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CONTENTS

	PAGE
<i>Editorial</i>	353
<i>Original Articles :</i>	
1. Groundnut in Madras and its Economic Importance (Part II) by G. Venkatanarayana	355
2. A Note on the Behaviour of Three Inter - Racial Hybrids in <i>Gossypium Arboreum</i> L. by V. Santhanam	383
3. A Note on Fruit - Cracking in Arecanut by K. V. Ahammed Bavappa and P. C. Sahadevan	386
4. A Gigas Form of Coconut by G. V. Narayana	388
Agricultural Five - Year Plan	391
News Letter	393
Weather Review	395
Departmental Notifications	398

THE MADRAS AGRICULTURAL JOURNAL

Hints to Contributors

The pages of the Madras Agricultural Journal shall be open ordinarily only to the members of the Madras Agricultural Students' Union.

All articles for publication should be addressed to the Editor, Madras Agricultural Journal, Lawley Road P.O., Coimbatore.

In view of the high cost of printing, contributions should be as concise as possible and should conform to the best usage in the leading journals published in India and abroad.

All papers should be typed with double spacing on one side of the paper only and with wide margin. They should not ordinarily exceed 5,000 words or 12 pages of printed matter including tables and illustrations in the Journal. Manuscripts should be carefully revised; numerical data and calculations checked. Main headings in the text should be typed in capitals with paragraph indentations and followed by a period and two hyphens. Sub-heads should be lower case and be underlined to indicate italics. Latin nomenclature and local terms etc., should be in italics. Original papers must conclude with a summary of not more than 300 words, drawing attention to the main facts and conclusions.

Tables: The number of tables should be restricted to those absolutely necessary, as numerous tables detract from the readability of the article. Each table should be numbered consecutively from I up and must have a heading stating its contents clearly and concisely. The tables are to be typed on separate sheets with their positions marked in the text.

Illustrations: Wherever possible illustrations should be made with pen and Indian ink for reproduction as line blocks. The name of the author, title of the article and figure number should be written on the back of each figure in blacklead pencil. Each figure should have a legend typed on a separate sheet.

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Graphs: Graphs should be drawn in Indian ink on co-ordinate paper ruled with blue lines. Any portion which is desired to appear in the reproduction should be drawn over with Indian ink.

References: References and reviews of literature should relate only to closely pertinent papers. The list of references should come at the end of the article, after the summary and should be arranged in alphabetical order of authors' names followed by the year of publication in brackets, and then the title of the paper, name of periodical, volume number in bold face type and then the page number, e. g. Darlington C.D., (1944) Heredity, development and infection. *Nature* 154; 164-9. Abbreviations for names of journals are to be in the approved form as given in the World List of Periodicals.

The responsibility for statements, whether of fact or opinion, rests entirely with the author of the article and not with the Editorial Board of the Madras Agricultural Journal.

EDITORIAL

The Agricultural Five - Year Plan : We publish elsewhere in this issue an account of a recent discussion that took place on the Agricultural Five Year-Plan, at the Agricultural College, Coimbatore.

With the achievement of independence after a long period of subjection, planning for a better state of things has become a major item in the National programmes. In accordance with this policy, planning for a better way of agriculture has also assumed great importance and the Report on the Five-Year Plan which has been released by the Planning Commission is an invitation to the people of India "to pave the way for progress and prosperity by disciplined and well-directed endeavour and constructive, co-operative and co-ordinated effort."

Measured in terms of the money involved, this plan is almost breath-taking in its magnitude and scope. Even for a single State, Madras, the amount involved is of the order of 137 crores of rupees, out of which nearly 20 crores are earmarked for agricultural and rural development. Eighty crores are set apart for major irrigation and power projects, 27.6 crores are for social services, 2.1 crores for cottage and other industries and 5 crores are for transport.

