country, a question may be raised as to whether there has been a corresponding upgrading in the standard of research, and therefore, in the net contribution through research to the welfare of the country. Co-ordination to be effective and efficient has necessarily to embrace all technical work on subjects or crops which are allied in so far as techniques are concerned. If the research programmes and reports on crops and subjects requiring similar techniques are dealt with by independent bodies, and the research projects on allied problems are tackled in centres totally unconnected with each other, though at times situated near to each other, there is the danger of overlapping activities or the emergence of conflicts, which are not conducive to research, especially in schemes for which provision exists only for the appointment of juniors on the lowest scales of pay.

No research programme or project can ever reach the requisite standard if assigned to persons living in a whole new wage level, even while high attainments and qualifications are expected of them. These, as well as the uncertainty of tenure which characterises the research posts associated with a number of research projects, may not help to attract the best talents to the scientific fields. Difference in emoluments and prospects as between the research personnel in the States and the Commodity Committees or the Central Government or as between the technical personnel of these bodies and those engaged by Agricultural Departments in the same States and working at times in the same town, may also have repercussions on the morale of the less fortunate sections of our public service, at the same time shutting out the best of the country's talents from the research fields in the States. Upgrading of research may require, therefore, not merely organisational changes but also a change in the service conditions of research personnel at all levels.

With the establishment of the Indian Council of Agricultural Research and Commodity Committees, the State Governments have been left to cater to their research projects through the aids to be obtained under certain specified conditions for temporary periods from these central bodies. Naturally enough, this may tend to induce the States to think of only local problems as distinct from extra-State problems or fundamental research. An accentuation of the awareness of administrative difficulties rather than the universality of science or the fundamental requirements of the country as a whole is a feature that has to be prevented. Any change in our agricultural research set-up has necessarily to consider these features, so that fundamental research which is the life-giving stream for applied research as well as for regional or national interests, are not allowed to become the victims in the clash of ideals, and excessive stress on local or other extrascientific problems may not at times simmer and froth over the larger interests of the country.

That research cannot be restricted to a geographical or in the sense of space or in terms of restriction of knowledge transfer. When research projects and programmes are planned on the knowledge gained in a particular centre or region, the scope, standard, efficiency and applicability of research are necessarily bound to the level of the mental horizon of those who have shaped the project or programmes. The Scientific Committees of the Indian Council of Agricultural Research are intended to outgrow such local barriers and

restrictions, but these Committees can effectively discharge their functions only if they are free from the domination of loyalties other than to science. The constitution of these scientific committees firstly on a regional basis, and then, at the ultimate national level, with the representatives of the best available talent, may be a pre-requisite for neutralising these extra loyalties and affiliations, though the ultimate discussion on the committees' recommendations and the acceptance of the same may rest with the appropriate bodies composed of both official and non-official representatives. Thus, while a thorough discussion by all the concerned authorities and public representatives is guaranteed, full freedom for a scientific approach and scrutiny both on a regional and national basis is also ensured by the arrangement suggested above.

In respect of most of the agricultural crops grown in this country, rainfed cultivation continues to be dominating feature. Evolution of hardy, drought-resistant, high-yielding, quality strains to suit the eminently risky conditions of culture of unirrigated crops has not been commensurate with our requirements in the past. Such work entails the need to comb the wilds, semi-wilds, and the vast unirrigated regions of cultivation for spotting out material with a wide array of desirable attributes. Explorations of regions outside the country and examination of the collections maintained in breeding centres elsewhere may also be helpful and even necessary, if a comprehensive, economic and fruitful approach is intended. As it is, when such work is handled by a multiplicity of State agencies, generally with meagre resources, the net result may be a partial approach that may lead to misleading indications. All these deserve to be replaced by co-ordinated action in the field of agricultural research.

The system of conducting crop research in the States with their generally meagre resources and with similarity of a host of problems, may inevitably lead to the tagging of research on crops of diverse peculiarities to a single agency in some of the States. This may further limit the possibility of pursuing research at the highest possible standard in respect of all such crops and subjects. Meagre, piecemeal and part-time attention at a multiplicity of centres on crops and subjects of diverse requirements may not only be prejudicial to the interests of research but it may also generate a false sense of feeling that all what is possible is being done for research.

According to the present practice, release of improved strains is being effected in each State after certain tests in cultivators' lands. The procedure adopted in the conduct of these tests is not always standardised. Scattered block trials are taken up in some cases,

while for others only rough observational trials are conducted. In any case, ryots' fields chosen at a few places cannot be the best medium for affording a reliable clue. It can never be as reliable as tests conducted under a standard plan in stations located in all the typical regions and in every soil-climatic zone, under standard agronomic practices. This is the system followed in Japan and can well be emulated by us. The plea that our Government farms are not representative of ryots' holdings seems to be a worn-out plea. Firstly, the ryots' land is not a static conception. It has to improve and it has improved greatly in recent years. What we have to aim is to improve the pattern of cultivation and have our improved strains ready to suit such improved conditions. We do not have to try our strains under primitive conditions, as that would mean our acceptance of the view that Indian agriculture will be always primitive.

One of the greatest evils in research to be guarded against, is the contingency of its degenerating to a mere routine, such as testing of a few methods or practices copied from elsewhere or of a few proprietary substances, or aimless crop selections from any available bulk. Though such an eventuality may be a remote one, it is by no means unexpected when the facilities provided for research are meagre and the personnel insufficient or ill-equipped. To wrench oneself from old moorings and traditions is often as difficult for a scientist as for a layman. The solution to all such problems is a bold policy whereby research is conceived, planned and built up on a scale to enlist the best of the nation's talent to work under a system of unified and co-ordinated guidance with ample facilities for both fundamental and applied research to suit the needs of every region, free from all unnatural restrictions such as those imposed by State barriers.

Methods and policies being of crucial importance for the improvement and success of the future of agricultural research in this State and in the country, it has been found necessary to dwell at some length on a few of the more outstanding features of the prevailing system. As important as any of these is the delineation of problems in all branches of agricultural research, which deserve attention in the immediate and distant future. This is a matter on which the Crop and Subject Specialists are expected to, and should rightfully give the lead. In the present note no endeavour is made to anticipate these recommendations or suggestions of the Crop and Subject Specialists.

What Next in Agricultural Extension?

by S. N. VENKATARAMAN,

B. A., B. Sc. (Ag.)
Headquarters Deputy Director of
Agriculture (Extension), Madras

In considering the future for agricultural extension work in the Madras State as well as in India it is well to remember that in the next five years the whole country will be organised in the Community and National Extension Blocks. In the Madras State 498 such Blocks will be spread over the entire State. The impact of these Blocks on agricultural extension work has also to be considered. It is well to emphasise that so far as agricultural extension is concerned it is very necessary that in these Blocks work should be on a more and more intensified character and on a much larger scale, with increased agricultural production, as well as improvement of agricultural standards.

There are many aspects of agricultural extension work which are receiving attention in greater detail in these days. The Government of India have sent out a few teams under the Indo-American Programme to make recommendations regarding the steps to be taken for the co-ordination of agricultural research and agricultural extension. Unlike in other countries where agricultural extension is largely devoted to education of the ryots, in India the problem is to spread agricultural improvement on a mass scale among a class the bulk of whom are illiterate. The problem, therefore, is one of work in these areas so that the intensified effect on agricultural extension work is brought home to every field, as well as every villager. As the work of agricultural extension is more important, I propose to confine myself here with its essential features apart from any administrative or patterns which may be employed, since the actual work is the most important and requires the utmost attention. In considering work, it may be relevant to consider what has been achieved and what more can be achieved. In Madras State, due to a number of reasons consequent on the need for intensified production to meet the deficits, there has been expansion in many lines of activities. At present, improved strains of paddy has spread over $2\frac{1}{2}$ million acres or 44% of the area. *Sesbania* as

a green manure has spread from a practically negligible area to nearly 1.4 million acres. The consumption of ammonium sulphate has increased from 25,000 tons five years ago, to nearly 75,000 tons. Improved strains of cotton have occupied about 5.3 lakhs of acres or 63% of the total cropped area. In millets the progress has not been much. We have achieved only about eight lakhs of acres, which is less than 16% of the total millet area. In groundnut also, progress has been only about 15 or three lakhs of acres. In sugarcane the effect has been phenomenal, as 95% of the area or about 1,10,000 acres are under improved varieties.

With this background of achievement, it may be possible to plan for the future with a specific object of meeting the needs of the State as well as of the Nation. In the Second Five Year Plan, the deficit of foodgrains in the Madras State has been estimated at about 7 lakhs of tons, and it will be our endeavour in the short period of five years to completely wipe out this deficit. For this purpose, it is very necessary that the area under improved strains should be increased from 2.5 to 5.1 million acres or nearly 80% of the area. In millets where the progress has been much less it is necessary to increase the area from about 8 lakhs of acres to 2.6 million acres. The supplies of ammonium sulphate to food crops has to be increased from 60,000 tons to one lakh and fifty thousand tons and to all crops to 1,75,000 tons. In addition, as organic matter is the most important and cheapest way of adding fertility to the soil, it is necessary to increase the area under green manure, *Sesbania*, from 1.5 to 2.5 million acres. The production of oilseeds has further to increase by 1,30,000 tons in the plan period and of cotton by one lakh of bales, while sugarcane production has to be increased by ten lakhs of tons on the assumption that about eight factories proposed will come into operation.

All these require much careful planning, as well as high efficiency in the execution of work. For this purpose it is necessary that the method of extension should be so adapted and the work co-ordinated so that the largest possible result can be utilised in the smallest time. The most important items in this respect are the supply of seeds, manures, and irrigation resources by mechanical means or otherwise.

The extent to which these methods have been adopted and are to be adopted in future are indicated below:—

To cover an increased area of nearly $2\frac{1}{2}$ million acres under paddy and 2 millions under millets it will be necessary at the end

of the plan period to organise distribution for over 99,000 tons of paddy and millets over 12,000 tons. Several methods of seed distribution have been evolved in the past, in multiplying seeds from the nucleus stage on to the producer. Formerly we used to supply every year 1,000 to 1,500 tons of primary seed from seed farms to be multiplied and to 6,000 or 7,000 tons of secondary seeds to be distributed to ryots. This method involved not only the handling of considerable quantity of seed, stocking and financial difficulties, but it was found that beyond a certain stage extension was comparatively slow. In order to get over the difficulty, a new plan has been introduced in the Madras State, whereby each village will have its own seed farm to cover the entire area in the next year by primary seed as every pound of seed can be multiplied about 40 to 50 times. A quantity of primary seed equal to one pound per acre of the village area is distributed in the village itself in order to cover the whole area by the next year. The multiplied seed is not procured but exchanged immediately with bulk seed from other ryots, through the Village Associations, of which there are about 16,200 established in the Madras State. During the first year of the operation, it was possible to cover about 7,000 villages for paddy and about 2,000 villages for millets under this scheme. In the coming years it is necessary that the entire State is covered with Village Seed Farm seeds, i. e. about 20,000 villages in the Second Five Year plan period. It should be the endeavour of all agricultural extension workers, both in the Community and National Extension Blocks and outside to see that every important village is covered with improved seeds of paddy and millets from the Village Seed Farm. Equally important is the application of manure. If the supply of ammonium sulphate is pushed up to 1,50,000 tons, the increased production will be about 3,00,000 tons of rice, which is quite substantial. Ammonium sulphate is comparatively costly and its application is decided by economic considerations. It is, therefore, necessary to have also a cheap manure, and particularly so as South Indian soils require organic manure in large quantities, especially paddy lands. The future expansion in this respect is to cover nearly $2\frac{1}{2}$ million acres with *Sesbania* as against $1\frac{1}{2}$ million acres at present. Of all green manures tried, *Sesbania* has been found to be the cheapest. As a line crop it gives upto 5,000 lb. of green leaf per acre closely planted around borders of paddy fields and it is enough to manure the field, the cost being hardly one anna per acre for seed. Besides, as a pure crop, *Sesbania* gives about

50,000 lb., enough to cover ten times the paddy area, and this is also economical. But *Sesbania* is an annual crop. It is further necessary to have a permanent arrangement for supply of organic matter in the form of green leaf. For this purpose, *Gliricidia maculata* or *Indigofera teysmanii* planted on the high borders and bunds of the field have been found very efficacious, giving two cuttings per year, enough to manure that area under paddy. The area under *Gliricidia* has expanded from a very small beginning five years ago, to nearly 40,000 acres at present and the total area so far covered is nearly a lakh of acres. It should be our endeavour to see that by the next five years another lakh of acres is covered, so that the problem of supply of organic matter is solved and a permanent supply of green leaf is assured on a large scale. Altogether, the green-leaf programme gives about 10% to 15% extra yield in paddy and estimated to give permanent increased production by 1,34,000 tons of rice at comparatively very little cost to the ryot by the end of the Second Year Plan.

It is necessary in agricultural work to have some easy methods of approach to the ryots and intimate contact is required, and it is for this purpose the Department has organised Village Associations in every village. There are now about 16,200 associations so formed, in the State as against a total of 20,000 villages. The next and most important step in this connection is to make these associations work efficiently, so that they form a compact medium for the spread of agricultural improvements in each village by discussion amongst themselves and with local officers of the Agricultural Department. They should be made to work as media for communicating requirements in seeds, manures etc. required for each village and also for other improvements like introduction of new plants, implements, horticulture and other improved cultivation practices. Apart from other types of village organisations it is found that such an organisation devoted more or less exclusively to the agricultural improvements and extension in each village serves a more useful purpose rather than a generalised organisation. In the future, for extension work these organisations will be made to work in its fullest capacity. There have been discussions about the way in which the ryot is to be approached in regard to agricultural improvements. There are also differences of opinion in this connection as methods of foreign countries are also freely discussed for adoption. It is, however, well to remember in this

connection that the pattern of agricultural extension is to be developed to suit the needs of each locality, particularly in Madras State, where a large body of ryots are illiterate, and have only small holdings. It is necessary to have a direct and factual approach to the actual needs of crop. In this respect personal contact is the most important, and it is that which has to be developed to the fullest extent.

Unfortunately the area covered by each extension worker is comparatively large; roughly it worked to about 1,00,000 acres in the year 1953. From December 1954 the Department has been re-organised to have a demonstrator with a depot and complementary staff for every two firkas and adding the staff employed in the Community and National Extension Blocks, the present area to be covered by an Agricultural Demonstrator is something like 70,000 acres.

It is understood that the area is about the size of a county in Tennessee, which acts as an extension centre for that area. In Madras we have for each Demonstrator a jurisdiction more or less akin to the Tennessee University. Our methods should, therefore, be adapted to the jurisdiction of each agricultural extension worker. A new method was tried in the National Extension Block in Tanjore District where a demonstrator was employed for every firkas or about 30,000 acres. The result was that it is possible to extend agricultural improvement practically throughout the area even in the first two years of working. It has been possible to extend green manures over 60% of the area, Village Associations in every village and improved strains in nearly 70% of the area; the intention being that the entire area should be covered in the course of three years. With the introduction of 498 Community and National Extension Blocks in the Second Five-Year Plan, it may be possible to have for each Demonstrator a jurisdiction of the order of 30,000 acres, with greater intensification of work. But one thing is necessary and that is the intensive programme already being carried on should be on a much more amplified scale in these Blocks. For this purpose, it is very necessary to have technical supervision of the highest order.

A further development which has been proposed in the All-India Second Five-Year Plan is the intensification of seed multiplication. It has been proposed to have in Madras about 500 seed-farm blocks of 25 acres each in areas contiguous to

Community Projects and National Extension areas. With these additional 12,500 acres exclusively devoted for multiplication of pure seed, it may be possible to have a large quantity of pure seeds which can be used for every crop to be developed for expansion in the Village Seed Farms in the whole cultivated area. This will be a great step in the improvement, as the Department will then produce the entire requirement of nucleus seed.

A further step contemplated in the Second Five-Year Plan is the introduction of plant protection centres in four places in the State where complete equipment with 400 sprayers, 400 dusters and power sprayers will be available for large-scale operations. It is possible that the Government of India will also be starting one regional plant protection centre for operations against pests and diseases for large-scale use, including aeroplanes. The present work of plant protection covers about 300,000 acres every year, in addition to a large number of fruit plants. In order to take efficient and prompt action in advance, before the pest or disease breaks out in any serious manner we are having in Madras State a weekly forecast of pests and diseases which are likely to occur or which have occurred and are likely to spread in some areas. This information is broadcast through the Radio. It is necessary that the fullest use is made of this information and plant protection measures taken in this State sufficiently in advance, so that the damage by pests and diseases is minimised to the fullest extent possible.

With a view to help the ryots with a permanent source of supply of water, and to help the existing sources of irrigation, the Agricultural Department launched the filter-point scheme. So far about 1,873 filter points have been sunk. In areas with a sandy sub-stratum. The programme is to increase this by 2,000 filter points in the year 1955-56, and another 3,000 in the Second Five-Year Plan, altogether 6,900 filter points capable of irrigating permanently about 69,000 acres would be available in Madras at the end of the Five-Year Plan period. A cheap coir filter point, costing only one-sixth of the ordinary brass filter, has also been devised and introduced. This work on filter points should be pushed through, as it forms an entirely new source of supplementing the existing water supplies and enables raising of crops even in summer, where other sources fail.

I have so far discussed the most important features of agricultural extension in the Madras State in relation to actual

requirements of work and what can be achieved. It will be very difficult to formulate or forecast what changes may occur in the pattern of the organisation for extension work or in the methods of approach, but it should be such that the requirements of ryots are individually met from field to field, and it should be our endeavour to see that each ryot is made to know and carry out all improvements possible. Personal contact is most important in this respect. If the programme I have just indicated of Agricultural Extension work on the production and improvement side is carried out with vigour, it will be a great improvement in the future of agriculture in Madras State, whatever the pattern or set-up may be in the organisation employed.

Recent Advances and Possibilities in Agricultural Research

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The title in no way implies any disparagement of extension or publicity work, but merely wishes to emphasise the need for more and better research. There is an old saying in Tamil "You can take up in the ladle, only what is left in the pot" and it is the primary duty of every research worker to do his bit in keeping the pot always full.

As mentioned in the Memoirs of the Agricultural Department, there is a real need for a constant examination of the programme of research and developmental work to meet the changing needs of the country from time to time. The memoirs, a substantial volume of which was recently published, serves as a convenient review of the work done so far, i.e. till 1948, but it is already more or less out-dated by the recent developments and achievements, even in our own department.

Agricultural research is a vast field of many specialised sciences, which have all one common object, of improving crop production. There is of course never any doubt about such research being essential, but what is not always remembered is that it should also be quite a continuous process and there can never be a stage when one can rest on his oars and allow the current of publicity to carry him through. It is obviously impossible to exhaust or even to indicate the possible lines of development in all fields of agricultural research, and so the present paper will merely outline the scope for further knowledge in just a few aspects.

Agricultural Research may be grouped into five main classes:

- (1) Agronomic,
- (2) Genetic,
- (3) Chemical,
- (4) Physiological and
- (5) Pathological.

(1) *Agronomic*: Tillage and other cultural operations, spacing and rotation of crops come in this class.

(2) *Genetic*: These include fundamental cytological studies, hybridisation work, both inter-specific and intra-specific and subsequent selection and fixation of desirable pure types, followed by trials to assess the yielding potentialities, culminating in the evolution of improved strains and varieties.

(3) *Chemical*: All studies relating to plant nutrition, the availability of nutrient elements in different soils, their uptake by crop plants under different seasonal conditions and systems of cropping, the inter-relations of nutrients within the plant system, how best to detect, determine and rectify nutrient deficiencies, and the formulation of optimum fertilizing schedules for various crops; all these come under this head.

In recent times the importance of micro-nutrients is being recognised, not only in maintaining proper growth but also in regard to the possibilities of utilising them to increase productivity as well.

As one of the incidental benefits, (though as yet only to a very small extent) of the armaments race in atomic weapons, we may mention the use of radioactive isotopes in the study of plant nutrition problems. In the more advanced countries of the West and even in the East - (as in Japan for instance), these "tagged" elements are being utilised to trace the paths of uptake of nutrients like phosphorus, in crop plants at different stages of growth and very valuable information has already been secured. Thus, by using radioactive P^{32} it is found 80% of the total uptake of phosphorus by wheat plants was from the added fertilizer and only 20% was taken up from the soil reserves. The phosphorus also gets transferred from leaves and stems into the earheads as the plants mature. Another valuable observation was that fertilized plants are able to take up more of soil phosphorus than unfertilized plants. The ability to utilise soil phosphorus varies with different crop-plants; thus tomato seedlings are unable to utilise the P "fixed" in soils, whereas other crops like Sudan grass could utilize a certain proportion of the soil-fixed phosphorus.

Radioactive isotopes are also useful in determining root development and zones of active root growth in plants far more rapidly than was ever possible by the older imbibition methods. Radioactive Nitrogen (N^{14}) has been useful in nitrogen fixation

studies and (C^{14}) is used in photosynthetic researches and carbohydrate metabolism. As another interesting use of radioactive isotopes may be cited the finding that lemon juice was the most active of all substances tested, to remove phosphorus residues from the teeth, although the actual pH of the fruit juice or of any other mouthwash had very little effect upon the phosphorus depletion from teeth.

From the narrow chemical viewpoint, we may cite as recent advances, the use of liquid ammonia and urea as nitrogen fertilizers, various new methods of making rock phosphate more easily utilizable by plants, and a spurt of research on soil conditioners, the best-known being Krilium. Similar ion-exchange resins have recently gained prominence in de-salting brackish water and thereby even for reclamation of saline and alkaline soils.

In analytical methods, some of the older tools have been improved and perfected as in spectrochemical research. Among the newer tools should be mentioned chromatography, in the detection and estimation of numerous plant products ranging from amino-acids to growth-hormones, in even very small quantities of plant material. The use of labour-saving devices and standardised methods in Western laboratories enables them to handle analytical samples nearly 4 to 5 times what we are able to get through in our laboratories. These devices are simple and relatively inexpensive and need only some thought and skill.

The purpose of the foregoing list is merely to stress the fact that we in South India have a very long way to go before we can expect to emulate the tempo and output of research that exists in other countries. There is also a very great and urgent need to carry out adequate soil-nutrient surveys in different tracts and regions in the Madras State, in order to plan manurial experiments in a more intelligent and purposeful manner, wherefrom better results may be expected in quicker time.

(4) *Plant Physiology*: Being a sort of border-land science it is rather difficult to demarcate where exactly plant chemistry ends and physiology begins, and hence the present distinction is chiefly one of convenience.

Thus the problem of nutrient deficiencies in crop plants is one that is being tackled in other countries both by the chemist and the plant physiologist. When the shortage of nutrient elements falls below a certain critical level the plant develops a characteristic

pattern of visual symptoms on the foliage and other parts of the plant and very often these are known by the term of physiological diseases or physiological disorders. As typical examples we may cite "frenching" or "little leaf disease" on various fruit trees caused by zinc deficiency and "die back" due to copper deficiency. Before these deficiencies get acute, there is usually a preliminary symptomless stage, which is detectable only by careful chemical analysis.

The usual methods of correcting such "deficiency disorders" are by supplying the deficient nutrients in a suitable form and manner, either as soil dressings or foliar sprays, or by injection methods. In view of the complexities of physiological balance and interrelations between different nutrient elements, whereby an excess of one element leads to deficiency symptoms of another element (e. g. Manganese toxicity stimulating iron chlorosis symptoms and Magnesium deficiency being induced by excess of potash manuring) a great deal of systematic and painstaking research is necessary before we can suggest remedial measures for our South Indian crops and conditions. Here again, there is a real need to carry out adequate soil-nutrient surveys over the entire State as has been done in Australia, New Zealand and many other countries, so that we may be able to programme and test out various remedial measures, before recommending suitable remedies for general adoption.

Growth Hormones: A very wide variety of quite remarkable effects have been obtained in recent years on plant growth and development, by the use of chemicals that go by the name of growth-regulating substances. To recount only a few of these effects, we may cite weed control by selective herbicides, induction of better rooting in cuttings, prevention of fruit-shedding, (e. g. Button-shedding in coconut), improvement of fruit-set, induction of seedless fruiting as in tomatoes, prolonging dormancy in tubers (like potatoes) as well as breaking the dormancy when needed for planting purposes, regulation of flowering and fruiting as in pineapples, to stagger the ripening and thereby prolong the fruiting season, hastening the ripening of fruits like bananas and citrus and prevention of cold storage disorders like "Brown spot" etc.; these are some of the remarkable effects obtainable. Some of these chemicals, like benzotriazole for example, causes a breakdown of apical dominance and induces extensive morphological modifications in the leaves and leafstalks - but this occurs only when the chemical is applied to the soil in which the plants are growing; as foliar applications, even at very high concentrations upto 1000 p. p. m. have no effect at all.

Obviously a vast field of research lies here, wherefrom practical results may be expected in a number of aspects closely related to increased crop production.

The problem of drought resistance is of very great importance in crop production, but it must be admitted that we are no nearer any solution to this problem as yet, because in spite of considerable study in various countries we do not have any recognised or generally applicable criterion for an objective assessment of drought resistance. In view of its complexity, real progress may be expected only after intensive studies are carried out under rigid control of environmental conditions like moisture, light, and temperature, and internal factors like nutrient levels etc.

5. Pathology: The same is the position with regard to disease-resistance. This takes us on to the next group. Both against insect pests and fungus diseases we have in recent years developed a variety of chemicals that are more effective than the traditional old-time remedies of Bordeaux mixture and fish-oil sprays, but here again there still exists a real need to intensify research. The scope and possibilities of systemic insecticides against insect pests of the stem-boring type, the interrelations between different pests (e.g. mites increasing when jassids on *Bhendi* are reduced by D. D. T.), these require a good deal more of study.

Against fungus diseases like paddy blast, the search for resistant strains is a continuous one and we are still only on the fringe of the subject.

In the field of virus research we have hardly any information, beyond perhaps the occurrence of such virus diseases on specific crops. Advances in protein chemistry and the electron microscope are being put to use in other countries to investigate virus diseases, but in India and South India in particular, we have yet to make up a time-lag of nearly thirty years.

Fertilizers

by S. VENKATACHALAM &
DR. A. MARIAKULANDAI

Introduction: It is a well-known fact that in India, the population is steadily going up, while the productivity of the land is going down. It is this sorrowful state of affairs that leads our country to the verge of starvation at critical times as in world wars or famine. There is only one way of putting an end to this and that is by ensuring an increase in the yield per acre of our lands, through the use of fertilizers. Fertilizers alone can save us from famines.

Fertilizer production in India: The need for the use of fertilizers becomes clear in view of the insufficiency of available organics such as cattle manure and composts. The use of green manures is limited to soils which are fertile enough to support a green manure crop. In poor soils newly brought under cultivation as in the Lower Bhavani area, a good crop of green manure cannot be obtained unless nutrients are supplied to the soil. Supplying readily available nutrients to the hundred thousand acres is possible only in the form of artificials.

Our country is far behind all other civilised nations in the production and use of fertilisers. A glance at the figures relating to the consumption of chemical fertilisers in various countries of the world is enough to show that acre-yields of crops runs somewhat parallel to the consumption of fertilisers. In our country the production of fertiliser is not sufficient even to meet the present low demands. More factories for the production of nitrogenous and phosphatic fertilisers are needed. The use of fertilisers also has to be considerably stepped up. The following table shows a comparison of Indian production and consumption of fertilisers with that of Japan (F. A. O. Statistics, 1952). Factories as at Sindri have to be established in other parts of the country, and particularly in the South. The Trichinopoly deposits of phosphates have to be exploited for the production of fertilizers like silicophosphates and phosphoric acid.

Table showing the production and consumption of fertilizers in India and Japan

	Production		Consumption	
	India	Japan	India	Japan
(In 1000 metric tons)				
Nitrogenous — as N	38	457	63	442
Phosphatic — as P_2O_5	13	285	13	243
Potassic — as K_2O	...	44	...	96

Profitable use of fertilisers: A review of manurial trials conducted in our State and the extensive soil surveys go to show that the requirements of our State with regard to manurial constituents are organic matter, nitrogen and phosphoric acid and for the best results, the artificials are to be used in conjunction with organics. Experiments on ryot's fields in Tanjore delta has also proved that the use of artificial nitrogen alone is not good enough and a combination of nitrogen and phosphoric acid is essential for maximum benefits.

One of the important factors in the efficient use of fertilisers is knowing how much to use and when, for a given type of soil. Of the many methods developed to determine this, the most practical one is the rapid tissue test. The procedure involved is very simple. Nitrogen is tested by adding a few drops of the nitrate reagent directly on the plant on the freshly cut tissue and the formation of a blue colour and its intensity are noted. Phosphate is tested by adding the phosphate reagents to freshly-cut tissue and the intensity of blue colour noted. These tests, though by themselves they are simple, require experience in interpreting the results. In a thorough study, tests can be made on plants from plots receiving known doses of nutrients and results of tests compared with yield figures as shown below:

	0	1	2	3	4
Level of nutrients	0	low	medium	high	V. high
Results of tests	0	low	medium	high	V. high
Yield	20	40	60	80	80

From the above results it is clear that to get maximum yield, nutrients at level 3 has to be applied and the test indicating High will be necessary. Level 4 can be avoided and to that extent the use of fertiliser can be minimized. Where a systematic experiment is not

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possible, tests can be made on the current crops and approximate doses of nutrients can be added. The yield data obtained therefrom can be compared with the results of tests and the experience so gained can be used for the future. A certain amount of standardisation is also required for the different crops to derive maximum benefit from these tests, as the critical stage of crop growth at which tests can be made with advantage and the part of the plant that is best suited differ from crop to crop. Such standardisations are being attempted in the chemistry section of this Institute.

In planning for the future for the use of fertilisers, importance should be given for such field tests and testing outfits. The TCM soil testing in which mobile units are to be used is a welcome step in this direction. Encouragement should be given to the production of handy kits that can be carried on cycles, as is done in Japan.

Newer types of fertilisers and newer techniques for fertiliser use: Technological advances and commercial developments in the field of fertilisers have outstripped expectations and have now become major factors affecting the very destiny of mankind. This was one of the factors missing from the calculations of Malthusian disciples. Synthetic nitrogen materials of low solubility in water such as urea-formaldehyde type is likely to reduce the bill on nitrogen fertilisers. Liquid fertilizers with low vapour pressure such as liquid urea, ammonium nitrate are being produced. Spray applications of urea are already becoming popular. In the field of phosphates, newer types of material such as fused phosphates and silico-phosphates are being produced. Special types of mixed fertilizers (i) to meet specific needs of certain soils or crops (ii) for use with irrigation systems, sprayers or transplanting machines (iii) for use in culture solutions, fish ponds or home gardens and (iv) to combine fertilizer action with the control of weeds, insects, fungi and other pests have been developed.

Fertilizers for certain soils: In the absence of adequate soil-liming programmes, high yields of crops in the humid regions are not favoured. Under these conditions non acid-forming mixed fertilizers are used. Dolomite is generally included along with the acid-forming fertilizers such as ammonium sulphate and ammonium nitrate. For alkali soils, free sulphur is included in the acid-forming mixed fertilizers in addition to ammonium sulphate. For peat and muck soils which are often deficient in one or more of the trace elements, the trace elements are included in the mixtures.

Fertilizers for certain crops: Tobacco, legumes, potato, citrus etc., have specific needs for which special fertilizer mixtures have been developed. Thus tobacco fertilizers average much higher in MgO , and soluble nitrogen. For legumes mixed fertilizers containing P_2O_5 and K_2O , but no nitrogen and ground limestone to render them alkaline in reaction are designed. (Jacob 1952)

Liquid fertilizers: Advantage can be taken of liquid fertilizers such as aqua ammonia, phosphoric acid, aqueous ammonium nitrate etc., for use in irrigation systems. These are cheaper than the salts. In Western United States, liquid ammonia from steel cylinders is commonly applied to irrigation water on a service basis. (precipitation of salts from the water can be prevented by applying a few parts per million of sodium hexametaphosphate to the water upstream). Liquid mixed fertilizers which have a low pH can be used on alkaline soils with advantage. (Jacob 1952)

The use of fertilizers for spray application and seed treatments hold promise. Treatment of seeds with 5% solution of dipotassium phosphate has given increased yields. Grass seeds spread in a mat of decomposable vegetable matter impregnated with fertilizers is marketed in rolls 20 feet long and 21.2 feet wide in U. S. A. This means of preparing lawn is said to prevent birds from eating the seed, to decrease soil erosion and to assure the purchaser of proper fertilization of the grass.

Herbicidal, fungicidal and pesticidal mixtures of fertilizers: Advantage can be taken of certain fertiliser materials that may serve not only as a source of nutrient but also to eradicate weeds or prevent the growth of fungi. Urea, calcium cyanamide etc., fall in this class. So also, some material used primarily to control weeds, insects or plant diseases also supply nutrients. Bordeaux mixture, borax, zinc chloride are among such fungicides. Certain recently developed pesticides for soil application are effective at rates of less than one lb per acre when they are placed in the seed or root zone of a crop. An example is the commonly known 2-4, D which kills the broad-leaved plants but are not toxic to most of the grasses and is being used in fertilizers without adverse effect on soil micro-organisms.

Chlorinated hydrocarbons used as insecticides such as DDT and chlordane have been used in mixed fertilizers. Similarly, fungicidal mixtures have been reported to be in use in America and

include various mercury compounds, sulphur, ferimate, Dithane, Arasan etc., Apart from these, there are also the multiple purpose mixtures supplying nutrients, herbicides and pesticides such as 7-5-5 grade containing 1% of 2, 4-D and 0.25% Lindane.

Method of application: Fertilizers should never be placed directly above or below the seed though separated by a soil layer. The American National Joint committee on fertilizer application has published (1938 quoted by Collings) its recommendations for some field and horticultural crops and this could be followed with advantage in the placement of fertilizers for different crops.

Fertilizers have a bright future and this is especially true in our country as we are just entering the fertilizer age. Large-scale production of fertilizers have only just been started and much remains to be done in this important field in our country.

Cytogenetics

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In Cytogenetics and Plant breeding, the conventional methods of collection, introduction, selection and hybridisation have been in use in this department since its inception. These methods are the most certain and are the basic ones for obtaining the desired plant selections. In the investigation of the fundamentals of genetics, much ground has been covered in the several crop plants, some systematic and others as and when the occasion arose. The storehouse of all desired characters has been in the wild plants from which the cultivated ones have been later selected. We have often to go back to nature to incorporate certain required characters into the cultivated type and also to invigorate it, make it resistant towards pests, diseases and adverse conditions. The scientist also watches for suitable mutations to occur in the homozygous materials. These occur at very low rates. Attempts have been made to increase the rate of incidence of such mutations by the application of agencies which cause changes in the heritable material. The conception of the gene or the heritable unit is still nebulous, though something is known about their location, arrangement and constitution. The gene cannot be newly created but an existing gene can be made to change by readjustment of its molecular structure. In taking recourse to hybridisation whether it be intervarietal, interspecific or intergeneric, only gene recombinations are produced.

In the following are stressed some of the lines of investigations which deserve a systematic trial so that the crop plants in general may be thoroughly understood and useful recombinations could be obtained with greater certainty. Experiments in the production of autopolyploids have been done in most crop plants in a satisfactorily systematic manner and a fairly wide ground has been covered.

In recent years considerable work has been done not only to produce artificially mutations but also to accelerate their production by the use of external agencies like x-rays, radium emanations, heat and chemical reagents. Interest in this kind of work was greatly stimulated by the discovery of Muller in 1928 that x-rays induced mutations in *Drosophila* similar to those occurring in nature but with a considerably greater frequency. Stadler (1928) working on the genetic effects of x-rays on barley and wheat, demonstrated the possibility of experimental

modification of heredity in plants by subjecting them to penetrating radiations. Since then several plant species, *Datura*, tobacco, cotton, maize, rice, millets, onion, tomato, flax etc. have been subjected to the action of several external agencies for production of variations and a considerable body of data has been accumulated. Although most of these induced mutations are recessive, and at first abnormalities and uneconomic ones are noted, numerous economic mutations appear in later generations. Horlacher and Killough (1931) studying the genetic effects of x-rays on cotton have put forth strong evidence for the occurrence of dominant progressive mutations also as a result of irradiation. With the improvements in technic systematic work with x-rays has shown that a good number of useful variations could be produced. Gustaffson (1947) discusses at length mutations in agricultural plants. Intensive and systematic work is being carried on in Sweden, England and America. Work on barley in Sweden has produced mutations for earliness, lateness, winterhardiness, straw characters, malting qualities and higher yield. In rape and mustard, strains with higher yield and oil content have been induced. The rate of mutations in some plants has been estimated at 300 times over the control. The usefulness of the x-rays in vegetatively multiplied plants is practically unlimited. There is yet another source of obtaining variations which has not been sufficiently exploited and that is vegetative buds. Vegetative variations known as "bud sports" have no doubt arisen from time to time in plants, but attempts have not so far been made, as a regular method of plant improvement to produce them artificially and increase the material for selection. The application of this method in encouraging the growth of dormant buds which may carry latent variations and which in normal agricultural practice are not given an opportunity to develop into shoots, and by causing injury and mutilations to them by cutting and grafting to sexually propagated plants have not been intensively investigated and that is presumably due to the lack of necessity for vegetative propagation in such plants which readily set seed.

Recently the United States Department of Agriculture has set up a programme of research with the co-operation of the Atomic Energy Commission, in which the influence of radioactive materials on the growth of crops is to be studied. The programme includes researches (i) to measure the effects of additions of radioactive materials to soil fertiliser on the growth, maturity, yield and composition of various representative crops, (2) to determine the influence of low activities of alpha, beta and gamma radiations on the germination of seed and the growth and vigour of seedlings, and (3) to ascertain the influence of the radioactive materials on the number and activity of the bacterial and other soil micro-organisms. Usually plant hybridisation work is laborious and time-consuming. Several methods have been adopted for artificial emasculation of hermaphrodite flowers such as hot-water treatment etc.

It would help in producing a large number of hybrids if methods are available in which the anthers are rendered sterile without the stigma being affected. Chemicals like 2, 4-dichlorophenoxy acetic acid Maleic hydrazide, = Tri-iodo-benzoic acids and Naphthalene acetic acid have been reported to produce such male sterility (Rhen 1952). An interesting application of genetic knowledge to plant breeding is the utilisation of male sterility in the production of hybrid seeds. Cytoplasmic male sterility was utilised for hybrid seed production in onion, maize etc. A preliminary experiment with 2, 4-D done in tenai, gave indications of positive results.

Somatic reduction has been recorded in a number of plants (Coffee, Cotton, *Oryza* etc.) and also been artificially induced. Huskin (1948 and 1949) has reviewed the literature on this subject. Sodium ribose-nucleate, and sodium nucleate were found by him to induce somatic meiosis in root tips of *Allium cepa* and other plants. This method of reducing the chromosome numbers from the diploid to the haploid level, as also that of higher polyploids to the diploid level has rendered the analysis of chromosome complements, and genomic analysis easy. This would give the breeder a useful tool to obtain completely homozygous plants. In many crop plants investigations on the relationship of the genomes between the cultivated races and the wild are being carried on in greater detail to know the degree of homology and the possible recombination effects, when hybridisations are made. A systematic study on this line of work is also called for.

The determination of linkage groups is of great importance in economic breeding as knowledge is obtained with regard to the genes that are combined together, the recombination possibilities, and the particular genes that could be made use of as marker genes for a particular linkage group. None of the crop plants grown in this State has been completely and systematically worked on this aspect.

The search for ancestral forms and through them the basic genome has been a very important item in the breeding programme of all crop plants. In seeking new genes, special attention should be paid to the centres of origin of the ancient forms, for it is in these centres that plants with great genetical diversity may be found. The transformation that has been effected in potato, maize, wheat, rye, cotton etc. as a result of the incorporation of wild genes collected through extensive expeditions is now a matter of history. The immense value of expeditions to these centres and collection of wild relatives of cultivated plants is emphasized. The study of the genetics of the wild plants related to the cultivated ones is also stressed.

In the field of plant improvement, cytogenetical work has to be intensified and more economic plants have to be brought within its

scope. More fundamental work untrammelled by considerations of immediate application will also have to be undertaken. This will help in the formulation of general principles and new and improved techniques which are vital to the progress of applied research. As science is primarily a mental discipline which is so variable with individuals, it is worthwhile to have a number of men working at the same problems and aspects to secure successful results. It is only by team work that substantial progress can be made.

Summary: The following investigations are suggested for inclusion in the future programme of cytogenetical research in this State: Systematic studies of (1) irradiation effects on crop and fruit plants with a view to production of new mutations, (2) Action of chemicals in the production of mutations as also male sterility for use in hybridisation and production of hybrid seeds, (3) Study of the relationships of the wild with the cultivated species and production of homozygous plants through induced haploids, (4) Systematic study of linkage groups and chromosome mapping as a help in the production of desired recombinations with greater certainty and (5) Collection and study of the wild plants with regard to their behaviour, genetics etc. and the selection of suitable races to be hybridised with the cultivated ones for crop improvement.

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Agricultural Entomology

by K. P. ANANTHANARAYANAN,
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As a result of intensive work during the past half-a-century, we have a large number of published records regarding the insect fauna, pest occurrences and their life-history studies, etc., in relation to all important crops grown in our State. The two publications of Ayyar T. V. R., "Annotated list of insects affecting the important cultivated crops of South India (1932)" and "Handbook of Economic Entomology for South India" (1940) give considerable information on entomological problems of South India. These are of inestimable value to guide future work. More recent achievements are in the field of insecticidal method of control. These and related progress, are to some extent brought out in the Departmental Memoirs of 1950. Appreciable work had also been done in the biological method of insect control and the pioneer work on the control of the cottony cushion scale in the Nilgiris and the Black-headed caterpillar of coconut carried out by Y. R. Rao and others (1944 and 1950) stands to the credit of the Madras State. "Bee-Keeping in South India" is another departmental publication, which is serving a very useful purpose by embodying valuable information on apiculture, relating to bees.

Insecticidal methods of control gained prominence after World War II. This feature accounts for giving a new and permanent place for Entomology in Extension Service.

Emphasis on insecticidal methods of control, have, however, brought in new problems. We have a strong and powerful weapon in our hands, and our immediate problem is to study (i) to what extent we can use, (ii) how best it can be applied, (iii) to what extent it is really useful, (iv) to know where and why it fails and (v) what exactly the other methods are that have to be brought in.

(1) **To what extent we can use insecticides:** Pesticides in use are mounting in quantity, thanks to convincing results and the increasingly effective propaganda exercised by the extension staff. A change in the mind of the cultivator is evident. He no longer keeps quiet when any pest is threatening destruction of his crops. One of the most important aspects of this change has been the recognition that crops can be made more productive by control of pests at proper times by proper methods, but if neglected due to ignorance or indifference, will result in considerable loss. In many places, primitive methods of farming still prevail. Lands should be made more productive by adopting modern scientific methods. Small holdings should get maximum income. One of

the methods is to reduce loss of yields from pests. There is much scope for increased use of pesticides.

In this connection, many insecticides have been departmentally tested as to their efficacy, the dosages at which they can be applied, the insects against which they are successful, the plants or crops which can be treated safely and the method of application without hazard to the operators. The synthetic chemicals and systemic insecticides are useful against a variety of pests and are safe to apply on almost all plants, with few exceptions. Sulphur has specific action against mites. DDT works well for controlling jassids, caterpillars, and beetles. BHC is useful to control a variety of pests and shows quicker action, but imparts a taint or off-flavour in the case of root crops, when applied to soil. Both DDT and BHC may injure foliage, especially of cucurbitaceous plants. The research on this line has to continue not only to study the beneficial and adverse effects independent of insecticidal action, but also to find out ways and means of assessing residues on treated material. There are limitations imposed by operational difficulties and risks that arise on the use of highly poisonous chemicals such as organophosphates, which injure man by contact, inhalation and by ingestion. The use of these requires careful planning, technical skill and experience and careful supervision. The use of these insecticides is therefore to be taken up with due caution and popularised only by slow degrees however effective they are. Problems of residues, of handling of substances deadly to man, and problems of deciding the economic use of the insecticides, are fields where more work and more information are urgently necessary.

(2) **How best insecticides can be applied:** During a severe outbreak, where the crop in extensive areas is brimming with insects of the same species, really spectacular effect is seen, by the action of insecticides applied on a large scale. But invariably it so happens that the insects have already caused havoc to the crop, even when we take immediate measures to treat the crops. In killing insects, we have incurred some expenditure too. One often feels that the presence of insects should have been noted earlier, to avert damage and minimise loss. Thus timely application is one of the most important aspects of the problem. Secondly, often we meet with more than one insect, in one and the same crop either at the same time or at different growth-phases of the crop. In many of our crops, the margin of profit is so low that it does not admit of expenditure for repeated treatments. Investigations now in progress towards determining critical stages, when the minimum number of treatments will assure maximum efficiency, are highly important. A further step would be to choose insecticides of multipurpose value and apply the same as prophylactic treatments. Hopeful indications in this line are not wanting. The pesticides Folidol and Endrin are new-comers satisfying these requirements. Though both are highly

poisonous, they have the merit of destroying a variety of insects at one stroke, and at the same time stimulating the plants to better growth and higher yields. The recovery of the affected plant is a new feature. Some borer pests, hitherto a serious problem, for example, the paddy stem borer and cotton boll worm, seem to yield to treatment with these insecticides. The problem on the choice of insecticide and preparation of a spray schedule for each important crop, would be the next line of approach in insecticidal method of control. Insecticidal method of pest control has come to stay and for years to come a major part of our researches is bound to be directed towards perfecting this. Newer and better chemical formulations are being discovered from time to time and even against external feeders, for which we have already evolved suitable remedies, better and more effective remedies are to be found. To speed up pest control work within a limited time over large areas, the possibilities of dusting or spraying by aeroplanes through State agency or by private firms and organisations at nominal cost to ryots, have also to be explored. The first of its kind has been reported in connection with control of *Pyrilla* of sugarcane in Bhopal.

(3) **To what extent insecticidal method is really useful:** We are going ahead with insecticides. The cultivator begins to think of nothing else than insecticides in tackling his insect problems. The intrinsic merit of this method is quick action and destruction of insects before our very eyes. But on the whole, the effect is temporary. On principle any insecticide which will leave a poisonous material as residue, however useful it may be for destroying insects, is not admissible, especially on food crops. This is a matter for serious consideration. On one side, we would like to have insecticidal action after one treatment to persist for long, with a view to check every new wave of insect attack, and at the same time we want no poisonous residue to remain for long on the treated crop to avoid danger to human beings and livestock. The real fact is that control by pesticides is only of temporary effect. It requires repetition, to save a crop completely from seedling to harvest. The operation does not eliminate causes for recurrence of the pest or pests in one and the same crop, during the same season. Hence at every season of crop growing, the same pests may appear regularly, in spite of tons of chemicals used in one season. In the light of these considerations, the insecticidal method of control has to be considered only as a measure of immediate practical value and for lasting and collective benefit reliance has to be placed on methods other than insecticidal.

(4) **To know where and why insecticidal method fails:** Insecticides act on pests by contact, inhalation or by ingestion. Some insecticides such as BHC, Folidol, etc. may combine one or more or all these qualities when once the insecticide reaches the insect. Insects living in concealed situations in roots, stems, buds, fruits, etc., for example the cotton stem weevil, borers affecting paddy, cholam, mango, orange, coffee, etc.,

caterpillars boring into buds, flowers of jasmine, brinjal or borers like mango stone weevil, fruit borer in brinjal, fruit flies in gourds, melons, plums, mangoes, etc., are all affected only slightly by application of insecticides outside. Similarly, mealy bugs and hairy caterpillars have protective coverings. These require special investigation for evolving satisfactory methods of control. In the case of all borers the adults lay eggs from outside. In the case of mealy bugs, the protective covering is least during a short period of the early young stage. In the case of hairy caterpillars, like *Amsacta*, newly-hatched young ones have less of hairs. The insecticides applied, should therefore be timed to the occurrence of these critical stages, failing which the efforts will be fruitless.

(5) **What exactly are other methods to be brought in:** (a) The problem of pest and pest control has to be viewed in a more comprehensive manner as a State problem. While insecticidal method of control has established and will continue to have a permanent and important role in the solution of all future pest control problems, other practicable methods also have to be explored. Investigations of a long-range and more costly nature likely to result in permanent good have to be undertaken. Control by biological methods, is one of this kind. It is practised widely in many countries. It is not new to India. Our State has done some pioneer work in the line. Use of the imported beetle *Rodolia cardinalis*, its multiplication and liberation and its subsequent establishment in the Nilgiris and effective control of the fluted scale, is a notable example. The control of the black-headed caterpillar of coconut by parasites is another notable achievement in this line. Indications of promise have already been obtained in the use of the egg parasite *Trichogramma* to control sugarcane borers and cotton bollworm. *Cryptolaemus montrouzieri* is noted as an effective natural enemy of Brinjal mealy-bug. There is unlimited scope for work in this direction, in view of the large array of parasites and predators recorded in our region. While insecticidal methods are no doubt effective and unavoidable to meet individual cases of pest outbreaks, it is no solution for the problem as a whole. Pests occur again and again and any natural force built up to check undue multiplication of particular pests would go a long way, especially with reference to those that are chronic pests in the State. The benefit is not merely to individual cultivators but to the region as a whole. The work, if established once, results in inestimable good for years. It is not within the scope of individual cultivators to undertake such a job. It is purely a State aid. Expansion of work in the direction of application of biological methods in pest control is necessary, whenever possible. Secondly, in any systematised pest control campaign, a knowledge of the relationship between weather factors and incidence of pests is a definite advantage. Our attempts at forecasts of pest outbreaks, can be made more precise. Insecticidal measures can be taken up at the very start of infestation. Prophylactic treatment can be reduced to the periods of likely occurrence of pests. Biological control, can be intensified at times favourable for the parasites to multiply in nature. This again is a long-range study.