To save undue strain on the Nation's finances the Commission relies on Village Production Councils to capitalise the land and labour of the country, with special reference to agriculture. These Councils will be entrusted with the following duties :—

- (1) Frame budgets of requirements of supplies and finance needed for fulfilling the programmes of production to be achieved at each harvest by the village,
- (2) Assess the results attained at each harvest,
- (3) Act as the channel through which all Government assistance is provided to the village,
- (4) Take steps to bring under cultivation, land not cultivated or managed by the owners,
- (5) Assist in securing minimum standards of tillage to be observed in the village with a view to increase the production of food crops,
- (6) Stimulate production through prizes and incentive schemes,
- (7) Promote the cultivation of high-yielding food crops,
- (8) Organise voluntary labour for community works,
- (9) Estimate and assist in provision of requirements of local raw materials for the artisans of the village and,
- (10) Assist in the procurement and sale of surplus food grains.

This is a formidable list. Every one of these items is no doubt quite necessary and a laudable one, but as pointed out in the discussion that took place at the Agricultural College on March 5th,

the whole scheme hangs upon a whole-hearted and enthusiastic co-operation by the people. This in turn depends upon how far the idea has caught the imagination of the masses and if one might venture an opinion based upon the prominence the subject has achieved in the every-day news of the country, the conclusion is that it has not done this so far. The Commission considers that the unused time, skill and other resources of the people should be canalised, on a voluntary basis. They have also suggested the development of a welfare organisation, the Bharat Sevak Samaj. This body is nonofficial in character but is to be supported partly by State funds, which would operate on the principle of mutual aid. Top priority is to be given to increasing food production, but education, public health, relief work etc., will also be the concern of the Samaj.

It is almost a truism to point out that the success or failure of an agency of this type will depend entirely on the type of personnel. There is also the Bhoomi Sena or College Extension Service, which aims at roping in the student section of the population for improving the agricultural situation. With almost half a century of experience of local self-government administration, it is now generally conceded that workers who are ready to devote all their time and energy to voluntary, unpaid work, are always hard to find and are seldom amenable to direction and discipline.

As mentioned earlier, the crucial question still remains as to how far the idea has fired the imagination of the masses, which alone will ensure the success of the Plan. It goes without saying that in the absence of a kindling spark and sustained care, no amount of heaped-up firewood would serve to give us the food that we need.

Other points that came in for criticism during the discussion were (1) the proposal to increase food production to the requisite levels, by regulating crop-planning patterns by legislation and (2) the redistribution of land to ensure a minimum economic holding to all, also by legislation. The general trend of opinion was that both these ideas would be possible only in a totalitarian regime. It was next to impossible for any government to gauge the minimum economic holding and to ensure that such redistributed holdings would also be in compact blocks. Further, to vest the Village Councils with authority to enforce items of improvements by compelling the farmers to take up scientific methods of cultivation, and develop their farms into efficient productive units, to make them agree to sell seeds and grains to government, to ensure adequate wages and terms of employment to agricultural workers, would smack even more of totalitarian methods. Agriculture in our country is not so much a commercial business as a mode or way of life and when legislation is invoked to channelise agriculture it means that the State is interfering in the people's way of life. As pointed out by Sri Ramunni Menon, Chief Secretary to the Government in the Special Planning Number, Madras Information (October, 1951), quoting Thoreau, "That Government is the best which governs least." This is true for all time and for all countries.

Groundnut in Madras and its Economic Importance *

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PART II

8. **Genetics and Breeding:** The groundnut crop being a recent introduction in most of the groundnut-growing countries of the world, has not received the attention which its importance would warrant. Comparatively little work has been done on the crop. Some progress on the genetics and breeding of the groundnut has been done in the United States of America and in India.