Lastly, the answer to "What next" will not be complete without mentioning one or two points relating to fundamental systematic studies, Education and Extension. Systematic Entomology forms the basis of all economic work on insects and for all-round progress in entomological research in the State, it is very necessary that we develop this aspect and evolve specialists in this line of work also. In the field of Education, the subject of Agricultural Entomology is even now considered as a minor subject and what was squeezed into a two-year period, remains the same. It is high time that this subject is given its right place, in view of the increasing importance that is now given for Plant Protection work. The student taking the degree, should be equipped with fuller information. Changing the syllabus alone without adding more hours is ineffective. The subject should have the work distributed to the full three-year period of the course. In the field of Extension, for some years to come, there should be more practical demonstrations under direct departmental supervision, especially when dealing with highly poisonous substances as insecticides. It may even be necessary that in special cases, results of research done in State lands should be put to further observation in cultivator's fields to carry conviction. There is unlimited scope for expansion of plant protection work in the State.

Conclusion: We are aware of the pests that infest various crops. For control of pests the use of pesticides is the rule of the day. It is gaining momentum. Science is tending towards the use of very poisonous substances for pest control. We should proceed with caution. In the meantime, information should be built up as to how to use the various insecticides with safety to the crop, safety to man and livestock and at the same time destroying pests. Insecticidal method of control does not confer long-range benefits, and it is likely to prove uneconomical with falling prices of produce and the low margin of profit. It should be the State's endeavour to adopt the more peaceful method of biological control of aiming at common and lasting good to all, without much cost to the cultivators. Wherever possible, Education and Extension should aim at maximum equipment and intelligent application of findings of research by convincing demonstrations in cultivator's fields in a more extensive scale.

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Prospects in Plant Pathology

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Plant diseases are worst of the natural hazards in farming that make agriculture a gamble. Numerous diseases attack our economic plants and the losses caused are so heavy in certain seasons that famines occur, bringing in untold sufferings to people. Even in advanced countries like the United States of America, where great progress has been achieved in the control of plant diseases, the loss sustained due to diseases is estimated at three billion dollars every year and it needs no mention that in India, where only a fraction of the farmers take to disease control, the loss sustained would be very much greater. The tragic aspect is that much of this loss is a preventible waste. Waste is unworthy of a great nation and is contrary to the laws of nature. However, disease control is not easy in all cases. New diseases and new races of old disease-producing organisms appear all the time. Man's interference with the balance of nature, by domestication of plants, intensive cultivation etc. has brought in an increase in the number and intensity of diseases. Hence much remains to be done and continuous intensive research is needed to minimise the losses due to plant diseases.

The losses caused by plant diseases are sometimes enormous and the cultivation of certain crops in some countries has had to be abandoned in the past, owing to the ravages of disease e. g. coffee cultivation was abandoned in Ceylon due to the severity of the rust disease.

Notable progress has been already made in the investigation and control of a number of plant diseases. Still, there are several diseases which are either very difficult to control or for which there are no effective control measures. A number of diseases like root rots and wilts caused by soil-borne fungi, as well as a number of bacterial, virus and deficiency diseases require further investigation. Even in the case of diseases for which effective control measures exist already the possibility for further improvements by the use of more efficient fungicides and by reduction in the cost of control measures have to be explored.

Among the various methods of disease control, use of resistant varieties is the cheapest method, as it entails no additional expenditure to the cultivator towards control measures. Evolution of resistant varieties by combining disease resistance with other desirable agronomic characters is not possible in all cases and it needs continuous research

to meet the everchanging situations due to frequent occurrence of new races of pathogens. Though success cannot be assured in all cases, yet this is a very fruitful line of work and has to be pursued to the maximum extent possible, especially in the case of diseases like paddy blast, wheat rust, red-rot of sugarcane etc., which are not easily controllable by chemical methods. Other methods of disease control, such as use of disease-free seed materials, seed treatment, soil sterilization, protective spraying of the crop with fungicides also play an important role in controlling plant diseases and further research is required for testing of new chemicals. Preventive spraying or dusting of fungicides form the most important item of plant protection work. It is interesting to note that a number of new and more efficient fungicides are put on the market in recent years and constant testing of the new chemicals is very essential, to make spraying more efficient and cheaper. Universal application of fungicides to crops whether there is disease or not seems to be in vogue in certain countries but it is a laborious and costly operation. Our experience shows that epiphytotics or epidemics do not occur every year in every place appear but only in certain years where conditions are favourable for its development. If these conditions could be studied and the incidence of disease forecasted in time much of unnecessary spraying operations can be avoided. So research has to be carried out for minimising the area to be sprayed. This can be done only by developing a very efficient and reliable method of forecasting disease incidence, so that spraying can be carried out only in such localities where the spread of the disease is most likely to occur. Of course the present weekly forecast system in operation in our State is a pioneer work in this direction, but attempts should be made to make it as accurate as possible, as this will ensure savings in the spraying bill, which may otherwise go up to Rs. 40 to 50 per acre for three or four rounds of spraying. Again, disease incidence is governed by three important factors viz. the host, the parasite and the environmental factors. For a correct forecast of disease incidence, all these factors require to be studied in detail, in collaboration with the meteorologist. The possibilities for further research in the selection and use of fungicides, improvement in the spraying and other equipments are indicated in the following paragraphs.

Use of Chemotherapeutants for the control of plant diseases: Much of the work on chemotherapy (that is by introducing curative chemicals into the plant) has been done on systemic diseases. Promising results are reported to have been obtained in the case of Dutch Elm disease, Fusarium wilt of carnations and tomatoes. Inorganic salts, sulphonamide derivatives, hydroquinones, benzoic acids, phenols, 8-quinolinol benzoates, azoderivatives and antibiotics have been used. Of the antibiotics used as systemic fungicides mention may be made of griseo-fulvin which is produced in cultures by *Penicillium nigricans*. Recently it is reported

that *Rhizoctonia* on gilly flower plants could be controlled by soil application of 8-quinolinol sulphate. There are a number of diseases caused by *Rhizoctonia* fungus and further investigations on the above lines may yield fruitful results.

Use of antibiotics for control of plant diseases: Antibiotics is an old phenomenon to the plant pathologist. The first of our modern antibiotics, gliotoxin was discovered and crystalized by a plant pathologist even before penicillin had been purified and the role of gliotoxin in plant protection was investigated as early as 1933.

The most common method of application of antibiotics is to use them as spray solutions. Streptomycin is reported to give perfect control of fire blight on both apples and pears, bacterial spot of tomato, common blight of beans, and wild fire of tobacco. Another antibiotic, viz. terramycin, which has also been extensively tested, gives control of bacterial diseases. The antifungal agent actidione is very effective against powdery mildews of various crops, though its toxicity to the host plant should be taken into consideration. Another promising use of antibiotics is in seed treatment. Even deep-seated infections of seeds by fungi are reported to be eradicated by actidione and helixin B. Budwood of plum trees is reported to have been freed of *Phytophthora pruni* by soaking infected twigs in solutions of streptomycin G. The antibiotic has been injected in trees by various techniques and shown to have a protective effect against certain pathogens. The ideal type of treatment would be a soil drench. The plant could then absorb the antibiotic from the substrate and transport it to the place of infection and this aspect requires further research. Antibiotics are often quite specific in their action; some will inhibit only a few species of microorganisms, while others will inhibit a wide variety. Expansion in the application of antibiotics to agriculture is possible only after extensive experimentation with various crops under local conditions. Several new organisms can be isolated from soil and tested for their ability to produce antibiotics which will control plant diseases.

Virus diseases: The importance of serology in virus research and the utility of the electron microscope in plant virus research have already been realized. Just as the optical microscope made a major contribution to bacteriology, the electron microscope has extended our limits of observations and the virologist can now observe the infectious virus particles. In course of time the electron microscope would make a contribution to virology comparable to that of the microscope to bacteriology. Observing viruses in their host cells has now become possible through the development of techniques for cutting ultra-thin sections. Virologists have already applied the thin-sectioning technique to a study of virus development in tissue cultures in the case of animal viruses.

This may be a fruitful field of investigation for plant viruses also. Since it has not been possible to see any internal detail in plant viruses, successful attempts have been made at breaking the virus into smaller fragments and this could be called a dissection, (undoubtedly the smallest on record) and examining them. Quantitative electron microscopy for the determination of the number of virus particles in a preparation merits a wider application. The picture already obtained by the present freeze-drying method are much superior to those obtained by the ordinary air-dry techniques and more study of the freeze-drying method is needed. A number of virus diseases affecting such crops as potato, tomato, tobacco, sugarcane, sandalwood etc., occurring in our State require detailed investigation.

Toxins and plant diseases: The micro-organisms causing diseases produce toxins (microbial poisons) that penetrate into host tissues. Although considerable study has been made of the toxins produced by pathogenic bacteria in medicine, its implication in plant pathology are only beginning to be appreciated. Knowledge of these toxins opens up new possibilities of eventually combating plant diseases, not by attacking the parasite itself but by inactivating its toxins by means of substances which would render them harmless, as is done in the medical treatment of diphtheria.

Low-volume spraying: The adoption of low-volume spraying technique whenever possible will have many advantages over high volume spraying. A large proportion of the cereal weed spraying with hormone weed-killers is now reported to be carried out using low volume spraying equipment. By applying a fungicide with a low volume sprayer, large areas can be treated very quickly with small demands upon labour and with only 10% of the water required for high volume spraying and with quite large savings in the actual amount of active chemical required per acre. However there are certain limitations, one of which is the factor of evaporation in warmer climates. In order to obtain an even coverage the size of the droplets must of necessity be small. Such small droplets of a water-based spray tend to evaporate very rapidly under tropical or semitropical conditions and this has restricted the adoption of low-volume technique. The results obtained elsewhere during the past two seasons have brought out the efficacy of oil-based fungicides in overcoming the evaporation factors. The following spray formulation 4 gallons of white oil, 4 gallons of diesel oil and 17½ lb of copper oxychloride containing 50% copper was reported to give excellent control of banana leaf-spot, using only five gallons of the mixture per acre. There was no scorching effect due to diesel oil. On the other hand the oil seems to play some synergistic role in the spray fluid. It is suspected that the oil itself has some fungicidal effect. Oil-based sprays is only in its infancy and there is

need for further investigations before their true value can be assessed, though there seems to be a good future for oil-based sprays.

Of late a number of fungicides on the market are claimed to be specific against certain kinds of diseases. These require careful screening and testing so that only the best of the lot may be recommended for large-scale use.

Finally it may be said that knowledge is never complete and there remain many mysteries of Nature yet to be understood. In this connection it may be mentioned that the great American essayist Emerson has written:

"He in whom the love of truth predominates will abstain from dogmatism. He submits to the inconveniences of suspense and of imperfect opinion but he is a candidate for truth and respects the highest law of his being". The real man of science, the seeker after truth is conscious of the paucity of his real knowledge, but has confidence in his ability to know and to understand.

The Need for Research on Soil Actinomycetes in India

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Introduction: Though actinomycetes are of universal occurrence in nature, their existence was noticed only two centuries after Antoni van Leeuwenhoek, who is considered to be the Father of Microbiology, first observed bacteria in his 'microscope'. The first report on an actinomycete was made by Ferdinand Cohn in the year 1875 and since then several reports have appeared on their occurrence in soil, composts and manure heaps and also as plant, animal and human pathogens and detailed investigations have been carried out. As a result it occupies at present a very prominent position in industrial and agricultural microbiology. Studies on actinomycetes started in the United States when Dr. Selman A. Waksman, at present Director of the Institute of Microbiology, Rutgers University, entered this field. In the spring of 1914, Waksman, while studying different groups of microorganisms in the soils of New Jersey Agricultural Experimental Station, came across the interesting but little-known group of 'ray fungi'. The reason for this neglect was brought out in his first paper on the subject in the following words: "The actinomycetes grow very slowly; they begin to develop from the bottom of the plate, and to the casual observer the colonies formed look like those of bacteria, even after 5-6 days' incubation; only the somewhat mealy or rough surface will disclose the fact that they are not bacteria. It requires careful observation to tell whether those white, pink or grey colonies are bacteria or not. Many counts of bacteria might have been confused, when this point was not known, and the fungi and actinomycetes were not taken into consideration". Intensive studies on the occurrence of actinomycetes in soil, their classification, physiological properties and their economic importance followed and his contributions to our present knowledge of actinomycetes as a taxonomically and industrially important group of microorganisms are invaluable. The knowledge available on the organisms at the time penicillin was rediscovered by Florey and his associates in England in 1941 was put to use by him for evaluating their use as antibiotic-producing agents and new techniques for isolation and study of these antibiotics were developed, as a result of which remedies for various deadly diseases have been found and thousands of lives

saved. In the place of a dozen or so laboratories working on actinomycetes throughout the world before 1940, nearly a thousand laboratories are doing intensive research on this group of organisms in the United States alone at present and perhaps another thousand or more laboratories are engaged in this work in other parts of the world.

It is to be regretted that this important group of organisms has so far been very much neglected in India. It is the intension of the author to bring out in this article the economic importance of actinomycetes and to make some suggestions for their study in India.

Actinomycetes as microorganisms: Actinomycetes form an important group of microorganisms intermediate between bacteria and fungi. Because of their filamentous nature earlier workers were inclined to include them under fungi, but the knowledge obtained now show that they are more closely related to bacteria than to fungi and the latest edition of Bergey's Manual of Determinative Bacteriology has included them under the class *Schizomycetes* and order *Actinomycetales* with three families, *Mycobacteriaceae*, *Actinomycetaceae* and *Streptomycetaceae*. The family *Mycobacteriaceae* includes acid-fast bacteria of which *Mycobacterium tuberculosis*, is the most important. The true filamentous actinomycetes are included under the other two families. *Actinomycetaceae* includes the aerobic and microaerophilic pathogens belonging to the genus *Actinomyces* and the aerobic, mostly soil-dwelling forms, to the genus *Nocardia*. The last family *Streptomycetaceae* is economically and industrially the most important and the members of this family are known to be present in large number in soil, in dust, in manures and composts, in fresh-water lakes and river beds and in food products. Some of them are known to cause important plant diseases and food spoilage. There are two genera under this family viz., *Streptomyces* and *Micromonospora* of which *Streptomyces* is by far the most important.

Saprophytic Forms: Actinomycetes are distributed in various types of soil and at different soil depths as well as in other natural substrates in saprophytic form and they play a very important role in the decomposition of plant and animal residues and the formation of humus under conditions which are unfavourable for the decomposition of organic matter by bacteria and fungi in general. Further, the important part played by the thermophilic forms, which grow in compost heaps at 60-65°C and decompose organic matter at that temperature where most of the bacteria and fungi do not function, is of great significance. The nature of their interrelationships with other microorganisms under natural conditions in soil and their significance in soil fertility is however not clearly understood.

Pathogenic Forms: Actinomycetes are known from very early days to cause human, animal and plant diseases. *A. bovis* was the first

pathogenic form isolated from cattle in 1877 and since then aerobic and anaerobic forms of *A. bovis* have been isolated from infections on various parts of the animal body. The disease caused by this organism is commonly known as 'actinomycosis'. *A. israeli*, *N. asteroides* and *N. madurae* are known to be associated with animal diseases, sometimes resulting in serious troubles, but so far no epidemics due to these pathogens have been reported.

Potato scab or the common scab of potatoes is the most important of the plant diseases caused by actinomycetes. The disease is known since 1890, even though the causal organism was not recognized as a streptomycete at that time. Potato scab is one of the serious diseases of this crop. It is widely distributed throughout the world and has been extensively studied. The pathogen attacks young tubers and causes lesions in the form of small, brown spots which increase in size, leaving a shallow depression with irregularly ruptured skin and thick, corky outgrowths. The organism persists in the soil in saprophytic form for a long period. Among the other pathogenic forms known, *S. ipomoea* causing sweet potato pox and some species of *Streptomyces* causing scab of sugar beet and mangolds are important.

Actinomycetes in Industry: Actinomycetes were known for long to produce various pigments in synthetic and complex organic media, but little was known about the chemistry of these substances. With the recognition of their ability to produce antibiotic substances the physiology and biochemical activities of the organisms have been studied in detail. It is now established that actinomycetes are by far the best microbial agents for the production of antibiotics as compared to bacteria and fungi. More than 200 antibiotics have so far been isolated from them, of which nearly ten have found industrial use and several more appear to be promising. *S. griseus* is the first of the series of actinomycetes which went into commercial utility in 1945 and in 1953 more than 4,00,000 lb. of streptomycin, valued at \$ 48 million (about Rs. 23 crores) was produced in the United States alone and during 1954-55 there has been a further increase in production, due to its use as animal feed-supplement and for plant disease control. The sale of other actinomycete antibiotics in the United States was estimated as \$ 160 million (about Rs. 77 crores) in 1953 and during the past two years several industrial concerns throughout the world have started using actinomycetes for antibiotic production, involving large investments. The evidence accumulated so far indicate that the antibiotics very greatly in their chemical composition and antimicrobial property with an ever-expanding field of applicability, which in turn widens the scope for commercial expansion.

Besides producing antibiotics, actinomycetes are known to synthesise vitamins, especially vitamin B₁₂. *S. griseus*, the organism

producing streptomycin is also known to produce vitamin B₁₂ when cobalt is added to the medium. Among the various enzymes produced by actinomycetes, protease, amylase, invertase, pectinase, and oxidase, particularly some of these produced by the thermophilic forms, are considered to be of great importance. Several species of *Streptomyces* and *Nocardia* have been studied for this purpose. Some of the faster growing species like *S. griseus* and *S. lavendulae* are known to produce lactic acid, succinic acid, acetic acid, ammonia etc. under specific conditions. The uneconomic quantity of these substances produced in the broth, however, prevents the industrial applicability of the organisms for the present.

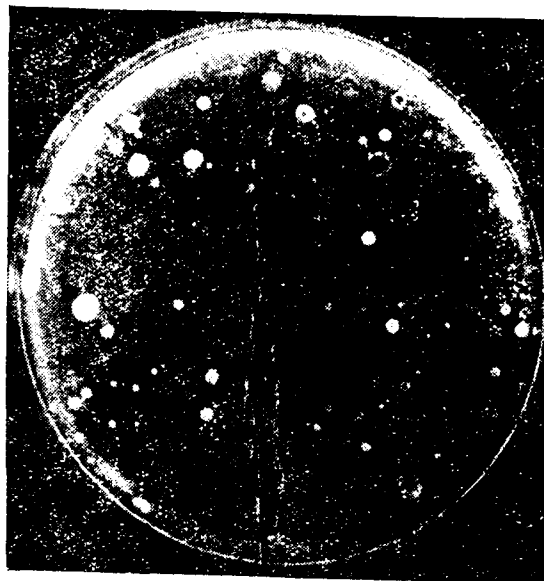


FIG. 1

Predominant development of actinomycete colonies in Ken Knight's agar medium plated with a soil sample at a dilution of 1:100,000.

FIG. 2

Antagonistic property of a strain of *Streptomyces lavendulae* producing a new antibiotic, Mycothricin, recently isolated by the author. The organisms inhibited are: (1) *Bacillus subtilis* (2) *Escherichia coli*, (3) *Pseudomonas fluorescens*, (4) *Candida tropicalis*, (5) *Saccharomyces cerevisiae* and (6) *Aspergillus niger*.



Actinomycetes in Agriculture: Large populations of actinomycetes are known to exist in soil and only a handful of species are reported to be plant pathogens, whereas others are, though indirectly, beneficial to the growth and development of plants. They play an important part in the decomposition of organic matter and humus formation. Another very significant function of actinomycetes is their antagonistic property which prevents the growth and spread of plant pathogenic organisms added to the soil. Though several actinomycetes have been known to be inhibitory to soil-borne plant pathogenic bacteria and fungi, they have not been advantageously utilized so far because of several difficulties involved. Recently antibiotics of actinomycete origin have come into use in agriculture as animal-feed-supplements and plant disease sprays. Some streptomycin preparations (Agrimycin, Agristrep, Strep-Nitrate etc.) are being put to use on a commercial scale. The inhibitory power of some of the metabolites of actinomycetes against plant virus infection seems very promising and probably the only effective remedy for some of the unsolved problems in plant pathology like soil-borne fungal diseases and virus diseases is in actinomycetes and the antibiotics derived from them.

Past work in India: The work done so far on actinomycetes in India is very little and comparatively insignificant. The first report on an actinomycete in India seems to be that of Joshi (3) in the year 1915. While studying nitrifying organisms in soil, he isolated a 'new type' of organism differing morphologically from other known ones at that time and called it a 'nitrite-forming organism'. The photomicrographs and the descriptions of the organism given by him show that he was dealing with an actinomycete. An organised attempt to study soil actinomycetes was made by Norris, Subrahmanyam and Ganesha Rao (5) in the year 1929. These authors collected soil samples from different places in India (some of them now in Pakistan and Ceylon) and isolated actinomycetes, using a starch-agar medium with minimum amount of nitrogen. The total number of colonies obtained per gram of soil varied from zero to four million. According to them 1 to 15 types of colonies were observed in each sample and a majority of them were chromogenic. In their concluding remarks they said: "With our present knowledge it is not possible to define the exact role of actinomycetes in relation to soil fertility and plant nutrition. Much work still remains to be done on the physiology of the more prominent varieties commonly occurring in the soil, particularly under conditions similar to those obtained in the depths of forest areas and the interior of manure heaps, before their importance can be properly assessed."

Since then a good deal of work has been done in other parts of the world and various aspects of the role of actinomycetes in soil fertility and plant nutrition worked out, but not much has been done in India.

It is not known how far the results obtained in other countries are applicable to Indian soils. Some attempts, however, have been made by a few microbiologists in recent years, to study the soil actinomycetes and some of the isolates have been reported to possess antibiotic properties (2). Studies made on the rhizosphere microflora of some of the important crop plants of South India have revealed that there is a greater accumulation of actinomycete population in the rhizosphere of Sorghum than in other plants investigated (1). *S. scabies*, the organism responsible for potato scab has been reported to be a serious problem in some parts of India (4) but no detailed study on the disease has been made so far.

Suggested methods of approach: As has been already pointed out, the main reason for not paying enough attention to the study of actinomycetes in the difficulty involved in the isolation, identification and classification of the organisms, as they are slow-growing, require special media for growth and special technical knowledge on the part of the investigator for these studies. A large volume of literature on the subject has accumulated and some excellent books have been written in recent years, but because of the small number of persons working in microbiology in India, knowledge on this subject is not much. Considering the importance of this group of organisms in the agricultural and industrial development of our country it is essential to start intensive research in this field immediately. It is not possible in this article to go into all the details of work to be done in India to overcome the deficit, but the following suggestions are made as a beginning:

1. A thorough survey of the actinomycete population in different types of soils and at various depths throughout India. The microflora of soil types like rice puddles, garden-land soils, tank and riverbeds etc. are bound to contain species of beneficial actinomycetes, as the climatic conditions in India are very conducive to their growth and development all round the year, in most parts of the country. It is also needless to say that this potential resource in soil is no less important than the mineral resources for which extensive surveys are being made at present.

2. Screening of actinomycetes for antibiotic production, vitamin production and for other industrial and agricultural utility.

3. Study of the part played by actinomycetes in the decomposition of organic matter, humus formation and soil fertility in general. Since actinomycetes play a great role in the decomposition of organic matter in compost heaps, special attention should be paid to study this aspect in different original methods of composting followed in India.

4. Study of the interrelationships of actinomycetes with other microorganisms in soil and to explore the possibilities of controlling the

injurious microorganisms by favouring the processes brought about by the beneficial actinomycetes.

5. Identification and classification of actinomycetes and of the soil types in particular.

These suggestions are in no way exhaustive, but are of immediate importance. With the increase in our knowledge on soil actinomycetes in India, further studies on some of the fundamental aspects like genetics and cytology, physiology and biochemical reactions of actinomycetes, actinophage and its relationship with actinomycetes etc. and some of the applied aspects like utilizing agricultural and industrial waste products for the production of antibiotics, vitamins etc. can be taken up. Since the study of actinomycetes forms a great part of microbiology, it is important that students of microbiology in Indian Universities should all be taught the subject in detail and trained for future work in this field.

Acknowledgement: I wish to express my gratitude to Dr. Selman A. Waksman, N. L., for going through the manuscript and offering very valuable suggestions.

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Some Suggestions for Intensifying Plant Protection Work

by S. A. IBRAHIM ALI,
Plant Protection Assistant,
Sattur

Seven years ago, when the Plant Protection Service was inaugurated in South India in 1949, there was a feeling of pessimism in the minds of the public with regard to its success. It was a time when the ryots were already fed up with methods of control like hand-picking, netting, pruning and the slow-acting pesticides like tobacco-decoction fish-oil soap etc. The introduction of quick-acting chemicals like, BHC, DDT, Zinc phosphide and the intensive propaganda and demonstration of pest control operations organised by the Plant Protection staff, dispelled this idea and the ryots are now convinced that Plant Protection service is quite indispensable for stepping up crop-production. Indeed, we have now reached a stage when our services are largely sought after and appreciated instead of our services being reluctantly accepted as before. The ryots have now become pesticide-minded and they are very particular in preventing the incidence of pests, rather than controlling them after their appearance.

The progress we have achieved in the field of plant protection can be easily gauged from the demand for pesticide everywhere. The annual sale of pesticides in departmental depots in 1948 which was only a few hundred pounds, has progressively increased to hundreds of tons. Now a situation has arisen when the departmental depots alone cannot handle the entire supply of pesticides to the public. The merchants were quick in cashing in the good work done by the department in the popularisation of pesticides. A large number of private dealers have entered the field and they are now almost competing with our department. Of course, it is a welcome feature and it should be encouraged, provided no malpractices are tolerated. Instances have been however reported where 10% BHC has been substituted for 50% BHC and Zinc phosphide adulterated with charcoal powder and sold at a cheaper rate. If such a state of affairs is allowed to continue, the public will lose confidence in the efficacy of all pesticides. Such fraudulent practices should be put an end to and the pesticide trade so regulated as to provide maximum benefit to the ryots.

Formerly, we had only a few reputed manufacturers of pesticides and fungicides catering to our needs. But with the large-scale use of pesticides, new concerns have been started to meet the growing demand.

As usual, unhealthy competition has resulted in price cuts and consequently degeneration of quality and efficacy of the drugs may soon follow. If the pesticide industry is to serve the cause of agriculturists, it is imperative that the Government should have strict control over the manufacturers. Rigid standards and specifications should be fixed for each type of pesticide and packed according to prescribed standards. In order to regulate the pesticides trade, the following suggestions are given;—

(1) All the manufacturers should be licensed and their products tested for active ingredients they are said to contain.

(2) As far as possible, pesticides should be packed in air-tight containers, which will remain unaffected during transit and storage. The name of pesticide, percentage of active ingredients, date of manufacture and directions for use should be noted on the containers. The manufacturers should also market small packings of 5-10 lb. to facilitate retail sale and prevent adulteration.

(3) The merchants who deal in pesticides should also be licensed. Periodical analysis of samples drawn from their stock should be done to prevent malpractices. The plant protection assistants should be invested with powers to draw samples and check malpractices.

(4) Dangerous pesticides like Folidol, Zinc phosphide, Agrosan, GN, etc., should be issued only on the authority of the plant protection assistants.

The present set-up and organisation of Plant Protection service is inadequate to meet the problem of pest outbreaks in a comprehensive scheme of intensive agriculture. The complexity of the pest control problem is fast increasing, with the introduction of numerous potent and dangerous pesticides like Chlordane, Toxaphene, H. E. T. P., Parathion, Schraden, Folidol, Endrin, Aldrin, etc. These require careful handling, systematic trials and assessment of results, before they are recommended to the ryots at large. There may come a time when some of our present-day popular pesticides like, BHC, and DDT will become obsolete and ineffective. Already reports are being received about the tainting quality of BHC and cumulative effect of DDT. Furthermore, insects develop resistant strains of their species against these insecticides. They respond to every new scientific offensive of man with a strong defence. Thus our search for newer and more effective drugs, along with useful parasites and predators should proceed unceasingly, until we are free from the ravages of pests and diseases. All these call for an elaborate organisation of highly-trained personnel to combat effectively pest and disease outbreaks. The following suggestions are offered in this regard,—

The Plant Protection staff should be organised into a separate section, with a network of specially trained field staff for each district. There need not be separate assistants or officers for Entomology and Mycology. Instead of stationing two assistants at the district headquarters as at present, each revenue division of three taluks must have an assistant, who should be in charge of both pest and disease control work. There should be a responsible officer for each division of three districts to supervise the work of the assistants in the division against large-scale pest or disease outbreaks. These divisional plant protection officers should be guided and controlled by the Government Mycologist and Government Entomologist as far as the technical side is concerned. For quick transport of men and materials, there should be a mobile unit attached to each divisional officer. Each unit should be fully equipped with power dusters and sprayers, hand-operated dusters and sprayers, spare parts, adequate stock of pesticides and fungicides, field equipments, etc.

In view of the backwardness of our ryots, who cannot take initiative themselves and carry out our instructions, it is imperative that the department itself should take control measures in all pest-affected areas. Suitable amendments should be made in the Pest Acts to enforce this provision. The cost of control measures can be collected along with land tax on acre basis.

In fine, plant protection service has got before it a wide field of useful work and with due encouragement from the government and the public, it is bound to play its rightful role in safeguarding crops from the onslaught of pests and diseases. It is very encouraging to note that provision has been made in the Second Five Year Plan to open more plant protection centres in the near future. This will certainly help a great deal in increasing not only the production of food crops, but also commercial crops that contribute to the prosperity of the nation.

What Next in Rice Breeding?

by K. RAMASWAMI,
Paddy Specialist

As indicated by the title, the paper deals with only one important aspect of the subject chosen for the Symposium, "What next in Agricultural Research and Extension?" Before taking the next step and trying to keep track of the possibilities ahead, one has to look back and see what ground had been covered already, and what aims have been attained.

Work so far: Rice Research in Madras State was initiated in 1913, i.e. a little over four decades ago. Starting with genetical studies on the different characters of the rice plant, the work in early years drew within its orbit numerous investigations relating to the nature of the rice plant with reference to its growth and yield. As genetic knowledge progressed, a vast collection of genetic stock, so essential in breeding, also accumulated.

Improvement of the yielding capacity of the existing major varieties by 'Pure line selection' was the main object of the initial breeding programmes, which was later extended to the synthesis of economic characters by hybridisation.

Ninety-nine strains resulting from 'Pure line selection' and nine strains evolved by hybridisation are now under distribution from the Paddy Breeding Station, Coimbatore and six other Agricultural Research Stations. Notable examples of successful hybridisation are the 'blast' resistant strains, Co. 25, Co. 26 and ADT. 25.

These 108 strains, capable of yielding 10 to 15 percent increases on a modest estimate, have now covered 40 percent or two and a half million acres out of the total area of 6½ million acres under rice in the State. Production now stands at three million tons of rice. Out of our population of 35 million, 70 percent or 24½ million are classed as rice-eating and the present production is found to be just sufficient to maintain them at a ration of 12 ounces of rice per day.

Taking all possible vicissitudes into consideration, double the quantity has to be aimed at which would mean that our production has to be stepped up by another three million tons. If the improved strains spread throughout the remaining 60 percent of the area also and if we

put the extra production at 100 lb. rice per acre, we may just produce an additional 1,75,000 tons.

This itself is probably the bright side of the picture. It is to be remembered that it is practically impossible at this stage of rice breeding to cover the extra area with strains. We have to reckon with a sizeable proportion of our lands subjected to drought and inundations as also saline and alkaline regions, for to which special strains are needed. Even in the matter of 'blast' resistance, we have only long duration strains at present. Short and medium duration strains resistant to 'blast' are yet to be evolved. We have also to eliminate loss from lodging, from premature sprouting of the seeds in short-duration varieties, due to their non-dormant nature.

We may now consider these various aspects separately.

Resistance to drought: It is estimated that an area of 3,70,000 acres is affected by drought every year to varying extents. The damage is caused in the early stages of crop growth in Malabar and South Kanara. Elsewhere it occurs in all stages. The average yield now obtained may be put at 500 lb. per acre but in certain seasons next to nothing is obtained by way of yield. The problem of evolving drought-resistant strains is not without hope, considering that there are already varieties showing moderate resistance. Besides, progenies are also available which are extracted from crosses between wild and cultivated types and between different dry types themselves. Rigorous testing of these materials remains to be done. It may be mentioned here that except probably what is claimed by Russian workers, no standard scientific method has as yet been evolved as an aid in breeding for drought resistance. Continued trials under natural conditions would appear to be the only feasible procedure at present.

Resistance to lodging: There are several areas in our State where lodging of rice crop in the pre-harvest stages, affects both the yield and quality of the produce. About six lakh acres of the first crop area in Malabar and South Kanara and about nine lakh acres in the other districts run the risk of being affected by lodging of the crop. It is estimated that a loss of 20 per cent is sustained by lodging and this over an area of 15 lakh acres as indicated above, is by no means negligible.

Some preliminary work in understanding the problem of lodging has already been done. The straw character of the existing varieties is found to vary considerably, resulting in different types of lodging. Non-lodging varieties have thick, persistent leaf-sheaths while lodging itself is to a great extent influenced by cultural practices. Genetically, the character appears to be governed by single factor difference.

The need is therefore felt for more elaborate studies relating to morphological and anatomical features of selected varieties, cultural features affecting lodging, as well as a thorough study of the root system. The problem is as important as it is many-sided; it is one that has a State-wide significance.

With the evolution of non-lodging strains, the problem of crop submergence can also be solved to a very great extent, barring of course, the typical deep water areas for which a character like 'stiff straw' has to be combined with certain other features as well.

There is still another important feature that has a close bearing to this problem of lodging. It is the dormancy of seeds. The grains of most of our short duration strains lack this character, with the result that if the ripening crop is caught in continued wet weather, the grains sprout on the plant itself. The damage caused is sometimes considerable. In fact, but for this drawback, most of our cultivators would be growing short-duration strains wherever conditions permit. Induction of dormancy in short and medium duration strains remains to be done on an extensive scale. Many of the existing varieties from cross progenies have also to be watched for this character. TKM. 6, a hybrid strain of short duration evolved from Tirurkuppam is a recent find which has this quality of dormancy to a remarkable degree.

Resistance to salinity: Saline and alkaline areas present problems peculiar to them. The cumbersome method of 'Kaipad' cultivation (Malabar district) in which the entire field is dug and patterned into regular mounds of sods to get the deposited salt washed down by monsoon rains, is perhaps the most ingenious cultural artifice that could be thought of. Nevertheless, a suitable strain would change the picture both in economy and in production.

In the case of other areas such a cultural practice is not feasible as the monsoon rains are scanty. There are, of course, the varieties SR 26 B and *Tellathokavadlu* which show a certain amount of tolerance. They need further improvement.

The next step will lie in the direction of making an extensive survey to collect resistant types from all over the country. Here again, it may be difficult to simulate, in a laboratory, conditions existing in the respective localities. What is required is an intensive hybridisation scheme and actual field trial of the progenies for a number of years.

Resistance to disease: Mention has already been made about the 'blast' resistant strains, Co. 25, Co. 26 and Adt. 25. These strains belong to the long duration group. Isolation of such resistant strains

of short and medium duration is the logical sequel to what has been recorded already. With this object, a scheme is now being worked and within the next five years suitable strains must be forthcoming.

A point to be noted in breeding for disease resistance is that more virulent 'strains' of the pathogen are found to develop as years go by. This makes the breeder's task all the more difficult. The only way out is to make the breeding itself a continuous process.

Conclusion: Broad indications of the work that lies ahead have been given without detailing theoretical concepts or technical procedure. Each aspect may well form a lifetime study by itself and unfold a number of ancillary problems in its course. Given the will and the facilities, success must come stage by stage and every stage will be a further landmark in the progress of rice-breeding in our State.

What Next in Millets and Pulses Research

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Introduction: Millets are grown mostly as unirrigated crops in areas of poor fertility. Being highly drought-resistant, they are the only staple food crops that could be grown in areas unsuited for the cultivation of paddy. Thus millets are complementary and not competitive to rice. Millets also provide fodder for cattle. It is estimated that they give nearly 6.5 million tons of straw to support 60 per cent of our cattle population. Chulam fodder, especially from the sweet juicy-stemmed varieties, is a prized fodder for the milch cattle of our State.

There are eight millet crops, of which Chulam, Cumbu and Ragi are known as the major millets and occupy nearly 75 per cent of the area while Tenai, Varagu, Samai, Kudiraivali and Panivaragu form the minor millets. These are cultivated over an area of nearly 5 million acres in the Madras State and the estimated production is 1.7 million tons of grain as against 6 million acres and 3 million tons of paddy.

Pulses, which are subsidiary food crops, are of great importance as the major source of protein supply in our diet. They occupy 1.2 lakhs of acres with an estimated production of 0.1 lakh ton of grain. This production meets only 10 per cent of our requirements viewed from nutritional standards. Large quantities are imported from other Indian States but the net available quantity for consumption in the State is still low.

Review of Work Done: Before formulating a plan of future work it is essential to take stock of our achievements so far.

Extensive collections of Indian and foreign varieties were built up from 1923, and the variations studied in the Millet Station, Coimbatore. Inheritance of most of the external characters and linkage groups were studied, as also factors affecting yield.

The second phase of work was directed towards isolation of pure lines from the local varieties. During the early years, grain yield alone was the criterion for selection. Subsequently, the yield of straw and quality of grain were also included as standards for selection work. Easy threshing ability in the strains was also another factor that entered into the picture. Since millets are grown mostly as rainfed crops, a fair degree of resistance to drought was insisted upon in the strains.

The third phase of millet improvement work consists of utilisation of knowledge of genetics in hybridisation work. For example, in the improvement of the quality of straw in *Cholam*, it was found that all the varieties of this State were pithy-stalked, while the *Patcha Jonna* of the Ceded districts was sweet and juicy-stemmed and was therefore well relished by cattle. Introduction of this desirable character in our varieties has been made by crossing these types and Co. 18 is the strain released. Work is in progress to introduce the sweet and juicy-stalked characters, which are governed by single genes, into all the strains. Short-duration strains have been evolved in *Cholam*, *Cumbu* and *Ragi* for cultivation during the irrigated season and these are liked for the smaller number of irrigations they require, as compared with the local varieties. In *Ragi*, a strain, K 3, which combines high yield, non-lodging character and resistance to *Piricularia* attack, has been recently released. A white-grained strain Co. 6, has been evolved by hybridisation combining high yield with white grains, rich in protein. Outstanding work on the utilisation of hybrid vigour has been accomplished in *cumbu* and good hybrids of medium duration are under distribution. This pioneering work of crop improvement in India is modelled after the well-known work on maize in America. The noteworthy feature of this work is the evolution of a cheap, yet efficient method for the large-scale production of hybrid seeds. In minor millets, a few high-yielding strains have been released, while in pulses the crop improvement work was taken up late and only one strain in each of redgram, greengram and Bengalgram have been released so far.

The following is a list of strains released so far :—

Cholam	...	23
Cumbu	...	7
Ragi	...	9
Tenai	...	3
Varagu	...	2
Panivaragu	...	1
Pulses	...	3
Total	...	48

Much progress has, however, not been made on the agronomic side. Manurial experiments recently started, indicate that only straw yield is increased in *cholam*, while in *cumbu*, increased yield of both grain and straw are noted. The results require confirmation, as also data on the economic aspects of fertilising. Raising of a nursery and transplanting the seedlings in the case of irrigated *cholam* and *cumbu* have been found useful under certain conditions.

Future Work: It is the inherent quality of research that however extensive the achievement to date is, what remains to be accomplished is vast. Millets and pulses improvement work is no exception to this general rule.

In *cholam*, the great millet, there are three distinct varieties cultivated under rainfed conditions. The Periamanjai *Cholam* of the Coimbatore district is valued for its grain as well as its straw. Further improvement in the quality of straw is possible in this type and is proposed to be achieved by infusing sweetness and juiciness into the stem which is pithy. The straw of the high-yielding types is characterised by blackish-purple colour but cattle relish better the reddish-purple straw. To improve the quality of straw still further without affecting the grain yield, this linkage has to be separated. This variety yields best when sown in July-August and if the sowings are delayed there is a progressive decline in yield of both grain and straw. Evolution of a high-yielding, short-duration type which will suit the late season sowings is an urgent necessity. The *Talaivirichan* type is preferred for cultivation in areas of high rainfall, because of its loose-panicked nature. But this variety has the smallest grain among our cultivated types and its fodder quality also is very poor. These two main defects call for immediate improvement. In the southern districts of Tirunelveli, *Irungu*, almost a wild variety, is exclusively cultivated for fodder purposes. The grain of this variety is brown and is unfit for human consumption. Although the new strain K. 3 (extracted type of Periamanjai-Irungu cross) is useful as a fodder-cum-grain type, further improvement of the pithy straw by introducing juiciness is important. A white-grained variety of *Irungu* is grown in the adjacent districts of Madurai and Ramanathapuram for grain as well as fodder. The quality of fodder and the grain size of this type have to be improved. In the irrigated season, *Vellai Cholam* is commonly cultivated even though *Sen Cholam* is preferred in parts of Salem and Tiruchirapalli districts. A dozen strains have been released to suit the various tracts. Evolving a few cosmopolitan types combining high yield with quality straw will go a long way in assuring uniformity of produce as well as ease in multiplication, distribution and maintenance of seed purity.

Pests and diseases commonly found attacking the *cholam* crop in the State are the *cholam* ear-head bug (*Calocoris angustatus*) and the smuts (*Sphacelotheca Sorghii*) and *S. reiliana*). Although effective insecticides and fungicides are available, it will be cheaper in the long run to cultivate resistant types. This will forestall any chance of the insects and pests becoming immune to the existing insecticides. For example we are led to believe that physiological strains of the ear-head bug immune to BHC. have already developed. Striga, a root parasite, is found in certain years to heavily infest the *cholam* crop. Preliminary

studies have revealed that resistance to this parasite occurs in an introduced sorghum variety which can be infused into many of our economic types.

Cumbu is cultivated over 1.2 million acres, but unfortunately it yields a fodder of very poor quality. If the ryots have any choice at all, this straw is not fed to animals, but is used only for thatching and such other purposes. Therefore, improvement in the palatability of cumbu straw is a matter of urgent investigation. Reducing the duration of hybrid strains without affecting the yield of grain is a possibility that deserves to be pursued. Spotting out of rust-resistant varieties has shown the possibility of infusing this desirable character into our strains.

Ragi, which ranks third in acreage under millets, is important for the reason that nearly 50 per cent of the area is raised under irrigation. It responds well to manuring and heavy yields upto 4,000 lb. of grain per acre are obtained. Evolution of a high yielding, short-duration, cosmopolitan strain combining non-lodging character and resistance to *Piricularia* is the immediate step in view. It has been found possible to infuse high protein content in Ragi and since the grain is consumed by middle and even upper-class people, because of its health-giving properties, further improvement in enhancing its nutritive value is desirable.

In minor millets, evolution of high-yielding types resistant to pests and diseases, with better fodder quality deserves immediate consideration. As already stated, intensive work on agronomic aspects is yet to be done. The optimum manurial and cultural practices, as also rotation and mixed cropping methods, that will suit different tracts have to be found out. Evolution of strains to suit different fertility levels is a necessary adjunct.

In advanced countries like the United States of America and Canada, with surplus food production, millets are mainly cultivated for feeding livestock. In the present drive for stepping up production, with emphasis on the spread of improved strains of cereals, better fertilising practices, assured water supply and with efficient plant protection measures, we may confidently hope to have a surplus production in the near future. It will be wise to foresee this eventuality and be prepared to face the situation. Fortunately the possibilities of using the additional production in numerous ways for the benefit of the country are already recognisable. Preparations of cereal breakfast foods, nutritive animal concentrates and industrial products like starch (by wet milling) readily suggest themselves. Breeding of strains suited for these specialised uses may however appear rather ambitious at this stage.

Pulses : Pulses are the main source of proteinaceous food for us, mainly because most of us are vegetarians, either by choice or out of economic necessity. But, the production of these in this State is very low. Immediate steps to augment the production by evolving suitable strains and efficient cultural and agronomic practices are problems awaiting solution.

On the extension side, much headway has yet to be made. The fruits of research like the evolution of strains, better methods of manuring, etc., have to be taken to the doors of the farmers and popularised. For example the improved strains of millets have barely covered 10 per cent of the total area. In the second five-year plan now being formulated it is programmed to cover 50 per cent of the area. An all-round effort in organising seed farms and in arranging seed distribution is necessary. The recently introduced method of village seed farms and voluntary seed exchange, tried in paddy and found successful, deserves to be extended for the spread of the strains of millets and pulses also.

Table showing nutritive value of grains of Rice, Wheat, Millets and Pulses.

	Protein	Fat	Mineral matter	Crude fibre	Carbo- hydrates
	%	%	%	%	%
1. Rice					
(a) raw, hand-pounded ..	8.5	0.6	0.7	..	78.0
(b) raw, milled ..	6.9	0.4	0.5	..	79.2
(c) raw, boiled and milled ..	6.4	0.4	0.8	..	79.1
2. Wheat	11.8	1.5	1.5	1.2	71.2
3. Cholam	10.4	1.9	1.8	..	74.0
4. Cumbu	11.6	5.0	2.7	1.2	67.1
5. Ragi	7.1	1.3	2.2	..	76.3
6. Tenai	12.3	4.7	3.2	8.0	60.6
7. Varagu	8.3	1.4	2.9	9.0	65.6
8. Kudiraivali	6.2	2.2	4.4	9.8	65.5
9. Panivaragu	12.5	1.1	3.4	2.2	68.9
10. Samai	7.7	4.7	4.8	7.6	63.7
11. Redgram	22.3	1.7	3.6	..	57.2
12. Blackgram	24.0	1.4	3.4	..	60.3
13. Greengram	24.0	1.3	3.6	4.1	56.6
14. Horsegram	22.0	0.5	3.1	5.3	57.3
15. Bengalgram	17.1	5.3	2.7	3.9	61.2
16. Cowpea	24.6	0.7	3.2	3.8	58.7
17. Lablab	24.9	0.8	3.2	1.4	60.1

From "Health Bulletin No. 23". The nutritive values of Indian foods and the planning of satisfactory diets—(1938) by W. R. AYKROYD.

Table showing the analysis of the straw of Paddy and major Millets.

		Ash	Protein	Oil	Fibre	Carbo- hydrates
		%	%	%	%	%
Paddy	..	16.3	3.3	1.5	30.5	37.8
Cholam	..	7.1	3.1	2.2	34.0	44.3
Ragi	..	12.1	2.2	2.4	28.2	44.9
Cumbu	..	8.1	1.9	1.3	37.6	43.7

(From Bulletin No. 33, South Indian fodders 1932 by P. V. RAMIAH.)

Cotton Research and Extension in Madras State

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Before it is proposed to tackle the problem of the present paper of "Cotton Research and Extension in Madras State", it is necessary to give a brief account of what is already achieved in Cotton Research and Extension in the Madras State". In the symposium held last year a review of recent advances in Cotton Breeding Research in the Madras State was presented by Kalyanaraman and Santhanam and the progress in Cotton Extension Work was reviewed upto 1952 by Balasubramaniam in the symposium on cotton extension held in the Fifth Conference of Cotton-growing Problems in India by the Indian Central Cotton Committee, Bombay.

Cotton, an important commercial crop of Madras, is grown at present over an area of 8.7 lakhs of acres, with a production of about 2.7 lakh bales, both as an irrigated and unirrigated crop. The American cotton, familiarly known as "Cambodia" in trade, was first introduced into Madras in 1906 and it is grown at present over an area of about 3.4 lakhs acres, of which about 1.5 lakh acres are grown under irrigation and the balance of 1.9 acres is raised as unirrigated crop. The *deshi* cotton known in trade as 'Tinnevellis' and 'Karunganni' occupies an area of about 4.7 lakh acres. A small area is also grown to other varieties classed under 'Salems' over an area of about 65 000 acres. These constitute "Uppam" and "Nadam" which are being replaced by Cambodia or Karunganni cottons. Unlike the other States of the Indian Union, cambodia cotton is grown in Madras both as winter and summer-season crops. Since it is well known that in summer, the cotton crop gives not only a higher yield but shows superior fibre qualities, a great impetus is now given to grow cotton in summer as an off-season crop, wherever irrigation facilities are available. This off-seasonal cropping does not in any way affect the food position of the tract but enriches the cultivators by means of a cash crop. It may be stated with confidence that in the map of India, the Madras cottons viz. Cambodia and Karunganni will in future occupy a very prominent place. In yield of *kapas* the irrigated Cambodia ranks foremost and is capable of producing about a bale of lint per acre. Quality cottons like Madras Cambodia Uganda 1 and Madras Cambodia Uganda 2 are placed outside the purview

of price control by the Government of India, along with two other varieties of Bombay, viz. B. C. 134 and B. C. 170.