(a) *Cytology:* Very little work on the cytology of the groundnut plant was done before 1930. Kawakami (1930) reported the chromosome numbers of the common *A. hypogaea* as 20 haploid and 40 diploid. Hunter and Leake (1933) reported that Badami (1928) "has found Spanish and Small Japan, both erect types to possess 10 chromosomes haploid, while Virginia, a procumbent type has 20," also that "the chromosomal difference is not limited to the number present, for those of Small Japan are nearly double the size of those of Virginia." Husted (1933) reported the somatic chromosomes of *A. rasterio* and ten varieties of *A. hypogaea* as forty in number. The haploid chromosome number of one bunch and two runner varieties of *A. hypogaea* were determined to be 20. The same author (1936) from a careful examination of 115 plants representing 33 species, varieties and hybrids has reported the chromosome number as 20(n) and 40 (2n). He has also concluded that in *A. hypogaea*, deviation from the 40 somatic number seldom occurs. Medes (1947) confirms the chromosome number previously reported and reveals the existence of other species having $2n = 20$ chromosomes e. g. *A. prostrata*, Benth. and *A. marginata*, Gardn. etc. Out of the eight samples of groundnut received from the State of Mato Grosso, one had $2n = 20$ chromosomes. Based on the genetical studies made by several authors and in the light of his investigations he concludes that the groundnut must be considered to be of a tetraploid nature. Further, he thinks that *A. hypogaea* must have arisen spontaneously by chromosome doubling from diploid forms.

(b) *Genetics:* Stok (1910), Stokes and Hull (1930), Hayes (1933) and Patel and others (1936) have studied the inheritance of some of the important characters of the groundnut. The work so far done on the genetical aspect of the groundnut crop is briefly reviewed here.

* Maharajah of Travancore Curzon Endowment Lectures in Agriculture—1951—1952. (Published with the kind permission of the University of Madras).

Crossing technique evolved at the Agricultural Research Station, Tindivanam (S. Arcot District). Flowering in the groundnut plant starts from the third week after sowing. The short-duration bunch varieties begin to flower earlier than the long-duration spreading varieties. Flower buds appear in leaf axils singly or in clusters of two to five. The maximum number of flowers appearing in any one leaf axil never exceeded five. The flowers when in clusters develop and open in acropetal succession. The deep-seated and congested cluster of the flower buds is protected by closely packed bracts. This makes the removal of unwanted flowers difficult and thus a large percentage of selfed seeds may be left in crossed plants. The flowers bloom between six to eight in the morning and the blooming of flowers occurs at random. The flowering period lasts for about 30 to 45 days in the bunch varieties and 45 to 60 days in the spreading varieties.

Emasculation is done by opening the flower buds between 4 P. M. and 6 P. M., about 12 hours before the time of blooming. The flower bud is gently held by the left hand and with the right the standard, wing and keel petals are opened with a pair of fine forceps, then the flower is emasculated, the tips of filaments are examined with a magnifying lens so as to ensure the complete removal of anthers. After the anthers are removed the petals are gradually manipulated to their original position so as to protect and cover the stigma. Care has to be taken to see that the calyx tube or any other part of the flower is not twisted or dis-jointed in the operation. Artificial pollination of the emasculated flower is carried out the following morning between 6 A. M. and 8 A. M. when the anthesis of flowers normally occurs. Bagging of the plant with muslin bags is not considered necessary to prevent natural crossing. Success in crossing depends on the carefulness of the operators. From 10 to 30 percent of the artificially pollinated flowers have been observed to set pods. Natural crossing is extremely rare in the common cultivated varieties but has been found to be somewhat frequent in the 'Kurumanni' or the 'Indigenous' variety of South India and var. nambyquare grown at the Tindivanam Research Station.

In an attempt at a genetical analysis of the several characters—Chlorophyll deficiency, abnormality, growth habit, branching, duration, hairiness, anthocyanin pigmentation, seed coat colours and degree of development of testa, considerable amount of data was collected as a result of examination of several thousand cross progenies. From these data, the mode of inheritance of the above characters was interpreted. The conclusions drawn agreed in most cases with the results obtained by earlier workers. The results of the genetical studies are as follows :

(i) When a green bunch variety is crossed with a green spreading variety, the F_1 s are all green and the segregation occurs

in F_2 in the ratio of 15 greens to one albino. Thus only two factors were located for albinism by Patel and others (1936) though Badami (1928) as reported by Hunter and Leake (1933) has concluded that it is a triple recessive.

(ii) Abnormal dwarf plants which are mostly sterile, were obtained in crosses between the spreading varieties and the bunch variety 'Corientes 3.' There are two factors for abnormality which give a 15 : 1 ratio in the F_2 . The abnormal plants are sterile. Hayes (1933) mentions sterility caused by a two-factor difference segregating in F_2 in a 15 : 1 ratio. It is possible that the abnormal plants obtained from among the cross progenies at Tindivanam and his sterile plants are the same.