The development of cotton industry in the Madras State is influenced by two factors viz. development of mills and cotton research. The former sprung up in large numbers in centres like Coimbatore, with the functioning of the Pykara Hydro-Electric Scheme and shortage of cloth created during World War No. II. Of the 80 mills working in the Madras State, about 38 are located in Coimbatore district alone and the annual requirement of raw cotton to feed the mills of the State is estimated to be about seven lakh bales. In general the cultivators of Coimbatore, Salem, Tiruchi, Ramanathapuram, Madurai and Tirunelveli are highly cotton-minded and many progressive cultivators pay great attention to the cultivation of this cash crop. Yields as high as 2,000 lb. of seed cotton are recorded in the irrigated Cambodia grown in garden lands under wells. On the agricultural side, both plant breeding and agronomic research have played a vital role in the improvement of yield and quality of the several varieties of cotton grown in the State. The progress of Cambodia cotton kept pace with the improvements of breeding technique, designed to bring higher yield, better ginning per cent, superior fibre qualities like length, fineness and higher warp counts. With the introduction of Cambodia 2 by pure line selection, the Cambodia bulk with a staple of less than 13/16" and spinning 26 counts was upgraded to 13/16" in staple length and spinning 33 counts. This strain was found to be highly adaptable to varying types of soil and suited many irrigated and unirrigated tracts of this State. As a result of intensive research and hybridization work, Madras Cambodia Uganda 1, which comes to maturity a fortnight earlier than Cambodia 2, gained popularity as a summer crop in the districts of Ramanathapuram, Tirunelveli, Madurai, and South Arcot and is now recommended to be grown as a cold-weather crop in Coimbatore, Salem, Tiruchirappalli and Madurai districts also. This cotton is superior to Cambodia-2 in ginning per cent (37), fibre length (1.00" inches) and spinning performance (44 counts) and on account of its superior length is placed outside price control. As a result of further breeding research involving multiple crosses, another new strain, Madras Cambodia Uganda 2, was evolved in 1953 and this is now gaining popularity in the *Masipattam* area, replacing the former strain, Madras Cambodia Uganda 1, rapidly. This new variety is not only earlier than Madras Cambodia Uganda 1 by a fortnight but it is capable of yielding 18 per cent more of *kapas* per acre, with finer and longer lint, capable of spinning 50 counts or more. Similarly, in the winter area, strain 9030, from a multiple cross, is promising in ginning per cent, fibre length, fineness, higher spinning capacity and resistance to *jassids* and is expected to replace Madras Cambodia Uganda 1 very soon. Breeding researches in the summer cotton at Srivilliputhur

has shown that great possibilities exist to produce quality cottons comparable to the imported East African styles with a staple length of 1-3/16". The reduction of duration of the improved varieties had a tremendous effect on the successful introduction of cotton in the summer areas as a rotation with paddy crop. Recent efforts made by the Agricultural Department on extending cotton cultivation in the deltaic areas of Tanjore met with success by the introduction of a still shorter duration variety like P 216 F, which could complete its harvest in five months yielding 1,000 lb. *kapas* per acre. This quality cotton is capable of spinning 40 counts and shows great adaptability over a wide range of conditions. Breeding researches are under way at the Agricultural Research Station, Aduthurai to evolve a still shorter duration, quality cotton capable of finishing in 4½ months.

Breeding work in Karunganni cotton has resulted in the evolution of Karunganni 2 and Karunganni 5 cottons by hybridization. These *Arboreum* strains are capable of spinning 30's counts as against 18-20 counts of local Tinnies and have now replaced the former strain Karunganni 1, evolved by straight selection methods. As a result of extensive hybridization work taken up recently, three long-linted cultures viz. 6186-9, 6874 and 6188 with a staple length of nearly one inch, and yielding more than Karunganni 2 or Karunganni 5 in the respective tracts have been isolated. One of these quality cottons, capable of spinning 40 to 42 counts will soon be released for the entire Karunganni and Tirunelveli zone of the State, covering about 4.5 lakhs of acres.

Research is under progress to acclimatise and successfully introduce Sea Island cotton in the West Coast of the State. Varieties like Montserrat and Andrews have indicated possibilities and with judicious transplanting and manuring, yields as high as 850 lb. of *kapas* could be realised on the poor *modan* soils of Malabar tract. The cotton grown in such areas is capable of spinning 100 counts, with a mean fibre length of 1.45 inches.

In addition to plant breeding research, agronomic studies on time of sowing and spacing, have furnished very valuable results in upgrading the yields of cotton. Early sowing and close spacing was in general found beneficial. In the case of Karunganni the harmful effects of *Irungu cholam* which precedes the cotton crop were got over by recommending indigo as a mixture with the cholam crop. In the case of manuring, application of ammonium sulphate as top dressing at 40 lb. nitrogen level in two split doses was found to be beneficial to the irrigated Cambodia crop and in the case of unirrigated cottons one dose at 20 lb. nitrogen at the time of sowing was in general beneficial. In the attempts to find out varieties resistant to stem weevil of Cambodia, a perennial

Brazilian variety named 'Moco' was found to be highly resistant and this cotton is recommended for growing in the backyards, of houses, waste lands, to meet the needs of extra-factory consumption. This perennial cotton with a staple length of one inch is capable spinning upto 50 counts and yields even upto 4 lb. *kapas* per plant under favourable conditions. Indents are being received every day for the supply of seeds of this variety from the various parts of India. Under mixed cropping, cotton-groundnut mixture, ragi-cotton mixture and chilli-cotton mixture were popularised and this practice served as an extra source of income to the cultivator.

With the above background it is now proposed to deal with the question of "What next in cotton research and extension in Madras State". This is indeed a difficult problem and needs considerable information regarding the potentialities of development, facilities available for expansion, demand, marketing, export and other factors. The future plans will have to be done with reference to the cultivation, trade and consumption by mills in a cash crop like cotton. According to the Second Five-Year Plan, the target of cotton production for the Indian Union is fixed at 55 lakh bales by the end of 1960-'61 and the share of Madras is 4 lakh bales. To achieve this production of quality cottons, which are much needed by the Indian Union to reduce imports and save foreign exchange, long-range research and short-term cotton extension schemes are aligned. The following are some of the points for consideration.

(1) In order to encourage the production of extra long-staple cottons the Indian Central Cotton Committee have agreed to fully finance such schemes for a period of 15 years and a scheme has been approved for Madras for the summer zone with the object of evolving extra long-staple American cottons with a staple length of 1-3/16" and more. In the Winter area similar attempts have to be made to breed extra long-staple cottons in alignment with the progress of the summer cotton and the gap in quality between the cotton grown in two different seasons of the year in the State should be narrowed down as far as possible to avoid the chances of malpractices like mixing etc., that may arise.

(2) The production of extra long-staple cotton is at present attempted in this State, by hybridization of cultivated Americans, both inter-specific and intra-species and sometimes involving complicated crossing programmes. Since inter-specific hybridization between Asiatic and American cottons which differ in chromosome numbers have yielded successful results by back-crossing techniques in Bombay State in the release of strains like BC. 134 $\times$ Co. 2 and BC. 170 $\times$ Co. 2 which are superior long-staple cottons, serious attempts are to be made in the breeding programme of this State also, by hybridizing select lines of

Karunganni with various promising lines of acclimatised *Hirsutum* cottons, to yield early-maturing, high-yielding and long-linted types, resistant to pests, diseases and drought. It may be mentioned that some of the Surat Asiatic - American hybrid derivatives, 2196 (discovered by the senior author), BC. 125 $\times$ Co. 2 etc. were found to be highly resistant to *Blackarm* and *jassids* respectively but as they were found to be late for the conditions of Madras, further work is necessary in this direction to evolve suitable types.

(3) Potentialities for fibre length, strength, fineness and immunity to pink bollworm, *jassids* and *Blackarm* are exhibited in wild species of cotton like *G. thurberii*, *G. raimondii*, *G. armourianum*, *G. anomalum* etc. Although these cottons are as such useless for cultivation and many of them have no lint, when suitable crosses are made with the cultivated types and fertility induced and stability fully restored by techniques like colchicine treatment, back-crossing etc., exceptionally long-linted types resistant for pests and diseases may be obtained. Careful planning, and an intimate knowledge of cytogenetics and genetics are required as adjuncts to the normal plant-breeding programme.

(4) Another method by which the quality of lint could be stepped up along with high yield is by exploitation of hybrid vigour. Successful results in this direction have been reported both in Madras and Bombay States with a staple length of 1 1/4" and an yield of 1,000 lb. of *kapas* (under Madras conditions) in the inter-specific cross Cambodia-2 $\times$ Sea Island as a rainfed crop in the West Coast. Another advantage of the hybrids is that they can be continued as ratoons in the second year and yields as high as 1,500 lb. of seed cotton could be realised immediately without waiting for purification etc., normally practised in the plant breeding programme. Further researches are necessary and as suggested by Dr. Harland, various pure breeding lines of perennial *Moco* and acclimatised perennial *barbadense* types have to be utilised for further study to fully exploit the possibilities of heterosis in the production of extra-long-staple cottons. Care is however necessary in this kind of work to see that the seeds of F_1 hybrids are not utilized for multiplication. This project will have to be treated as a special one and the areas grown should be carefully demarcated; where other American varieties are not under cultivation. The chief problems in this work are the production of hybrid seeds in large scale every year and the high cost of production of seeds.

(5) In the attempts to improve the quality of Cambodia cotton, the problem of pests and diseases needs careful consideration. Pests like *jassids* and diseases like *blackarm* cause serious losses and have of late become items of regular study in the plant breeding programme.

Fortunately, some information is available on the mechanism preventing deposition of eggs on the leaves in the case of *jassids* by the work of Parnell and others. Hairiness of laminae is considered to be one of the major factors and the genetics of hairiness of laminae has been worked out by Knight and others. Research is still in progress to explain the *jassid* resistance in glabrous-leaved types like *G. armourianum*. Similarly in the case of "*blackarm*", a series of genes controlling the inheritance of resistance are involved and resistant varieties have been built up by Knight and others. Efforts are also made to combine *jassid* and *blackarm* resistance in the same plant. In the case of Madras Cottons also, such studies are necessary in greater detail in the coming years to build up types resistant to both *jassids* and *blackarm* as a whole-time study under the long-range programme. Under the short-term plan, the only possibility to control *jassids* is with the aid of pesticides like 'Endrin', 'Folidol' etc.

(6) In the breeding of American cottons, the problem of immaturity of fibres is an important consideration. A type which is immature tends to produce yarn which will be "neppy". Varieties which are least neppy and possessing high maturity percentage have to be synthesised through a survey of all types of cultivated American cottons and studying intrinsic fibre maturity in the wild cottons like *G. thurberii* and *G. raimondii*.

(7) In the programme of purification of varieties, the possibilities of building up perfectly homozygous lines by the exploitation of haploids in both the American and Asiatic cottons needs careful consideration. Haploid plants which have only one complement of chromosomes in the somatic tissues are rare and methods of artificially inducing it at will, just as chromosome complement in a plant is doubled at will by treatment with colchicine, will have to be attempted in the breeding programme. Likewise, parthenogenesis to induce the development of apogamic plants as recently discovered by Balasubramaniam by crossing *G. hirsutum* x *raimondii* hexaploid having 78 chromosomes with Karunganni cotton (26 chromosomes) needs careful consideration. The importance of such studies has been recently pointed out by Dr. Harland also, to isolate homozygous lines in cotton.

(8) On the extension side, it is necessary to multiply the approved strains in a pure state and in order to rapidly multiply the seeds to cover the entire tract, Agricultural Co-operative Societies should be organised in every taluk centre and they should act as official agents on the model of Bombay and Madhya Pradesh States. In this direction, one Cooperative Society has recently been organised to multiply and distribute seeds of Madras Cambodia Uganda 2 in Srivilliputhur taluk. State legislations like the Cotton Control Act, Cotton Growing

and Pressing Factories Act and Cotton Transport Act should be tightened up to prevent mixing up of varieties. By the implementation of the Cotton Control Act in stages the area under cotton in the different tracts will be fully covered with improved seeds in due course.

(9) The average low yield of seed cotton in this State and other States of the Indian Union should be up-graded by increasing irrigation facilities, manuring, application of pesticides etc., on a national basis.

(10) The cotton crop that is grown is at present valued mainly for its fibre and the seed is used for cattle food. In countries like the U. S. A. and recently in Pakistan, cotton seed is crushed and the oil extracted and used for many industrial and domestic purposes. In India, cotton seed oil is extracted in Punjab, Rajasthan, PEPSU and Madhya Pradesh States and the oil is used for Vanaspathi and the cake sold as cattle food or manure. The 'Linter' that is extracted from the seed after ginning is used in the manufacture of cellulose, carpets, ropes etc. Thus the seed that is used as cattle food in this State could be utilised for oil industry and the cake used for cattle food and manure. This step will not only help the cultivator in getting the maximum monetary returns for the cotton seed, but also helps in curbing the use of uncertified seed for sowing purposes. The Cooperative Societies will then be in a position to stock the full quality of sowing seeds with confidence and induce the cultivators to go in only for approved seeds sold by recognised agencies.

(11) Other factors like price support, export and import policies, regulated markets, and certification of lint will go a long way in inducing the cultivators to grow cotton over large areas and attain the targets fixed under the Second Five-Year Plan even earlier than expected.

The Future for Oil Seeds Research in Madras State

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Research on Oil Seeds is a recent development in the department of Agriculture of Madras State, and has been in progress only for the last twenty-five years, but the results achieved in breeding, agronomy, plant protection and other aspects of their cultivation are quite substantial. Intensive selection and hybridisation work in groundnut, gingelly and castor has resulted in the evolution of a number of strains with high yields, high oil-content and other desirable agricultural and commercial qualities. Amongst these, four strains in groundnut, three in gingelly and four in castor, have established their superiority over the local cultivated varieties. In coconut, which is a perennial plant with a high percentage of cross pollination, selection based on the characters of mother palms, seed-nuts and seedling progenies is being carried out in the promising ecological types. Hybrid vigour as a means of improvement has also been utilized in coconut by crossing the 'tall' and the 'dwarf' types to produce progenies possessing the desirable features of either of the parents like earliness, yield, etc. On the agronomic side, a few problems connected with these crops have been investigated. In groundnut the optimum economic spacing, manurial requirements, the best crop rotation, and remunerative mixed cropping practices have been determined. For castor and gingelly, the optimum spacings have been fixed. In the case of the coconut, proper cultivation and manuring practices and efficient green manure and subsidiary crops have been fixed. From the investigations carried out on pests and diseases of the groundnut crop, effective control measures for the 'Surulpoochi' pest and 'Tikka' leaf spot disease have been found out. The correct stage of harvest that would ensure maximum yield and good quality produce have also been determined for these crops. The problem of storage of groundnut pods and kernels has been investigated and results of value to agriculturists and trade have been obtained. In spite of the fact that substantial progress has been recorded in the improvement of these crops, a large number of other problems connected with their cultivation still remain to be investigated. Only when proper solutions to these problems are found out, can it be claimed that oil-seeds cultivation and the industries utilising oil-seeds as a raw material have been established on firm foundations. Suggestions regarding the lines on which the future oil-seeds research in this State should be pursued to attain the above objectives are set forth in the following sections:

Groundnut: Though the improved strains now under distribution are heavy yielders with good quality produce, still they cannot be

claimed to meet all the varied requirements of the growers, consumers and industries. As far as the growers are concerned, there is an urgent need to evolve types resistant to drought, pests and diseases, amenable to mechanical cultivation and with short period of seed dormancy. With the increasing edible uses to which groundnut is put to, there is demand for a type with low oil content and high sugar content. In the *Vanaspathi* industry, the need for a type capable of giving colourless oil is keenly felt. For these reasons, breeding of new forms with special attributes like semi-spreading habit of growth, medium seed dormancy, low oil and high sugar content, white seed, etc., has become imperative. With these objectives in view, an intensive breeding scheme on this crop has just been initiated in this State with financial assistance of the Indian Central Oilseeds Committee. The nutritional aspect of the groundnut crop is rather a complex problem requiring thorough investigation. Though the normal nutrient requirements of the crop have been determined, still the economic doses of the nutrient elements and the changes brought about by them and other micronutrients under varied conditions of soil, need very careful study. A physiology scheme for carrying out comprehensive investigations on this aspect has also been started recently under the auspices of the same Committee. With the decline in prices of groundnut in recent years and growing foreign competition in the international markets, it has become increasingly necessary to reduce the cost of production of the groundnut crop to the maximum extent possible. Sowing and harvest account for a very large share of this cost. Use of labour-saving implements for these operations, including intercultivation, can be expected to reduce the cost of production considerably. Trials with bullock and tractor-drawn implements for carrying out the above operations have been taken up under a third scheme sponsored by the Oilseeds Committee. Work in respect of control of major pests and diseases affecting this crop and evolving strains resistant to them have to be carried out by adopting the latest breeding techniques.

Gingelly: The three strains now under distribution no doubt meet the requirements of the growers of the State for raising the crop in different seasons and under varying conditions of cultivation, but there is a great need to evolve cosmopolitan types that would come up well in all seasons and in all tracts. There is also a need to step up the present yield level of the crop by bringing together all the economic features now found scattered in different forms. A programme of cyclic crosses between selected economic forms has been started for this purpose and the work will have to be pursued rather intensively for achieving the desired results. The specific nutrient requirements and their optimum doses have still to be determined for this crop. Manurial trials aimed at securing this information have been initiated. Among the pests and diseases affecting this crop, the shoot-webber pest and the "phyllody" disease are the most serious and studies have to be pursued on their control both by chemical treatments and by breeding resistant varieties.

Castor: The strains of castor under distribution are outstanding in their yield performance. But on account of their long duration, they have not become as popular as they should be. The prospect of reducing their duration without sacrificing yield appears bright, as types with very short duration are found among the new introductions. To keep up the purity of improved strains under cultivators' conditions there is a need to impart some distinguishing feature to the standard strains so that the off-types could be easily recognised and removed. As hybrids between certain inbred types exhibit a high degree of vigour, with consequent increase in yield, exploitation of this vigour for production of hybrid seeds is a line of improvement worth pursuing. Work in this regard has been commenced and crosses between certain predominantly pistillate and staminate inbred forms have been attempted for fixing up the most suitable combination. As in gingelly, work has to be carried out on determining the nutritional requirements of the crop and an efficient rotation. The 'Semi-looper' caterpillar is the most dangerous pest, doing considerable damage to this crop. Any control measure against this pest will be a source of great relief to the growers.

Coconut: In recent years large-scale production of selected seedlings of the ordinary tall variety and of the Tall $\times$ Dwarf hybrids has been started. Exploitation of other promising exotic varieties like Cochin-China, Andaman Ordinary, Java, Philippines, etc., and other fruitful combinations of T $\times$ D hybrids form the main programme of breeding in coconut. Determining the optimum and the economic doses of the manures to be applied to the palm at various stages of its growth is another important aspect requiring investigation. Bringing the vast stretches of unproductive gardens along the sandy coastal belt to a state of normal bearing by providing adequate manuring and summer irrigation (with the aid of filter-points) is yet another line which has great potentialities. This item of work is proposed to be taken up immediately at one of the Coconut Stations. As the results obtained from the trials on the West Coast Stations are not applicable in their entirety to the conditions on the East Coast, there is a real need to establish a regional research station for coconut on the East Coast also. Button-shedding, occurrence of barren nuts and effective control of the rhinoceros beetle are some of the other serious problems facing the coconut grower, on which systematic investigations are urgently needed.

The above review outlines the major problems connected with oil-seed crops that still await solution and the steps that should be taken to tackle them. Already there are signs of success in many directions. If these problems are pursued with zeal, it will not be long before the cultivation of oil-seeds in this State and the industries depending on them get well established, and open up new vista of prosperity for the Madras State as a whole.

Agricultural Research in Groundnut Cultivation

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Introduction: Modern agricultural science developed from the days of Liebig and Schubler in Germany, Boussingault in France and Lawes and Gilbert in England. Since then research in agriculture has made vast strides and other sciences like chemistry, biology, physics, etc., have also contributed to its development. Improvements by way of evolving new strains, new control methods against weeds, pests and diseases, etc., are also being effected year after year. The urge for bettering the achievements of to-day is growing and is bound to grow, as is reflected in the title for this year's symposium.

In the Madras State research in agriculture started from 1902, when an Economic Botanist was appointed for plant breeding. However, research on oilseeds, particularly on groundnut, was started in a full-fledged manner only from 1930. During the last 25 years great improvements have been made in the cultivation of groundnut in this State, much to the benefit of ryots. The recent advances in this field have been dealt with by Seshadri C. R. (1954). Improvements which are in the trial stage and which are sought to be effected in the field of agronomy and mechanical cultivation, with particular reference to groundnut are discussed in this paper.

1. Improvements by Breeding: Breeding strains for some special attributes besides high yield, is the foremost item in the improvement work on groundnut. With the greater knowledge acquired in the breeding technique suited to this crop it is possible by hybridisation to evolve new strains which combine desirable economic characters and high-yielding ability.

The bunch variety of groundnut is extensively grown in North Arcot District and Pollachi taluk of Coimbatore District. Its cultivation is gradually finding favour in other districts also, on account of its short duration and ease of harvest. Unfortunately, this type has a major drawback in the non-dormant nature of the seeds. Unlike the seeds of the spreading groundnut, the seeds of the bunch type do not require any resting period after harvest. If wet conditions prevail at harvest time, the mature pods begin to sprout in the field. The harvest of the bunch groundnut is possible only after rains and any delay in taking up this operation results in large-scale germination of the nuts in the field. It has

been reported from the bunch-growing areas that in certain years even upto 80% of the produce are rendered unfit for marketing due to sprouting of seeds. The seeds of spreading groundnut do not germinate immediately on maturity as they require a resting period of one to two months. There is therefore an urgent need to evolve a bunch type of groundnut with dormant seeds. This problem has been receiving attention at the Agricultural Research Station, Tindivanam and some progress has been made in this direction. After years of work a strain (AH 6481) has been evolved by hybridisation. The strain has a bunch habit of growth and dormant seeds. In the trials conducted at Pollachi the strain has shown superior performance. But its duration is longer than that of the ordinary bunch groundnut. More intensive work is necessary to evolve dormant bunch strains with short duration.

After the War, there is not much of export of groundnut and almost the entire production is utilised for crushing purposes. The growth of Vanaspathi industry in India has accounted for a large share in the internal consumption. In the manufacture of Vanaspathi or vegetable ghee, the groundnut oil has to be decolorised before hydrogenation, as the oil available in the market is coloured on account of crushing kernels with pink seed coats. A white-seeded type of groundnut will naturally yield a colourless oil, thus eliminating the need for decolorisation and refining, which are costly processes. A dirty white-seeded spreading type is available in the varietal collection maintained at the Agricultural Research Station, Tindivanam. But it is not a heavy yielder and recently two white-coloured bunch types have been introduced from Australia and East Africa. These will be utilised for evolving white-seeded new forms.

Though India is one of the biggest producers of groundnut in the world, the per capita consumption of groundnut is very small, about 1-2 lb. In Madras State before partition, the per capita consumption of groundnut was about 3 lb. In America, the per capita consumption for edible purposes is much more, being about 11 lb. There is therefore large scope for increasing the consumption of groundnut kernels in the State. Groundnut kernels are rich in nutrients and its popularisation among the masses will go a long way in improving the health of the people, especially of those accustomed to a poor cereal diet. The varieties that are at present cultivated on a large scale in this State are mainly commercial types suitable for crushing. The qualities that are usually preferred in a dessert-type are large, uniform size, good colour and low oil content. There are no forms in the existing collection which combine all these features and high yield. They are found distributed in different forms and hence by intensive selection and hybridisation work they will have to be brought together in one form. This item of improvement has already been initiated at the Agricultural Research

Station, Tindivanam and four promising strains are undergoing tests in cultivators' holdings. The performance of these in the districts is found to be encouraging and it should be possible to release one of them for general cultivation shortly.

2. Improvements in Agronomy: In this State groundnut is invariably sown by dibbling the seeds behind country ploughs, whereas in the Andhra State sowing is done with the country seed-drill known as '*Gorru*'. In foreign countries sowing is done with tractor-drawn implements in rows 2 to 3 feet apart. Till now the Department has been recommending a spacing of 6" $\times$ 6" for the bunch and 9" $\times$ 9" for the spreading groundnut. These spacings are obtained by adopting a seed rate of 100 lb. for the bunch and 80 lb. for the spreading. Row cropping as practised in Andhra and elsewhere has been found to be economical as it facilitates intercultivation and harvesting operations with implements. Experiments are under way to find out the effect of adopting wider row spacings between rows and closer spacing in the row. The results obtained during the last two years show that adoption of wider row spacing for groundnut results in higher yields and saving in expenditure for sowing, intercultivation and harvest. This practice should be made a regular feature in groundnut cultivation by intensive propaganda. It is estimated that if this practice is adopted even over a tenth of the groundnut area in this State, it will lead to a gain of forty lakhs of rupees to the groundnut cultivators.

The problem of manuring the groundnut crop has been receiving the attention of the Oilseeds Section for nearly two decades now. Results so far obtained show that the groundnut crop responds well to applications of potash and in certain years to phosphoric acid also. In recent years the trend in fertilisation is to supply all the ingredients required for the crop and not the only one to which it is partial. Complete fertilisers are more popular nowadays in foreign countries and also in this country. Years of trial have revealed that application of mixtures with low nitrogen, medium phosphoric acid and high potash, result in higher yields. A number of such proprietary mixtures with different proportions of NPK are in the market at present. A recent advance in fertilisation methods is the placement of manures in the zone wherefrom the plants could utilize them to maximum advantage. There is also economy in the use of fertilisers by resorting to placement. Methods of placement and implements for that purpose are under trial and the results will be passed on to the ryots in the near future.