(iii) The spreading habit is caused by two semi-spreading factors which are both dominant to the bunch factor. The segregation in the F_2 showed one bunch to every 15 of the other dominant types. The classification of the 15 dominant types into distinct 'spreading' and 'semi-spreading' groups presented considerable difficulty due to various factors. This is in agreement with the observation made by Badami (1928) that erect is recessive to spreading with a bifactorial difference. Hayes (1933) has reported that the segregation for habit is on the basis of 15 : 1 ratio.

(iv) Branching is dominant over non-branching and is inherited in a simple Mendelian ratio of 3 : 1 in F_2 . The branching is linked with the spreading habit with 30 percent of cross-over.

(v) Late duration is dominant over early. The F_1 is intermediate in duration and F_2 segregation is in the ratio of 3 non-early and one early plants.

(vi) Hairiness is dominant over sparse hairiness and is caused by a single gene difference.

(vii) There are four distinct seed-coat colours in groundnut viz., dark purple, red, rose and white. There are duplicate factors for the rose colour. The factor for red and the factor for purple are dominant to rose but the red and the purple factors are expressed only in the presence of rose factors. The purple is dominant to red. The white seed coat colour is recessive to the coloured seed coats. Some of these findings are in agreement with those obtained by earlier workers.

(viii) The purple pigment in the plant is produced by duplicate genes which give in F_2 15 : 1 ratio. It is suggested that the two factors which produce the rose-coloured testa might also produce the purple pigment on the plant.

(ix) The partially developed or 'ruptured' testa is incompletely dominant over the completely developed testa. The F_2 progenies segregated into three groups—ruptured testa, slightly ruptured testa and complete testa in the ratio of 1 : 2 : 1.

(c) *Breeding*: As in the genetic studies, breeding work on the groundnut also is of recent date, and has been carried out only to a very limited extent in a few countries. It was Stok (1910) who first attempted a systematic selection to improve the local cultivated varieties of Java. Subsequently, similar work seems to have been started in America, French West Africa, India and other countries. Groundnut breeding work in Madras was started as early as 1926 but was intensified from 1930 with the organisation of a separate wing in the Agricultural Department for work on the oilseed crops of the State. Work on this crop has also been in progress for some years now in other groundnut-growing States in India principally Mysore, Bombay, Madhya Pradesh and the Punjab. The main aim of the breeders on this crop has been to produce races with high yield and high oil content. But as the study of the crop advanced, more experience on the behaviour of the crop under different environmental conditions was gained and new uses to which its products could be put to were found out, the scope of work of the groundnut breeder has also increased considerably. Besides yield and oil content, other agricultural and commercial qualities of the crop have also attained great significance in breeding. Earliness, seed dormancy, shelling outturn, natural test weight of pods and kernels, size of kernels, free fatty acids and resistance to drought, insect pests and diseases are some of the characters which are considered to be of great importance to the agriculturist and the trader. As most of these qualities are greatly influenced by soil and climatic factors, one of the important lines of work of the breeder of this crop at the present time is to evolve high-yielding strains with desirable attributes suited to particular soil and climatic conditions. The intensive study on the various developmental aspects of the crop carried out at the Agricultural Research Station, Tindivanam has shown that the variations available in the representative collection maintained on the station are capable of being utilised for the above purpose.

Groundnut improvement work is being carried on at the Agricultural Research Station, Tindivanam by the recognised methods of introduction and acclimatisation, selection and hybridisation.

Introduction and acclimatisation: Varieties and forms of the groundnut were collected from the different groundnut-growing countries of the world and were grown, studied and maintained at the Tindivanam Station. Detailed study made of this representative collection of over eighty varieties and forms helped the workers to classify them systematically and construct a simple key for their identification. The variations in respect of different characters exhibited by the varieties and forms from season to season and the extent to which they could be utilised in the breeding work on the crop was clearly understood from the study.