The advantages of rotating groundnut with cereals in drylands have been well established. Demonstration plots in ryots, fields to bring home to them the advantages of such rotation are being organised in a number of centres in the districts. It is hoped that this groundnut and

cereal rotation will become a regular feature in this State and help the cultivators to reap maximum benefits. The practice of raising groundnut in wetlands after the harvest of the main crop of paddy is also becoming very popular. With increased irrigation facilities, the practice is bound to become more popular as it has already caught the fancy of the growers.

3. Improvements in the Mechanical Cultivation of Groundnut: The recent trend in agriculture is towards mechanisation. Whereas in other countries mechanical cultivation has made rapid strides, in India it is only in the initial stages. Groundnut cultivation with machinery is being tried at the Agricultural Research Station, Tindivanam from 1948. A separate scheme financed by the Indian Central Oilseeds Committee with the object of evolving tractor and bullock-drawn implements is also being worked out in this State. The results achieved so far are very encouraging and hold great possibilities for the future of groundnut cultivation in the State. A brief account of the achievements and work in progress are given hereunder.

(a) *Seed Drill:* These are designed on the model of the bullock-drawn mechanical seed drill for use with the tractor. Three or four such designs have been under trial and they have given encouraging results. With some minor improvements it is hoped to recommend an efficient drill for large-scale use with the tractor. These drills are capable of sowing an area of 12 to 15 acres in a working day of eight hours.

(b) *Tractor Guntaka:* Modelled on the H. M. guntaka No. 2, a tractor guntaka with 6-foot blade has been designed. Trials carried out with this implement have given satisfactory results even under adverse conditions of soil moisture. The implement is capable of lifting 8 to 10 acres of groundnut crop in a day.

(c) *John Deere (side delivery) rake:* This implement costing about Rs. 2,000/- was tried along with the groundnut harvester. It collects the harvested plants and leaves them in neat rows six feet apart. To a certain extent it takes out the pods left in the soil and brings them up to the surface. The power required for this being low, it can also be hitched behind the tractor guntaka.

(d) *Peanut Picker:* A peanut picker costing Rs. 3,300/- manufactured by Messrs. Ransomes and Jeffries Ltd., Ipswich, England and supplied by William Jacks Company, Ltd., has been under trial at Tindivanam since 1948. After extensive tests and modifications suited to local conditions, the machine has been giving more or less satisfactory performance. The harvested vines with the pods are dried for about three days in the sun and fed into the machine. The pods are

separated, winnowed, cleaned of mud, etc., and bagged. The picker is worked with a 5 HP oil-engine or from the belt drive of the tractor and can handle the produce from 10 acres in a day of 8 hours.

Trials are also in progress with groundnut pod and seed graders and groundnut hand-decorticators. These implements when perfected, will prove as great aids to groundnut cultivation in the State.

From the above review it will be seen that groundnut improvement work in this State has a very bright future and promises to place the industry on sound foundations.

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Castor Production in the Madras State

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Introduction: Castor bean has been an important item of commerce since olden times. For many centuries the oil has been used in medicine, in printing, dyeing and machine lubrication. Chemists have found new uses for castor oil and its derivatives. The products are in extensive use for the manufacture of paints, plastics, rayon, textiles, nylon, special lubricants, transparent soap manufacture and many other special items. Great strides have been made in this direction in other countries, but India is only making a beginning in this respect.

Of late, on account of its varied industrial uses, the importance of castor beans in international markets has been high. After World War II, the export of castor beans from India has dwindled, due to increased internal consumption. This has been made possible by the springing up of industrial concerns utilising castor-oil on a large scale.

The area and production statistics in India could be precisely known only since 1920-21 and even then the figures for the different years are not strictly comparable. They were of doubtful accuracy. However taking the face value of the figures, as compared with an area of nearly 1.8 million acres under castor in 1921-22, the crop covered only about 1.4 million to 1.6 million acres during the period 1922-23 to 1928-29. This declined later to less than one million acres by 1941-42. The declining tendency of the crop in the twenties, although the exports were generally on an increase, may be largely attributed to a fall in the demand for castor-oil in India, largely as a result of increasing competition of mineral lubricant oils.

As regards export trade, India has Brazil as a serious competitor in the World market. The conditions in Brazil are very favourable for castor bean production and that country is now the biggest producer of this oilseed in the World. Therefore, India can expect to export castor seed only if she can produce larger quantities at cheaper cost. However, one factor

favourable to India is that it has a well-developed castor seed crushing industry compared to Brazil and thus has scope for developing its export trade in this direction. At present, the scope for increasing the area to increase production is highly limited. Hence every endeavour is to be made to increase per acre production. This is feasible by adopting improved methods of cultivation, judicious manuring and sowing improved strains.

Much headway has been made in other countries in increasing the production of castor beans by mechanised farming in all stages of crop growth. However, in India the use of machinery in castor cultivation appears to be not feasible at present and the new frontiers open are the use of better seeds and adopting improved agronomical and manurial methods for increased production. The per acre production of beans in this State is as low as 226 lb. compared to 600 lb. in Uttar Pradesh.

Extension Work: In these days the problem of a breeder will be to impress upon the farmers, that his improved seed will really do well in the farmer's lands at little expense and trouble. So far a farmer has been content with selecting good seeds from selected plants and raising them after proper cultivation and manuring. Little does he know about the cross fertilisation of the seeds and their subsequent degeneration. Here research can do a lot and in increasing castor bean production in this State, the part played by hybridisation is going to be of primary importance.

Present Breeding Technique in Castor Crop Improvement in Madras State: (A) *Pure Line Selection:* The procedure adopted in this method is as follows:

First Year: Observation trials. New collections are sown with the already improved strain as check and studied. Plants showing desirable economic characters like good branching, long fruit clusters, compact setting of capsules, non-dehiscence, resistance to pests and diseases (by visual observation only) are selected. The selected plants are selfed by using close-meshed cloth bags of convenient size and selfed seeds gathered.

Second Year: Purity Study. The selfed seeds of the selected plants are sown in single rows and plants studied for purity of their morphological characters and incidentally their yielding ability. The unstable lines are rejected and promising pure lines alone taken for further study.

Third Year: Replicated row tests. The promising ones are raised in single rows under replicated conditions, adopting randomised block layout. The selections are compared with standard strains in respect of yield, duration etc. The yield data are scrutinised statistically.

Fourth year: Preliminary yield trials. Those that show promise in the replicated row tests are put under preliminary yield trials. The selections are sown in three-row plots (effective one row only) under replication for comparison with the standard strain. The yield data are analysed here also statistically.

Fifth year to Seventh year: Comparative yield trials: Selections that have done well in the preliminary yield trials are advanced to comparative yield test for three years. The selections are sown along with the strains in five-row plots under replicated conditions in which three rows only are utilised. The yield figures are subjected to statistical scrutiny every year and only those that are consistently recording higher yields are given out for trials in the districts. Qualitative studies are carried out from the preliminary stage on the produce of all the selections under trial with a view to maintaining a high standard of quality.

(B) Hybridisation: Producing improved strains of castor by breeding, takes a great deal of patient hard labour for about eight years, involving inbreeding and cross breeding. Complicated and tedious as this is, it is simple compared to the task of discovering that it could be done and how to do it. In self-fertilised crops an experimenter can depend on nearly all the plants to be like the parents but that is not so in a cross-fertilised crop like castor. The selected parents are purified by careful selfing for two generations. The inbred lines with the desired characters are raised alongside and hybridisation attempted. Selection of lines for new combinations are done in the progenies of F_1 and F_2 generations. They are then brought to purity studies and further work is similar to that indicated under item (4) above.

The evolution of better strains by breeding methods and the exploitation of hybrid vigour in castor may play an important part in this State in increasing castor bean production. The commercial production of hybrid castor beans has not been attempted so far in India, although it is in vogue in S. America. Nowadays

in most of the advanced countries the exploitation of hybrid vigour in many cross-fertilised crops has been successfully done and this may be considered as a new trend in advanced agricultural research.

Review of work done in other countries: At the Illinois Agricultural Experiment Station, the use of natural crossing plot in making castor been hybrid has been tried as far back as 1944 and 1945. The technique was similar to that used for making single cross of corn, except that the pollen and seed parents were planted in alternative rows.

Yet another method evolved in the United States of America for commercial production was by three-way crosses. Here the pronounced pistillate character in a female line when sib-pollinated was found to segregate in the ratio of 1:1 for plants which have only pistillate flowers and plants which have the normal monoecious racemes. This line was used as a female parent in producing commercial F_1 single-cross hybrid seed. These pistillate F_1 hybrids suggested the investigation of three-way cross by scientists in America, for making commercial hybrid seed. The procedure involved for production of three-way hybrid castor beans is:—

(1) Cross the selected female line to a selected male parent which would produce pistillate F_1 progenies. This female line was initially obtained by sib-pollination and types with well-pronounced pistillate character selected by roguing the off-types. Generally, upto eight rows of the female line can be satisfactorily pollinated when interplanted between two rows of the desired male parent.

(2) Cross the pistillate F_1 progenies obtained from the previous cross to a selected pollen-producing line with good combining ability. As mentioned above, planting upto eight rows of pistillate F_1 plants to two rows of the pollen line will be adequate. Since all the F_1 plants will be pistillate it would not be necessary to rogue normal monoecious plants as was the case in the initial cross.

Methods Suggested for Production of Hybrid Castor Seeds in Madras State: At the Agricultural Research Station, Tindivanam, inbred lines with the desired characters are available for the production of single cross as well as three-way cross hybrid seeds.

TMV I strain of castor is well suited for use as the female line in the single cross hybrid as the pistillate nature of the raceme

is well pronounced. This can be used as a seed parent. From the 140 inbred lines grown and maintained on the Agricultural Research Station, Tindivanam, suitable pollen parents can be easily selected. The pollen parent can be raised in each outside row as well as in alternate rows to that of seed parent lines. The seed parent may be emasculated before pollen is shed by hand. The emasculation process may last several weeks. The seeds in the female parents which are naturally hybridised may be harvested when mature and plants pulled down. To cut down the expenditure in emasculation the production of hybrid seeds may be limited to only the main heads, though this might result in reduced quantity of hybrid seeds.

Three-way Cross Hybrid Seeds: As already stated, the strain TMV I, is best suited as a female parent in view of the well-pronounced pistillate nature. It may be sib-pollinated and the resulting seeds sown. In the progeny consisting of the normal monoecious plants and completely pistillate plants, the former may be rogued. The completely pistillate line will be crossed to a selected male parent. The resulting progeny will have all pistillate flowers. The hybrid seeds obtained by this single cross may be crossed to another selected pollen parent. The hybrid seeds will be tested along with the strains in yield trials and their superiority over the strains under distribution will be established. The production of three-way cross hybrid seeds at this station on a large scale by the above procedure will go a long way in increasing the production of castor beans in this State.

Summary: Castor is not, of course, a major oilseed crop of this State, but it is grown to an appreciable extent in the districts of Salem, Coimbatore, Trichinopoly and North Arcot. Of late, the oil is put to varied uses and this is especially so in America. Important uses of the derivatives are for lubrication of jet airplane engines, all-purpose greases, hydraulic fluids, plastics and many others. The cake is also in great demand. The crop has a bright future. In the matter of world production Brazil is the largest producer, followed closely by India. To increase the overall production of beans in India and in Madras, the only way open is to increase the per acre yield, as no increase of acreage under castor is possible at present. The acre yield in Madras State is low compared to other centres and States.

Great strides have been made in foreign countries, in the exploitation of hybrid vigour and production of hybrid castor seeds by improved breeding techniques. The methods adopted by them are worthy of emulation in this State. The procedure to be adopted, for increasing the production of beans in the Madras State, has been indicated in the article. It is hoped that the production of hybrid castor seeds will help increase the per acre production in the Madras State in the near future.

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Sugarcane Research in Madras

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The opening of an agricultural research station at Samalkot in 1902, marked an era which led to the opening of the Indian Sugarcane Breeding Institute under the inspiring leadership of Dr. Barber. The crisis which the crop faced from *sereh* disease in Java and red rot in India stimulated new lines of research. After half a century of progress, the industry in Madras is now facing a second crisis, but it is hoped that history will repeat itself and sugarcane will record further progress.

Sugarcane presents many advantages to the research worker. For a breeder, it is a hybrid polyploid vegetatively propagated. It is both a plantation and a peasant crop. It can be cultivated only by resourceful ryots and requires good treatment.

The present and the future prospects are indicated below :—

Plant Nutrition: The sugarcane soils of United Provinces, Bihar, Punjab and Bombay are classified and surveyed on the genetic system. Varietal, manurial and cultural trials are now based on such trials. Investigations by Parthasarathy and Rama Rao (1951) indicated differential moisture uptake by the plant in clayey and loamy soils, wet and garden-land soils. Even though the clayey soil retains high moisture it does not easily part with it for the plant. Similarly, even when it is higher in fertility status, it is not efficiently utilised in clayey soils (Rama Rao, 1954). The inability of heavy soils to part with moisture and nutrients, necessitates higher doses of manure to be applied to them. The physical status of the soil is of great importance in the application and utilisation of artificial manures.

The complexity of transmission of applied manurial ingredients from the soil to the plant, necessitated the development of tissue tests, as better guides than chemical analysis of soil. Tests carried out at Anakapalle indicated that the levels of nutrients and moisture in plant tissues vary within a narrow range. This points to a fundamental mechanism in the tissues which regulate these levels. Foliar or tissue diagnosis may prove a better

guide to sufficiency or deficiency of nutrients than a direct study of the soils for the purpose.

Overhead irrigation was developed in recent years to save water. It is now known that sugarcane plant can absorb moisture through the leaf and pass it down to the roots (Van Dillewijn, 1952). Transpiring water takes up with it nutrient elements and the reversal of the process may leave the plant deficient in nutrition. But feeding the plant through the soil generally leads to wastage in the applied nutrients. It is now known that the leaf can absorb considerable quantities of salts in solution. Experiments with tagged elements indicated that the photosynthate of leaf moves rapidly to all parts of the plant, nutrients absorbed by leaf are rapidly distributed to all parts of the plant, nitrogen absorbed by root is redistributed to growing parts after three months and there is continual mixing of elements between tissues and all tissues are dynamic in exchanging old elements to new ones without altering concentrations. (Burr, 1953). There is not only quick transmission of elements by foliar feeding, but there is great economy in the same. This foliar feeding becomes necessary for the second and subsequent manuring when the crop is heavy and impenetrable. There is saving in manure by over 60 per cent (Sugar 47, page 64). Overhead spray irrigation leads to economy in water and leaves the soil in better tilth. By better distribution of irrigation water, sugar content in cane is increased. The use of anhydrous ammonia in irrigation water leads not only to economy in nitrogen but also to better distribution of the same (Baver & Humbert, 1953).

The high degree of negative correlation between moisture in tissues and sugar content was pointed out (Parthasarathy, 1951). The need for strict control of irrigation water was recognised more than two decades ago in Hawaii, but in earlier stages day degrees were adopted for irrigation control and in recent years leaf sheath moisture is adopted as guide. The possibilities of spray irrigation and foliar feeding may in future lead to considerable economy in water and a better distribution of nutrients and increased sugar content.

Interculture: Many of the intercultural operations, particularly in early stages of the planted crop, are designed to protect crop plants against weeds. In recent years selective weedicides have been used to kill broad-leaved plants. The annual and

perennial grasses are more difficult to deal with, although nut-grass is susceptible to 2,4-D. The great potentialities of chemical weedicides are still to be developed in this State. A correct spraying schedule has not been worked out.

Planting in deep trenches, high banking, controlled irrigation, propping are all designed to minimise lodging in cane. Lodging brings many disadvantages in its wake and leads to loss in quality to the tune of 25% and in yield upto 40 to 50 percent. Detailed studies (Vaidyanathan, 1953) indicated that varieties differ in their reaction to lodging. Loss in sugar content in a variety like Co. 449 is much less than in Co. 419.

Resistance to wind is yet to be studied fully. In minimising lodging, cultural treatments are more important than other factors. In the Andhra area, canes are propped heavily, with 4,000 to 6,000 bamboos. Yet the clumps lodge badly, but that system facilitates lifting up the clumps to erect position. Cheaper techniques like stocking and trash twist propping (Parthasarathy and Reddy, 1951) are not efficient with very heavy crops. The cane plant is top-heavy and losses due to lodging are heavy even in a twelve-months crop. This factor had been mainly responsible for *adsali* and longer duration crops not being popular in this State.

Pests and Diseases: The early shoot borer (*Chilo traca infuscafellus*) and top borer (*Scirpophaga* sp.) are the two important pests on sugarcane in the State. The habits of the borers in the field and the broad cycles are yet to be studied in detail. The reaction of the cane plant to the infestation by early shoot borer was studied and reported (Parthasarathy *et al* 1953). Apart from variation in the degree of incidence between varieties, the reaction of the plant to the borer appears different. The two borers protect themselves from the earliest stages and spraying of chemicals may have only a limited significance. Systemic insecticides may be more intensively studied, to render the plant distasteful to the borer.

Among the diseases, smut is important. Pineapple disease of planted setts as affecting seriously the plant population appears to be widespread. The solution for smut appears to lie in the development of varieties resistant to it. Pre-treatment of setts

may not prove popular with ryots and as such treatment of the soil to protect the setts may have to be developed. In the alternative, systemic fungicides may have to be applied to the seed nursery crop.

Yield Trends: The crop yield competitions in Madras (Reports on development scheme) brought to light the heavy yields recorded by cultivators in the State.

TABLE I
Maximum yields recorded with Co. 419 variety

Centres	Tons per acre.	
	1951 - 1952	1954 - 1955
Gudiyatham	96	81
Nilakottai	87	74
Pugalur	69	84
Nellikuppam	...	129

Agrobiologists calculate 197 tons as the possible maximum yield of sugarcane and the world record in 129 tons in a 24-month crop. An yield of 129 tons cane per acre was recorded in Madras in a 13-month crop. In Hawaii, a change in variety contributed 40 - 45%, irrigation control 20 - 25%, and control of pests and diseases 10 - 15% towards the total increase in sugar yield from five tons to nine tons per acre. The basic factor is the establishment of a well-equipped research station. The amount spent on research in some of the cane countries of the world is shown below :

TABLE II

Country	Staff	Substations	Expenditure
Louisiana	136	5	\$ 4,96,989
Hawaii	59	10	\$ 8,21,216
Hawaii University } Experiment Station }	40	11	\$ 2,61,188
Puerto Rico	67	3	\$ 6,85,600
Florida	121	6	\$ 5,90,961
Madras	...	1	...

Even if we were to consider 100 tons of cane of good quality as our potential, the present average yield of the State is only 27 per cent. Compare this with the over-all efficiency of a sugar factory which is 85 per cent. The plant in the field is a better machine than the machinery of a sugar factory. The plants do not require repairs, replacements, fuel etc. and there is no breakdown and stoppage of functions. The field efficiency in agricultural production is therefore chiefly the human inability to understand nature. The plant must therefore be placed in its natural environment to grow at its best and the recent advances in sugarcane breeding in hybridising the cane plant with *S. spontaneum* and *S. robustum* are only preliminary attempts in that direction.

A change in variety is the first step in increasing yield. The Coimbatore Sugarcane Breeding Institute has done yeoman service in its field. Collection of a large number of *Spontaneum* types from the Himalayas down to Cape Comorin is a heroic attempt in utilising the wild type. It is true that after Co. 419 no new types were released. This need not dishearten any one. There is no genetic deterioration in cane (Dutt and Subba Rao, 1949) and any possible deterioration in yield should be checked by proper fertilisation and control of pests and diseases.

The equable climate of the southern end of peninsular India permits planting and harvesting sugarcane almost round the year. Researches are already in progress to develop a second season for Nellikuppam. Cultural schedules suited to the characteristics of varieties and season are to be developed (Parthasarathy, 1951).

Price Policy: Last but not the least, is the stabilisation of price. While it is so with all crops, it is particularly so for sugarcane. The clash of interests between the cane supplier and the factory owner necessitated fixation of minimum prices. This system of laying on weight of cane without considering the sugar content, encouraged cultural systems that depressed quality. The factories took no practical steps to step up recovery percent but demanded fixation of a lower price for cane. The general remark that payment on quality basis is not feasible is in correct, and should not be sufficient reason for continuing this incorrect cane price policy. Tests conducted at Samalkot sugar factory indicated the possibility of testing small units like two tons of cane. The cane area may be split into small zones or in the alternative, the hourly analysis of the primary juice may be related to the supply units

at the carrier for payment on quality (Parthasarathy, 1954). Unless the ryots participate in increasing sugar content of cane by an alteration of price policy, all attempts in that direction are doomed to failure. In Australia where extensive lands are available, sugar content in cane is increased without reference to yield. In our State, where pressure on land is high, increased production per unit of land is necessary but this should also be combined with quality of cane (Dutt, 1950).

Conclusion: The selection of a variety combining the high yield and softness of Co. 419 with the resistance to breaking and smut disease and high sugar content of Co. 527 is our future aim. The utilisation of the new *spontaneum* collections at Coimbatore may lead to this achievement at an early date.

The newer techniques of feeding the plant through the leaf for its moisture and nutrient requirements will lead to considerable economy in the applied water and manure for the cane field. The development of newer forms of nitrogenous manures like anhydrous ammonia and ammonium sulphate nitrate combined with foliar feeding reduce the danger to the soil by the residuary chemical radicals. Pests and diseases remain to be tackled through selection of resistant varieties. Borer pests, which are the most important ones in this State protect themselves from the very first stage of their entrance into the plant. Similarly, the smut fungus is protected. Systemic insecticides and fungicides are to be tried. The habits of the borers in the field and the brood-cycles require intensive study. A schedule of spraying weedicides as related to the habits and regeneration of weeds in the field must be developed to eradicate pernicious weeds like *Nutgrass* and *Trianthema*.

High yields are being recorded through increased application of fertilisers. The cumulative effects of removal of larger quantities of nutrient elements from soil, the cumulative after-effects of large doses of fertilisers and the susceptibilities of highly fertilised crop to newer types of diseases remain to be investigated. Sugar industry in India cannot prosper without the participation of the farmer in the sphere of profits. In this, payment for cane on the basis of sugar content is to be developed in one or two phases in the immediate future.

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What Next in Fruit Research and Extension in Madras State

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Introduction: The achievements and results of economic importance in the sphere of fruit research in this State over the past twenty-five years are of no small order. A brief review of the progress in fruit research and extension is presented in the paper.

Fruit Research: Fruit research in the State may be said to have commenced in the year 1941 when a separate Fruit Section was formed. The following are some of the notable results achieved so far.

(a) *Temperate Fruits:* Pruning methods suited to different bearing habits of apples, plums, peaches, pear and persimmons were determined. The problem of mild winters and woolly aphid was got over, the first by linseed oil emulsion and Sandolin "A" Sprays and later by use of resistant Merton rootstocks. The pollination behaviour of plum varieties for recommending best inter-planting and top-working practices, a quick method of ripening persimmon fruits are some of the other results.

(b) *Sub-tropical fruits:* Citrus received major attention. Many of the results of research on this crop have passed into growers' practices. Lemons were popularised. Varietal introductions and devising suitable propagation techniques are the other achievements in other subtropical fruits, such as fig, pomegranate, avocado, passion fruit, etc.

Tropical Fruits: Work on tropical fruits was intensified. Evolution of new types through hybridisation in mango, purification in papaya, regulation of fruit harvests in pineapple through hormones, clonal propagation of cashew, optimum propagation techniques for all, including selection of suitable rootstocks are some of the major achievements.

Fruit Extension work: Horticultural extension work in the State is of very recent origin. For several years, it consisted only

in furnishing information and advice on specific problems and reached only some well-informed and enterprising growers. Since 1948, the work has been expanded with the initiation of a post-graduate course in Horticulture and with the establishment of four Model Orchards in representative fruit-growing regions.

The Future in Fruit Research: The review of past work highlights problems, areas and subjects that need further attention. The following suggestions may be given to further the cause of fruit development in the State.

(a) Importation of varieties from other countries to enrich collections. Systematic plant introduction on a well-regulated basis would immensely benefit the horticultural industry.

(b) Application of plant hormones and chemicals to the solution of specific problems in particular fruits (e.g.) difficulty to establish young transplants and incompatibility in grafting in mangosteen.

(c) Evolution of maturity standards and research on the usage of mechanical contrivances for judging correct maturity of fruits.

(d) Research on the utilisation of horticultural by products.

(f) There are several other problems specific to particular fruits, the solution of which would go a long way in the development of the fruit industry as a whole on sound economic lines. These include reinvestigation of propagational aspects, research on manurial and water requirements, plant protection in fruits, study of root-stocks cultivated and wild, etc.

The Future in Fruit Extension work: Madras State has done pioneering work in fruit extension work as already indicated. A net-work of ten more Model Orchards are proposed under the Second Plan. These are long-range measures. But short-term measures are necessary for speedy transmission of available data. A few of these are:—

(a) Organising fruit shows and exhibitions in different parts of seasons as a regular feature year after year.

(b) Periodical meetings in fruit-growing centres between research staff, extension workers and growers.

(c) Opening fruit parlours in railway stations and in central places in cities and towns with a nice display of scientific information.

(d) Publication of results in regional languages as handouts, press releases etc. and their door to door distribution.

(e) Imparting horticultural instruction in schools and colleges by special lectures by experts and film shows etc. Film shows may also be held in public cinema halls. Production of such feature films will have to be done by the Government.

(f) A separate Directorate in Horticulture will be necessary to put into operation the full programme of fruit research and extension.

Banana Research

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Introduction: Planned research on problems of economic importance in bananas is only of recent undertaking in India, as it started with the commencement of the Banana Research Scheme in Madras, Bombay and West Bengal States with financial assistance of the Indian Council of Agricultural Research. In a country which claims the origin of this important tropical fruit and which is unequalled in its extent of its varieties, banana research has not attained much headway. In this respect the results achieved at the Imperial College of Tropical Agriculture are widely known and particularly in systematic studies, the contribution of Cheeseman is an outstanding one.

Systematic Studies: This aspect has attracted most of the foreign workers and yet it is a problem which bristles with complications. The confusion in banana systematic studies originated with the inclusion of certain indefinite and varying characters in the description of species by Linnaeus in *Musa paradisiaca* L., as having persistent male phase, culinary quality of the fruits and loose bunch with fruits held in lax manner and of *Musa sapientum* L., to include all edible varieties except the Cavendish group. There were a few other botanists who held the view that *Musa paradisiaca* is only a sub-species of *Musa sapientum*. Such theories have been dismissed by Cheeseman (3) as not well-defined nor botanical. He postulates that the cultivated banana varieties (triploids) of *Eu-Musa* section have originated from the wild species *Musa balbisiana*, Colla and *Musa acuminata*, Colla. It is further observed that many of the best dessert varieties like Gros Michel have more of the characters of *Musa acuminata*, while a few show relationship to both the species. *Musa sapientum* can be said to be the last group which has the combined characteristics of *Musa acuminata* and *Musa balbisiana*. Therefore the fruit quality of dessert bananas is traced to *Musa acuminata* and the characteristics of cooking varieties generally associated with *Musa paradisiaca* are now taken to be distinctive features of *Musa balbisiana*. However Cheeseman and other workers are for the present in favour

of retaining the specific name of *Musa paradisiaca* L. These two species *Musa paradisiaca* and *Musa sapientum* are best considered as type species and at present carry negligible significance in nomenclature and classification of banana varieties.

Taking the line of demarcation of the different sections of the genus *Musa*, Cheeseman's findings have not been accepted *in extenso* by others and may require revision. His distinction of various characters between *Musa balbisiana* and *Musa acuminata* may have to be regrouped. From the observations made at the Central Banana Research Station, Aduthurai, it is seen that the partitioning of the *Callimusa* section, at least for certain well-known members like *Musa coccinea* from the *Eu-musa* section, lacks precision. Even in the chromosome number of certain species Agarkar and Govindaswami (i) have differed from Cheeseman.

In South India systematic work on bananas received a good deal of attention by Jacob (4) and subsequently by Venkataramani (5). Jacob's observations and descriptions are no doubt valuable. However, his coining of new species as *Musa sapidisiaca* Jacob K. C comprising the cultivated varieties of South India, though appreciated by workers in Kew, at best recognises the natural hybridity of cultivated bananas, but does not indicate the correct specific status of the varieties. The second aspect of the problem peculiar to this country especially, because of different dialects and languages, is the bewildering array of synonyms in the nomenclature of varieties. This problem can be solved only by studying the varieties in different situations and all the varieties at one central place. This has been attempted at the Central Banana Research Station, Aduthurai and it has been possible to reduce 126 varietal names to 55 distinct varieties, based on specific distinguishing characters. So our main objective should be to have an exhaustive national collection of banana varieties of India and from foreign countries so that the studies can be pursued on more fruitful lines.

Hybridisation: Cytological studies on bananas have received much attention in the hands of foreign workers, in the last three decades. In Trinidad, Cheeseman and his colleagues initiated breeding work on new varieties along planned lines although he has not attained complete success in evolving a variety completely resistant to the virulent Panama-disease and at the same time possessing the economic characters of Gros Michel. This work is still in progress. In banana hybridisation, selection of suitable

male parents is an important question and in this country we have got a good number of bananas occurring in the wild state and in diversified forms. The aim should be to improve the keeping quality of the fruits, dwarfness or semi-tall nature and resistance to the Panama wilt and Bunchy top diseases. Especially in the Coromandel Coast, where cyclones are not infrequent, the evolution of semi-tall varieties of the popular varieties, *Monthan* or *Poovan* will be of great economic advantage. Initial studies at the Central Banana Research Station, Aduthurai proved that such a hybrid of intermediate characters is possible and an interspecific hybrid of *Monthan* x *Musa coccinea* was obtained. But the hybrid could not be utilised for further breeding because of female sterility and absence of pollen. In India cytological studies of bananas received some attention at Poona (1) and Calcutta (2). However, the studies were not pursued fully. In a country where wild species occur in abundance, there is a vast scope for research in evolving new varieties. The Western Ghats of Madras and Bombay states contain many wild bananas, showing large variations and forms of *Musa acuminata* especially and with such potentialities there is a real need for the continuation of systematic and cyto-genetical studies.

Sports in Bananas: Apart from hybridisation, obtaining varieties with desired characters in bananas is possible. Bananas are highly variable and unstable in character and mutations and abnormalities recorded in bananas are many. Since vegetative propagation is the rule in this fruit, perpetuation of such clones of desirable characters is possible and the degeneration and reversion of some characters are also equally possible. "*Pedda Pacha Arati*" is a semi-tall mutant of the dwarf variety, *Mons Marie* and so also it is reported that the Australian varieties "*Mons Marie*" and "*William's Hybrid*" are the semi-tall mutants of the dwarf Cavendish. *Pedda Pacha Arati* has now become very popular in Malabar. Ecological variations are not rare in bananas. "*Sirumalai*" and "*Virupakshi*" are the well known eco-types of "*Vannan*" and the modifying influences of various environmental factors are being studied during survey tours under the Banana Research Scheme. Such variations also throw light on the acclimatisation and adaptation of certain varieties to suitable localities. In pursuance of that objective, the performance of different varieties is proposed to be studied at the various Agricultural Research Stations of our state. These studies will enable zoning of the varieties to different regions in Madras State.

Propagational Studies: Studies made at the Central Banana Research Station show that sword suckers of both *Monthan* and *Poovan* varieties flower and fruit earlier than broad-leaved suckers. Nursery and field investigations show that it is quite possible to use bits of rhizomes of parent plants as well as daughter suckers of bananas as useful material for propagation. The advantage of early and quick propagation by bits of rhizomes is almost negligible under Aduthurai conditions as the annual increase in area by fresh plantation is little for which fully developed banana suckers from the existing plantations are always available in excess. The real advantage will occur only when a superior variety is evolved or introduced which required easy multiplication and spread.

With regard to the selection of suckers, one more consideration arises viz., at what stage of the mother plant the suckers have to be allowed and separated for planting elsewhere. The studies on this aspect has just been initiated at the Central Banana Research Station, Aduthurai.

Plantation Practices: Among the plantation practices the manurial requirements of the crop is a vital problem. Past trials in this direction conducted at the various Agricultural Research Stations have not been on a co-ordinated scale. The results of the manurial trial in the wetland area of the Central Banana Research Station with the *Poovan* variety have shown that the best manurial dose per plant is given by the treatment in which $\frac{1}{2}$ lb. nitrogen is applied as cattle manure and $\frac{1}{2}$ lb. as ammonium sulphate in two doses, the first dose three months after planting and the second five months after planting, in addition to the basal dressing of 25 lb. cattle manure per plant. Under Aduthurai conditions of heavy clay soils there was no response to potash and phosphoric acid. As the next step with the above results, a trial at the Central Banana Research Station, Aduthurai is under way to determine the exact time of application of manures, especially ammonium sulphate and its influence on the flowering of the plant.

Besides the time of application of fertilisers and its quality, the method of application of manures deserves special attention in bananas. Usually the basin system of application is practised. However one disadvantage in that practice is that it may retard the root penetration and thereby the anchorage of the plant is impaired and consequently they become susceptible to wind havoc. To obviate this difficulty and to mechanise the manurial applications trench

manuring is sometimes adopted in foreign countries. Such a system, it is claimed, induces the roots to go deep. How far this system of manuring is suitable to our perennial system of cultivation has to be investigated.

The role of micro-nutrient elements in bananas has not been investigated so far. It is a common sight that the margins of the laminae of certain banana varieties show a scorched appearance and this feature has not been studied, though it is quite possibly due to a deficiency in one or more of the trace elements.

To determine the manurial requirements of a crop, investigation in one or two centres will not be sufficient as the results are necessarily limited to identical soil types. A co-ordinated programme has to be chalked out to initiate such trials in representative tracts.

Diseases: Without the mention of Panama disease, a review of the research on bananas would be incomplete. Hybridisation work carried out in Trinidad to combat this disease has not yielded full benefits. Fortunately some of our important varieties 'Poovan' are highly resistant to Panama disease. But the problem does not end there because there are equally susceptible varieties like "*Rasthali*". It has also to be noted that Panama disease which was unheard of a few decades ago, is slowly making its appearance in some tracts of this country. As such, systematic and rigid enforcement of quarantine measures, coupled with the elimination of susceptible varieties in cultivation have to be adopted. From onwards, breeding to obtain disease-resistance in varieties have to be started on a planned scale before the disease commences to tell on our banana industry.

Hill bananas stand on a different footing and deserve special consideration. Research on the problems of hill bananas has not commenced and this lacuna in banana research needs immediate attention. Madura district of this State holds a monopoly in hill bananas and there is a well-organised industry flourishing there. An approach has to be made in good time to tackle the problems obtaining there.

The problem of marketing of bunches of banana has not received adequate attention as in other countries. The entire production is consumed within the country and nothing is exported. But in foreign countries, like the Caribbean Islands, bunches are sent to European countries and Gros Michel is eminently suited for such

transport. However, such problems have not arisen in this country. But the wastage in marketing can be minimised by the correct stage of harvesting and packing the bunches properly. In Queensland banana covers of plastic film are found to be very useful in improving the quality of the fruit. Trials with Indian varieties should also prove useful and a beginning has been made in that direction at the Central Banana Research Station, Aduthurai.

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What Next in Soil Science

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Introduction: Soil is the basis of all agriculture. Although it has been shown that vegetables and some other crops can be grown in water cultures it is on the soil that agriculture all over the world depends. Soil not only gives support to the plants and trees growing on it, but it is from the soil that plants take the major part of the nutrients and water required for their growth and reproduction. It is on the produce of plants that men and animals live. Soil is therefore very important and has been studied from time immemorial in order to increase and maintain its productivity.

During the last decade soil science has made tremendous progress in every aspect, physical, chemical and biological, as compared with previous periods. In some cases the change has been almost revolutionary.

According to the modern concept of soil science the colloidal complex is the seat of most of the changes taking place in the soil and is therefore of paramount importance. Emphasis is also laid on the role of biological agencies in the soil. In fact the study of soil science to-day calls for a colloidal-biological approach to the manifold problems confronting the soil scientist. The plants and the colloidal complex in a soil are so intimately connected that they form a part of the soil system. For a proper understanding of this complicated system intensive research has to be carried out in regard to the various components of the soil mineral matter, the process of humus formation and the change it undergoes and the nature and activity of the macro and micro-organisms, with their enzymic inter-relations. All these aspects still remain to be fully understood for arriving at reliable conclusions on soil fertility and crop production.

Factors Influencing the Growth of Higher Plants: The growth and development of plants, as is well known, are dependent on various factors, internal and external. The external factors which are of importance are (1) light; (2) mechanical support; (3) heat;

(4) water; (5) air and (6) nutrients. Except in the case of light, soil is the medium for the supply of these factors for plant growth. The interaction of these factors and their resultant effect on crop growth are still not clear. The problem of balanced manuring for efficient crop production with reference to different soil types, climatic conditions and water resources has to be studied further. We know certain elements must be present in a soil in available form for the plant. Apart from their presence their concentrations in relation to each other must be adjusted properly for ensuring good and healthy crops free from diseases. Physiological balance is one of the important objectives of sound fertilizer practice. Knowledge of this aspect is at present scanty and much work has to be done in this direction. The mechanism of the release of plant nutrients from soil particles to plants and the relationship between micro-organisms and plants have to be studied further in detail. With regard to plant nutrients the following four factors have to be examined. (1) the quantities of the various primary and minor elements required for maximum crop production, (2) the forms in which they are present in the soil (3) the extent of their availability and (4) pH and soil solution.

A few of the important aspects on which soil research is to be directed and the problems of practical importance to agriculture that have to be tackled on the basis of theoretical knowledge gained so far, are dealt with briefly in the present paper. The study of many of the intricate problems of soil science has become possible on account of the development in recent years of refined methods of attack such as spectrography, X-ray analysis, tracer technique involving the use of radioactive isotopes of manurial elements etc. Chromatography is also being pressed into service in soil analysis.

Soil Colloids and Plant Nutrition: Clays and with them soils, differ widely in their cation exchange capacities. Montmorillonite-Kaolinite, illite and hydrous oxides groups are the four broad classes in naturally occurring clay. The cation exchange capacity for unit weight of these groups decreases in the order stated. The colloidal complex governs such important factors as soil pH, degree of ionic saturation, ratio of cations, influence of these on the activity of absorbed ions and the effect of these on the metabolic activity of the plant. The colloidal complex brings about a selective absorption of nutrients supplied and partly influences the reaction of the soil.

Plants vary widely in their capacity for producing plant material consequent on the intake of unit doses of nutrients. The amount of dry matter produced by absorption of 318 lb. of N (maximum amount usually taken from 1 acre of soil) is found to be 6 tons for soyabean forage, 13 for corn and 56 for sugarcane. Research on this aspect of production of different amounts of plant material by different plants for unit nutrient doses should yield profitable results.

Micro-Organisms and Soil Fertility: The soil is teeming with life. The innumerable number of different forms of micro-organisms in the soil contribute not a little towards soil fertility. Any condition that adversely affects their growth and activities is bound to bring about undesirable changes in the soil. Again, it is not all organisms that are favourable for plant life. Some are definitely harmful causing diseases to crops. Knowledge of these organisms and their control by proper soil management deserves attention. A few other organisms, while not causing disease, may affect crop growth by competing with plants for available plant food.

In addition to the competition for food there is another type of microbial rivalry. Thus certain bacteria, fungi, actinomycetes have the power to produce substances that will inhibit or kill other microbes. The ability of certain micro-organisms to produce antibiotics has brought about revolutionary changes in the treatment of many serious human and animal diseases. Several preparations containing specific ingredients such as penicillin, streptomycin, aureomycin, are now available to cure diseases. Although the soil harbours many disease-producing organisms it is also a source of life-saving drugs.

The activity of microorganisms sometimes help each other. Certain groups of organisms produce metabolic products which serve as a source of food to others. As a striking example of this is the release of ammonia by certain bacteria. This is a source of food and energy to nitrifying bacteria. The series of inorganic transformations taking place in the soil such as ammonification, nitrification, production of sulphate etc., are so complicated that they are still not fully understood. The chemistry of humus formation and compost preparation is also exceedingly difficult to explain. Problems relating to the mechanism of nitrogen fixation by symbiotic and non-symbiotic nitrogen-fixing organisms in the soil are also not fully understood, but great benefit can accrue if the

symbiotic and non-symbiotic nitrogen fixing bacteria are efficiently utilized. The significance of carbon-nitrogen ratios and their bearing on soil fertility has to be studied in detail with reference to crop growth, climate and rainfall. In the biological field, we have little information about the nature and extent of the different forms of micro-organism and their role individually and cumulatively on the numerous physical, chemical and other changes taking place in the soil. Methods for the satisfactory classification of the soil micro-organisms into distinct groups based on their nutritional and other requirements and in relation to their importance in the maintenance of soil fertility have to be worked out.

Plant Nutrients and their Availability in Soils: Among the primary plant nutrients, nitrogen, phosphorus, potassium, phosphorus is by far the most difficult to deal with. The inefficient utilization of phosphorus by plants has long been known, especially in laterite and lateritic soils. The experimental use of radio-active phosphorus has recently emphasized the point even more thoroughly. By adding fertilizers containing tracer phosphorus it is possible to determine the proportion of applied phosphates absorbed during the year of application. This technique will have to be applied to ascertain the fate of phosphates added to the soil and to follow the changes taking place in the phosphorus absorbed by the plant.

Potassium is present in most of the soils of the State in adequate amounts, except in the soils of the West Coast and the Hills, but most of the crops grown in the State do not respond to potash fertilization.

The soils of the State are generally deficient in nitrogen and methods of increasing the content of the soils with regard to this nutrient must be explored.

The placement of phosphatic and nitrogenous manures should be studied to obtain the maximum return from the nutrients. A proper balance of the three essential plant food materials nitrogen, phosphorus and potassium has to be worked out for different crops in the various soil-climatic zones of the State.

Trace Elements: Numerous trace elements in minute amounts have been found to be essential for optimum plant growth. Of these, the more important are iron, manganese, copper, zinc, boron and molybdenum. Except for iron, trace elements are found sparingly

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in most soils. Every year the crop removes small quantities of this natural reserve and crop production over a long period depletes the soil to such an extent that many areas in the world suffer from trace element deficiency. The roles specific of trace elements in plant nutrition and our knowledge on these with reference to our soils and crops is very little.

Work that has to be taken up in the Chemistry Section: Some of the major items of work of great significance that has to be undertaken in the State are the following:—

- (1) The reclamation of saline and alkali soils.
- (2) Soil survey and efficient land utilization.
- (3) Efficient use of fertilizers with reference to water supply, soil types and crops.
- (4) Application of latest methods and techniques in the elucidation of problems in soil science such as rapid soil tests, tissue tests, spectrophotography, chromatography, and the use of radio-active isotopes.
- (5) Systematic field experiments with major and minor plant nutrients to evolve suitable fertilizer mixtures for different crops in the soil-climatic zones of the State.
- (6) Cultivation of inoculated legumes in rotation with cereals for the enrichment of the soil in respect of nitrogen and organic matter and for structural improvement (tilth).
- (7) Prevention of soil erosion.
- (8) Conservation of soil moisture for plant growth in regions of scanty rainfall.
- (9) Study of the clay fraction of the soil types.

All these items are important for the advancement of agriculture in the State. The first item, namely the reclamation of saline and alkaline soils is easy of attainment and if the large areas of such soils present in the State can be improved and put to crops agricultural production can be considerably enhanced. Our knowledge of base exchange can be utilised for the purpose. It has been shown at Mettumarudur in Trichinopoly district that even the worst type of alkali soil, where not even grass will grow, can be made to produce over 3000 lb. of paddy per acre and that the method of reclamation must depend on the nature of the soil. So a survey of the extent

and nature of the saline and alkali soils in the State is imperative. After this, suitable blocks of alkali land with good water resources can be taken up and reclamation experiments carried out with different soil amendments. A separate technical staff with sound knowledge of soil science should be appointed for this important work to enlarge the cultivable area in the State.

As soil is very important in agriculture, it is necessary that an inventory of the soils of our country should be made. The purpose of such an inventory is to classify, and study the soil types so that they can be put to best use. There are several other purposes served by soil surveys. The soil survey of some parts of the State have been made twenty five-years ago and earlier. These surveys had as their object the manurial requirements of paddy tracts. So the soil and sub-soil to the depths 0-9" and 9"-18" only were studied. As is well known, the unit of study of the soil at the present time is the soil profile i. e. the succession of soil horizons from the surface down to the parent rock. So the earlier soil surveys are not useful now to understand the soil fully. It is therefore necessary to carry out soil surveys of at least the important tracts of the State. For this purpose, there should be a permanent organization attached to the Agricultural Chemistry section. The organisation or soil survey party should undertake detailed soil surveys and map out the soils in each of the soil climatic zones. The party should be given the necessary equipment and transport facilities.

Variations in Crop Yields

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Introduction: The main aim of all agricultural research workers is focussed on the problem of maximisation of crop production with minimum cost. Evolution of yielding strains, formulation of economical and profitable manurial programmes, utilisation of labour-saving implements, economic use of water for irrigation and tapping to the maximum extent all the available irrigational sources including underground water, have all received their legitimate and proper attention at the hands of agricultural research workers in different parts of the country. Of late a relative study of the merits and demerits of the method of cultivation adopted in different countries has also received their attention. The adoption of the Japanese method of rice cultivation in India is a typical example of this aspect of agricultural research.

Now it is imperative to study the causes that depress the yield of crops inspite of having access to high-yielding strains and all other practical aids and facilities for their proper cultivation. An analysis of the variation of crop yields in different zones will reveal that the main causes for this variation are (i) failure of rains at critical growth-periods of crops, (ii) loss of crops due to pests and diseases and (iii) loss to crops due to weather abnormalities like cyclones, hailstorms, heat waves, frost etc.

Timely Rains: An analysis of the findings of agricultural research workers will reveal the great importance of timely rains in sufficient quantity received in an ideally distributed manner during certain critical growth-phases of the crop. In Australia, data have been collected to prove that half-an inch of extra rainfall at the time of germination of wheat benefits the farmers to the extent of about one million pounds of extra wheat grain.

Cultivation of crops, particularly in rain-fed areas, still remains a gamble with the monsoons. This is due to the failure of rains during critical growth-periods of the crops. The farmers want rains only in small quantities, but at the right time, when their crops are in real need of rains. To explore the possibility as

to how best the needs of the farmers can be met in this direction, the Madras Government propose to launch on a scheme of 'Artificial Rain-making'.

A detailed resume of the various techniques adopted to create artificial rain in different countries is outside the purview of this paper but the techniques include direct spraying of chemicals and dropping of ice crystals in the cloud region, using aircraft and also shooting smokes with various chemicals like silver iodide, calcium chloride, sodium chloride, etc., by using ground furnaces and also by balloon technique. In the experiments to be conducted in Madras State, all the known techniques, with the elimination of aircraft for the time being, are proposed to be tried to study their relative merits under the conditions prevailing in different parts of the State.

Loss to Crops due to Pests and Diseases: The pathologists of the Agricultural Departments in the various States have very effective prophylactic and remedial measures for various pests and diseases. In addition, they have gained a clear conception of the life-history of pests, their host plants, periods of activity and inactivity and so on. Similarly, in the case of diseases too, the origin and nature of damage to crops have been understood clearly. It is now evident that these pests and diseases are influenced considerably by the meteorological factors like temperature, rainfall, humidity, hours of sunshine and wind velocity.

What is now required is an organisation to assess the nature of relationship existing between the meteorological factors and the incidence of pests and diseases on cultivated crops. The Indian deputationists to Japan have stated in their reports that even in such a small country as Japan, there are as many as 276 Agricultural Meteorological observatories. In Japan every Agricultural Farm has a separate staff of at least three Assistants, solely meant for collecting data on the influence of the meteorological factors on the incidence of major pests and diseases on paddy, which is the main crop cultivated throughout the length and breadth of that country. Since data have been collected for nearly three-and-a-half decades, Japan is able to give timely warnings to the paddy growers regarding the onset of epidemics of 'Blast' and 'Stem-Borer', from a knowledge of the existing weather conditions. By getting this advance warning, the farmers are able to take appropriate measures and spray the crop. Such a state of protection to crops and

reduction of their damage by pests and diseases should also exist in every State in India, particularly in Madras State, where the loss to crops due to pests and diseases assumes an alarming proportion in years of adverse weather conditions.

Loss due to weather abnormalities like cyclones, hailstorms, heat waves, frost formation, etc., is not rare in cultivated crops. The coastal areas get periodically cyclonic storms, that cause considerable damage not only to cultivated crops like paddy, cholam, cotton, sugarcane, banana, etc., but also to perennial plantations like coconuts, mangoes, arecanut, etc. During hot summers heat waves and hailstorms are quite common. These weather abnormalities are capable of doing great damage to standing crops. In cold countries frost formation is practically an annual affair and particularly, the wheat growers of the Punjab know what an amount of havoc frost is capable of doing to their main crop of wheat.

It is possible to forecast the occurrence of these weather abnormalities if a network of observatories is maintained in particular localities. To cite a few instances, the observatories at Bombay and Poona were able to give timely warning of the cyclonic storm that struck the Bombay coast in November 1948. By this warning hundreds of lives of fisherman were saved. In addition, the agriculturists in the region had advance intimation of the approaching storm and they too were able to protect their crops to the extent possible. Another instance also may be cited. There is one instrument called 'Grass Minimum Thermometer', used for recording temperature of the air layer in contact with the surface soil. In the Punjab, if the difference between the readings recorded with this instrument on two consecutive days happens to be in the region of 30° to 35° F., immediately the wheat growers are given a warning of frost formation. Then the farmers will take necessary precautions to protect their crops. Even though the harvest of the wheat crop is to be taken up a week later they would immediately take it up on receipt of frost warnings, to get something as yield instead of allowing their entire crop to be completely damaged by frost. Examples like this may be piled up. But one thing is clear, i. e., that it is possible to predict these weather abnormalities, provided an efficient organisation is set up in this direction, in close collaboration with the Indian Meteorological Department. In America there are separate organisations to give warnings for every weather abnormality, including

'medium-term' projects like Malampuzha, Manimuthar and Amaravathi and the 'long-term' programme of Lower Bhavani calculated to benefit 3,83,000 acres on the whole.

Well-subsidy scheme: As a direct help to agriculturists, advances were given up to 50% of the cost of sinking a well and a farmer could receive the help to a limit of five wells. This was in operation from 1944 to 1951-52.

Filter-point tube-well scheme: The latest irrigation aid advocated since 1951, is the 'Filter-point tube-well' Scheme. This is designed to help the delta regions to grow a remunerative crop of groundnut or cotton in the fallow period, besides the paddy crop raised in the normal season. In addition, the paddy nurseries can be grown in advance of the receipt of channel water to enable early planting and getting higher yields. 1,060 filter points have been installed till 1954 and 600 more are expected to be completed during 1955.

Manures and Fertilizers: (a) *Green Manures:* The campaign on green manures and trial of different types like daicha, sunnhemp, wild indigo, pillipesara and *Sesbania speciosa*, for the wetlands resulted in recommending the cosmopolitan variety viz., *Sesbania speciosa*. This is very easy and cheap to grow, stands water-logging, yields seeds while growing along the bunds with the paddy crop and is the heaviest yielder of leaf per acre.

Among other leaf-yielding shrubs, *Gliricidia maculata* is the best, though *Indigofera teysmanni* is better suited for the West Coast.

(b) *Composts:* The municipalities are increasingly taking to production of nightsoil compost, as it is very remunerative. The individual farmers have also become compost-minded; they prepare composts in their own holdings and buy large quantities from municipalities also.

(c) *Chemical fertilisers:* The drive for increased production has made farmers go in for chemical fertilisers like ammonium sulphate and fertiliser mixtures. The annual sales in the residuary Madras State through the Agricultural Department is about 50,000 tons.

(d) *Oil-cakes:* Since a decade groundnut cake is so very extensively used as manure that cattle could not be fed with this cake in sufficient quantity. Out of a total production of three lakhs of tons, nearly two lakhs are applied to the land.

What Next in Agricultural Extension

by N. RANGANATHACHARI,
Agricultural College, Coimbatore

Introduction: The Agricultural department has been ceaselessly putting forth its efforts on the research and extension sides to better the lot of agriculturists who form the backbone of India's economy. Beginning with a handful of staff early in the century for the work of surveying the local agricultural practices and chalking out improvements, the department has gained much importance especially during the Second World War and shouldered the responsibilities of meeting the demands of farmers during the operation of the "Grow More Food" Schemes in respect of improved seeds, chemical fertilizers, iron and steel for fabricating agricultural tools and implements and supply of engines and pumps for irrigation purposes. The darkest days of food shortage have been tackled and now, though the food problem has considerably improved, the efforts of the department have not slackened and a closer network of field staff has been organised during this year.

In this paper, it is proposed to deal with the achievements so far gained, the needs of the farming population, and the future lines of work to be followed towards their economic uplift.

Recent achievements of the agricultural department in extension work: The residuary Madras State has 62% of its population engaged in farming. The agricultural policy and achievements in recent years are briefly as follows:—

Grow More Food Campaign and Five Year Plan. The G. M. F. Campaign was in operation from 1942 to 1949-50. The department distributed seeds of improved crop strains, manures and fertilizers, iron and steel for implements etc. at controlled rates, when due to inflation of prices they went beyond the purchasing capacity of the farmer and mostly disappeared from the open market.

In the meantime the Five-year Plan was launched from 1951 to 1955, with provision for 9 crores under agricultural improvements and 31 crores under irrigation schemes. The irrigation schemes included 'short-term' programmes of tank restoration,

'medium-term' projects like Malampuzha, Manimuthar and Amaravathi and the 'long-term' programme of Lower Bhavani calculated to benefit 3,83,000 acres on the whole.

Well-subsidy scheme: As a direct help to agriculturists, advances were given up to 50% of the cost of sinking a well and a farmer could receive the help to a limit of five wells. This was in operation from 1944 to 1951-52.

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Manures and Fertilizers: (a) *Green Manures:* The campaign on green manures and trial of different types like daincha, sunnhemp, wild indigo, pillipesara and *Sesbania speciosa*, for the wetlands resulted in recommending the cosmopolitan variety viz., *Sesbania speciosa*. This is very easy and cheap to grow, stands water-logging, yields seeds while growing along the bunds with the paddy crop and is the heaviest yielder of leaf per acre.

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(b) *Composts:* The municipalities are increasingly taking to production of nightsoil compost, as it is very remunerative. The individual farmers have also become compost-minded; they prepare composts in their own holdings and buy large quantities from municipalities also.

(c) *Chemical fertilisers:* The drive for increased production has made farmers go in for chemical fertilisers like ammonium sulphate and fertiliser mixtures. The annual sales in the residuary Madras State through the Agricultural Department is about 50,000 tons.

(d) *Oil-cakes:* Since a decade groundnut cake is so very extensively used as manure that cattle could not be fed with this cake in sufficient quantity. Out of a total production of three lakhs of tons, nearly two lakhs are applied to the land.

(e) *Other organic manures:* (i) Cattle dung — Only 50% of the estimated production of 20 million tons of cattle dung in the composite State is applied to the land and the rest is used partly as fuel and partly not collected at all.

(ii) Bones of Cattle: 1.5 lakhs of bones are estimated annually in the composite State; out of this, nearly 20% is collected, powdered and used as manure. The rest is going to waste.

Improved Seeds: As improved seeds contribute to nearly 15% increase in yields of food crops, seed farms are being run in the State for paddy and millets, seeds procured and distributed to a tune of nearly 4,000 tons of seed paddy and 38 tons of millet seeds in 1953-54 (residuary Madras State). A quick method of multiplying and distributing departmental strains of paddy seeds has recently been launched in the State known as 'Village Seed farm' Scheme. Village Agricultural Associations are formed, a few reliable farmers are selected from them and better strains of seeds are distributed to them at the rate of one pound for every acre under the crop in the village. An undertaking is given by the ryots who receive the pure seeds from the department that they would distribute the multiplied seeds to other farmers of the village in exchange for their local seeds raised by them. This system obliges the department to supply seeds only for the village seed farm areas and not to the entire village population.

Mechanised Cultivation: Farmers take recourse to mechanised farming to reclaim new areas and to carry out timely operations over extensive areas. To assist them in this direction, the department owns 159 tractors, of which 85 are fitted with bulldozer attachment and hires them out to farmers on request.

In respect of irrigation aids to replace human and animal power, oil engines and electric motors are being increasingly put to use. Here also the department comes to their help by offering on hire 1,726 oil engines and 411 electric motors which can command an area of 16,600 acres.

Agricultural Loans: Loans were advanced to farmers by the Revenue, Co-operative, and agricultural department for specific purposes, to the extent indicated below, in 1953-54.

Co-operative department	...	422 lakhs
Revenue department	...	18 lakhs
Agricultural department	...	14.28 lakhs

For the year 1954-55 provision was made for the agricultural department for disbursement of loans up to 70 lakhs for manures, 5 lakhs for tractor purchase, and 14 lakhs for pumping equipment.

VI. Soil Conservation: The Soil Conservation Board was constituted in 1951. It is tackling soil erosion problems in the Nilgiris and Malabar districts and portions of Coimbatore district. In Ketti valley (in the Nilgiris) 300 acres have been taken on hand under Soil Conservation programme.

Loans are also disbursed at Rs. 300 - per acre up to a maximum of Rs. 1,500 - per individual for carrying out Soil Conservation works.

As a famine relief work 5,752 acres have been contour-bunded in Coimbatore district.

Plant Protection: The plant protection work of the department was initiated in 1949. The chemicals used viz., B.H.C., D.D.T. and fungicides are sold at 50% of the cost price in areas declared as pest-infected for application to food grains, vegetables, chillies and betelvine. The area covered by the plant protection staff was 2.9 lakhs of acres in 1951-52 and expanded to 9.4 lakhs of acres, saving 48,000 tons of food grains valued at 1.3 crores of rupees.

The quantity of the various chemicals used by farmers increased from 500 tons in 1951-52 to 3,117 tons in 1953-54.

The increase in the yield of rice as a result of executing various schemes by the agricultural department amounted to 2,31,420 tons in 1953-54, by adopting the following improvements:

Ammonium sulphate & Superphosphate application	...	1,37,476 tons
Green manures	...	80,818 "
Improved seeds	...	6,455 "
Use of Tractors & Bull dozers	...	3,455 "
Filter point tube wells	...	2,915 "
Oil Engines and Electric motors	...	318 "
Total		2,31,420 tons

The requirements: After listing out the achievements by the department, we may now indicate the requirements by farmers.

The present policy of an all-out aid deserves to be continued in respect of distribution of pure seeds, manures, filter-point scheme, hiring out tractors and pumpsets, plant protection, regulated markets for commercial crops etc.

The most essential need of the hour besides the availability of the facilities enumerated above is easy credit for several items of farming. Loans are already being granted by different departments but it takes time for disbursement. An additional facility would be the institution of an organisation which can advance loans on pledging produce, exchange pure seeds for local seeds, distribute the agricultural needs of the farmer in the village. This will totally rid the cultivators of the necessity of obtaining credit at very high rates of interest ranging from 12% to 36% and playing into the clutches of merciless money lenders who are now standing in the way of the economic advancement of farmers.

Future Line of Work in Agricultural Extension: 1. The items of extension work now pursued must be organised as a network covering a wider area, enabling them to be within the easy reach of agriculturists from their villages.

2. The needs of the farmer have to be met by a multi-purpose device set up in each village to distribute finance for timely field operations, seeds, manures etc. for cash or in exchange for his commodities and also arrange to stock the produce and dispose it off when prices are favourable. The organisation is to be entirely managed by village leaders under the guidance of the Government; the initial financial outlay being advanced by the Government for equipping the Society with godowns etc., on long-term repayment basis.

3. The agricultural department on receipt of indents to will supply the godowns with stocks of seeds, manures, agricultural machinery etc. and transport them through mobile units to the village godowns on 'no loss, no profit' basis.

4. In projects like distribution of manures, plant protection, chemicals and equipment, essential farm implements and pumping units, the Government can enlist the co-operation of approved dealers in the above articles in stocking, carrying on propaganda and sales by sharing the cost involved in running the scheme i. e. cost of stocking, staff engaged in distribution etc.

At present each organisation is establishing a separate unit for the same item of work. By pooling the different organisations and sharing equally the cost of running the project, better work can be executed at lesser cost. Pooling comes in only at the ex-production stage.

5. Reviving the mobile vans with agricultural exhibits and running exhibition trains will greatly assist in impressing the population with agricultural progress.

6. Intensifying the community projects work and setting up a permanent exhibition of agricultural improvements in important towns and villages.

7. Running State farms or colonising new stretches of reclaimed land on Gezira model, which is briefly as follows:

The Gezira Scheme of Anglo-Egyptian Sudan, functioning on the triangle of land lying between the Blue and the White Nile over 5 million acres is a thought-provoking experiment representing a compromise between nationalisation of land and communal farming and individual ownership by small peasant proprietors. It is nationalisation diluted by being subject to a fixed period. There is a tinge of socialism in that land improvement necessary in individual cases is carried out at the cost of all, but not socialised to the extent of pooling the profits.

The financial burden is borne by the Government and two private companies. The Government is responsible for provision of land, construction, maintenance and operation of the dam, maintenance of main canals and payment of rent for the land. The companies maintain the subsidiary canals, supervise cultivation, collect and store cotton crop, advance loans to tenants, work the ginning factories and market the crop. The tenants grow the crop under supervision by providing labour (water and land are free for cotton as well as other food and fodder crops) for which loans are given on easy terms.

The profits are shared as follows:

Government 40%, Companies 20% and Tenants 40%.

Extensive lands now lying fallow and which are contemplated to be brought under cultivation as in Athur of Salem district deserve a trial on the above lines.

Summary: The subject is dealt with under three main heads viz., what has been done so far with the resultant achievements, what is the need for the hour and how best requirements can be met for the benefit of the farmers. The achievements in Grow More Food Scheme, manure distribution, irrigation facilities, seed supply, mechanised cultivation agricultural loans, soil conservation and plant protection are described. Among the needs of the farmers easy credit for cultivation, storing and marketing facilities are stressed. As a future line of work, intensification of extension branch, institution of an agency for not only meeting the financial needs of the farmer but for stocking produce, advancing loans on pledged commodities, supply of agricultural needs and marketing is mentioned. A fruitful way of enlisting the co-operation of trade in items that are common to both, utilising vast areas of newly reclaimed land on the model of Gezira is suggested.

REFERENCES

1. Madras Information — January 1955
2. Memoirs of the Department of Agriculture 1948
3. Madras Information — November 1954.
4. The Tirupur Cotton Market Committee Bulletin Vol. 5, No. 1, 1949.

What Next in Agricultural Extension

by M. J. DAVID,
District Agricultural
Officer, Pattukottai

We have been doing extension work for more than half a century and in the recent past have covered lakhs of acres with improved seeds and green manures through village seed farm schemes. It is no exaggeration to say that *Sesbania* has become a household word and that there does not exist a single ryot who does not know *Sesbania*. Each village has got a village Agricultural Association and each taluk a Taluk Agricultural Association functioning, apart from the Divisional Ryots' Association. These associations keep constantly in touch with the department and play a great part in extension work. These associations print a large number of leaflets detailing the remedial and preventive measures to be undertaken against pests and diseases and distribute them to the public. They give wide publicity about the Village Seed-Farms, green manures, pests and diseases, crop competitions, about cotton in rice fallows, and modified Japanese method, by putting slides in the local theatres at the appropriate times and thereby inducing people to step up production.

The members of these associations can be made to be of greater service to their fellow agriculturists by arranging inter-district exchange of farmers. The ryots of one division may not appreciate the value of cash crops like cotton, turmeric etc., but they can be easily convinced by taking them to other districts where they can see for themselves the growing of these cash crops. For instance, if the members of the Nagapattinam Taluk Agricultural Association are taken to a place like Coimbatore and shown the cotton crop or taken to Karur and shown a turmeric crop and explained the several advantages of growing such cash crops, the ryots will get impressed and in the next season they will be tempted to grow such crops. Likewise, if the Coimbatore or Karur ryots are taken to Nagapattinam and shown the three-mile belt of *Sesbania*, they will get impressed and will be tempted to grow the same in the next season. Without actually seeing the crops, the Agricultural Demonstrator explaining things will not bring very good results. For this purpose the State should undertake the responsibility of running extension specials and a fleet of extension buses equipped with loud speakers and other conveniences and manned by efficient and experienced extension publicity officers should be built up like a tourist service.

In the second five-year plan, there appears to be a proposal to cater to the needs of ryots in the matter of improved seeds by running

25 acre-blocks of seed farms. These seed farms can function effectively only if the seeds produced are exchanged against ryots' grain. Without sufficient drive the entire quantity of seeds produced would not be distributed and all the villages would not be covered. By having qualified officers in large numbers, large areas of seed farms can be supervised more critically. We can appeal to the trustees of temples and other religious institutions to give us some of the lands for starting these seed farms, and the money so saved can be made use of for paying the large number of officers appointed for running such seed farms. The seed produced at such farms can be exchanged for grain. The labourers of the farm may be paid half in kind and half in cash. The seed-farms can be maintained in such a way that they will attract the neighbouring farmers and other visitors who in turn will improve the standard of farming much to the prosperity of the nation as a whole. The produce of such seed farms can be distributed by taking them in lorries to the interior villages and exchanging the seed for the villager's grain.

So then the next step in extension work is greater participation of the farmers in the work of the Department by (1) exchanging the seeds produced in seed farms for their grain (2) by organising extension special trains and extension buses equipped with loud speakers and other conveniences in which members of village and taluk agricultural associations could be taken in hundreds to neighbouring districts by experienced officers and shown and explained the agricultural activities in well-run holdings, just as we take Agricultural College students. We must create in the minds of the mass of the ryots a feeling that we and they are joint partners in a great undertaking to double production and increase the standard of living of the mass of our people within the second five year plan period.

Weather Review — For April, 1956

RAINFALL DATA (IN INCHES)

Division	Station	Total rainfall for the month	Departure from normal	Total since 1st January	Division	Station	Total rainfall for the month	Departure from normal	Total since 1st January
North	Madras (Meenam-bakkam)	0.3	— 0.7	3.1	South	Madurai	0.3	— 2.4	2.7
	Tirur-kuppam*	0.4	— 2.4	3.0		Pamban	Nil	— 1.0	1.2
	Vellore	4.6	+ 2.3	5.9		Koilkattai*	1.1	— 1.8	4.2
	Gudiyatham*	3.4	+ 0.9	4.3		Palayam-cottai	1.4	— 1.2	3.9
East Coast	Palur*	0.3	— 3.2	2.6	West Coast	Amba-samudram*	0.7	— 0.8	5.3
	Tindivanam*	1.1	— 0.8	3.8		Trivandrum*	4.7	— 4.1	11.7
	Cuddalore	0.3	— 0.7	2.3		Fort Cochin	25.1	+ 13.4	41.9
	Naga-pattinam	Tr.	— 1.6	3.0		Pattambi*	12.0	+ 4.7	17.6
	Aduthurai*	0.5	— 2.1	3.5	Hills	Kozhikode	19.2	+ 10.3	28.1
Central	Pattukottai*	0.4	— 1.0	3.0		Taliparamba*	19.4	+ 11.0	22.6
	Salem	1.3	— 3.3	2.3		Wynaad*	4.2	— 2.6	11.4
	Coimbatore (A. M. O.)*	0.2	— 2.1	1.9		Nileshwar*	28.2	+ 19.7	33.0
	Coimbatore	0.1	— 2.4	1.8		Pilicode*	17.3	+ 8.7	23.3
	Tiruchirappalli	1.4	— 1.2	3.1		Mangalore	26.7	+ 19.0	28.4
						Kankanady*	27.2	+ 20.8	28.8
						Kotekar*	23.8	+ 17.3	£
						Kodaikanal	3.2	— 3.2	12.8
						Coonoor*	1.3	— 2.5	8.0
						Ootacamund*	3.3	— 3.4	8.9
						Nanjanad*	1.7	— 3.7	5.4

Note:— 1. * Meteorological Stations of the Madras Agric. Dept.
 2. Tr. — Trace (Rainfall 0.01" to 0.04").
 3. £ = It is a new station. Raingauge was installed only in March 1956.

The depression on 30—4—1956 near Gadag moved westwards on 1—5—1956 and emerged into the East Central Arabian Sea. Under its influence Travancore-Cochin and Malabar and South Kanara had widespread rains. Showers in these regions became scattered on the next day. The weather for six days from 3—5—1956 was mainly dry except for isolated showers in interior Tamilnad on 6—5—1956, scattered showers in Travancore Cochin and north Tamilnad on 7—5—56 and localised showers in Travancore-Cochin on 8—5—56. On 9—5—1956 a few places in interior Tamilnad had some mild showers. This sort of weather continued till 13—5—1956. A feeble trough of low developed off the Malabar Coast on 14—5—56, but the weather was dry on this day. A temporary advance of the monsoon took place on 15—5—1956 and Malabar and South Kanara had widespread rains. On 16—5—1956 the same weather prevailed in the West Coast, though in other places, except a few in interior Tamilnad, it was mainly dry. Malabar and South Kanara and a few places in northern Tamilnad had localised showers on 17—5—1956. Again the monsoon showed a temporary advance on 18—5—1956. From this day upto 27—5—1956 rainfall was fairly widespread in Travancore-Cochin and Malabar and South Kanara and scattered and localised in a few places in Tamilnad. In the last four days of the month the west-coast had fairly widespread rains and the weather in Tamilnad was mainly dry.

Considering the month as a whole the districts constituting the East Coast, Central and Southern portion of the Madras State had only sub-normal rains. The districts of Chingleput and North Arcot and those in the West Coast had fairly good rains. The Nilgiris district and the Kodaikanal area of the Madurai district had poor rains. Anyway the severity of summer was not actually felt anywhere in the State.

The noteworthy rainfall and the zonal rainfall in inches are furnished below:—

Noteworthy Rainfalls			Zonal Rainfall			
Date	Place	Rainfall in inches	Name of Zone	Rainfall for the month	Departure from normal	Remarks
20/5/56	Trivandrum	2.0	North	2.2	J. N.	Just normal
22/5/56	Alleppey	3.0	East Coast	0.4	- 1.6	Far below normal
23/5/56	Cochin	4.0	Central	0.8	- 2.3	do
do	Kozhikode	2.0	South	0.5	- 1.4	do
24/5/56 & 26/5/56	Mangalore (Each day)	4.0	West Coast	18.9	+ 10.7	Far above normal
			Hills	2.4	- 3.2	Below normal

Note:— J. N. — Just normal. Actual figure is + 0.025%.

Agricultural Meteorology Section,
Lawley Road P. O.,
Coimbatore, 11-6-1956

C. B. M. & M. V. J.

Departmental Notifications

Gazetted Service — Postings and Transfers

Name and present post	Posted as
Kandaswami M., Govt. Mycologist, Coimbatore.	Crop and P. P. O. Mycology, Coimbatore.
Mohamad Ali A. M., Asst. Agrl. Eng., Soil Conservation, Ootacamund.	Asst. Agrl. Eng., Paramakudi.
Ramakrishnan, Dr. K., Senior Lec., Madras University, Madras.	Govt. Mycologist, Coimbatore.
Ramasubba Iyer A. K., D. A. O. Sattur. (On leave)	Spl. D. A. O. Crop Sampling, Tanjore.
Seshadri A. R., Asst. Entomologist. (On leave)	Agriculturist, Coimbatore.
Shanmugam C. R., Trainee in Soil Conservation, Dohra Dun.	Asst. Agrl. Eng., Soil Conservation, Ootacamund.

STUDENTS' CLUB NEWS

The executive members and office-bearers of the Agricultural College Students' Club for the academic year 1956-'57 were elected at a General Body Meeting held on 9-5-1956 at 6 p. m. with Dr. A. Mariakulandai, the Vice-President, in the chair.

The members elected for different games and for other activities are given below:—

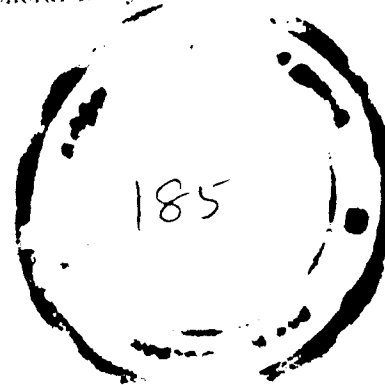
Sri D. Paulas of Class III	Club Secretary.
" P. M. Krishnamurthy of Class III	Games Secretary.
" T. N. Sivasankaran of Class II	Cricket Captain.
" V. Mariappan of Class II	Tennis Captain.
" G. C. Perumal of Class II	Hockey Captain.
" M. Sunchiah of Class II	Football Captain.
" N. P. K. Shahul Hameed of Class II	Minor games Captain.
" V. Rajaguru of Class III	Class Representative.
" K. Kothandaram of Class II	Class Representative.

The following were elected as office-bearers outside the Executive Committee for 1956-'57.

Sri G. Ramanathan	"The Tatler" Editor.
" S. Sundaram	Secretary, Debating Society.
" M. Thangavelu	Dramatic Society.
" T. S. Govindarajan	Social Service league.
" A. Chidambaranathan	Photographic Society.
" K. Karuppuswamy	Hiking Society.
Kumari R. Sivagami	Lady Students' Representative.

This newly-formed Committee stood welcome tea on 4-6-1956 to Dr. K. C. Naik, the new President of the Club. The Budget for 1956-'57 was provisionally discussed before placing it before the General Body Meeting.

G. RAMANATHAN.



3L
15-5-57
NSG-43

தமிழ்நாடு ஆவணக்காப்பக நூலகம்,
எழும்பு, சென்னை-600 008.

தவணைத்தாள்.

சே. எண் :

ப. எண் :

வழங்கிய நாள். (1)	திரும்பிய நாள். (2)	வழங்கிய நாள். (1)	திரும்பிய நாள். (2)