This has helped in planning the breeding work and putting it on a sound basis. The study also revealed that the groundnut plant was cosmopolitan in nature, as the introduced varieties and forms showed practically no change on acclimatisation. The range of values for the different characters that would be of help to the breeder were also revealed by the study.

Selection :

Mass Selection: From the trial of the varieties collected and tested at the Agricultural Research Station, Tindivanam (then Palakuppam) prior to 1930, two varieties 'Gudiyatham Bunch (Local Bunch) among the bunch varieties and 'Saloum' (West Africa) among the spreading varieties appeared promising. The produce of the elite plants from these two varieties that had high yield and uniform maturity of pods were separately pooled together and the mass selected bulks were compared with the other varieties including the local controls. These two mass selections proved, to be consistently heavy yielders. 'Saloum' was also found to withstand drought to a remarkable extent and record higher percentage increase over 'Local Mauritius' in years of low and precarious rainfall. These were further tested in the various parts of Madras State under cultivators' conditions and found to maintain their superiority over the local cultivated varieties giving increased yields varying from 10 to 50 percent (average more than 20 percent). A. H. 25—Saloum (now TMV. 1) though drought-resistant and yielding more than 20 percent over the local spreading varieties, has not found favour in certain localities on account of its slightly lower shelling out-turn (about 4 percent). The advantages of growing this mass-selected variety are being explained to the cultivators by carrying on special propaganda. The distinguishing features of the two mass selected strains along with their average yield and qualitative characters are given in Appendix II.

Pure line selection: With a view to utilising the variability available in the collection of varieties for evolving economic types, thousands of single plant selections were made from promising varieties for yield, high shelling out-turn, short duration, etc. These were carefully tested for yield and quality for a number of years. As a result of this work, a number of high yielding, bunch, semi-spreading and spreading strains with desirable qualitative characters have been evolved. Of these, the first batch of selections have also been extensively tested in the districts in ryots' holdings. Two of them, namely A. H. 698 selection from a West African variety 'Bassi' (now TMV. 3) and A. H. 334, selection from an American variety 'Carolina' (now TMV. 4) have come out successful in these trials. The former is suitable for cultivation under rainfed conditions during the monsoon season while the latter is suited to irrigated cropping during summer. A. H. 698 (TMV. 3) on account of its high shelling out-turn and its

habit of forming pods very shallow in the soil which makes harvesting comparatively easy, is very popular among the cultivators of the Central districts. The details relating to these strains are also given in Appendix II. Of the other improved strains of groundnut evolved at the Agricultural Research Station, Tindivanam some are under district trials while others are awaiting such tests.

There is a growing demand for groundnuts for edible purpose. For edible use groundnuts should be of low oil content and of good flavour. Such qualities are possessed only by the big-podded forms. There are nine such types in the collection maintained at Tindivanam. Unfortunately, all of them are poor yielders and their cultivation may not be remunerative at the existing prices for edible nuts in this State. To make their cultivation paying and at the same time meet the demand for edible groundnuts, it is necessary to evolve a high yielding, large-seeded type. With a view to evolving such a type numerous single plant selections were made from the nine big-podded varieties e. g. Texas, Jumbo—Runner, etc., and they are under various stages of trial. Ere long it is hoped to release an edible strain of groundnut for large-scale cultivation.

Hybridisation: One of the main problems in breeding improved types of groundnut is to evolve a bunch type with dormant seeds. As already stated most of the bunch varieties have non-dormant seeds while the spreading varieties have dormant seeds. To evolve a high-yielding dormant bunch strain, numerous crosses between high-yielding bunch and high-yielding spreading strains were made and from the progenies the plants showing the desired combination namely bunch habit of growth and dormant nature of seeds, were selected. One such selection, A. H. 6481 an extract from a cross between 'Gudiyatham Bunch' and 'Native Tanganyika' combines bunch habit, dormant nature of seeds and high yield. This strain is being tried in the important bunch growing districts of the State along with the other bunch strains and the local. After convincing the cultivator about its superiority, arrangements will be made for its large-scale multiplication and distribution. The characteristics of this strain are given in Appendix II.

Other important problems relating to the groundnut crop for solving which hybridization work has been taken up at the Agricultural Research Station, Tindivanam are :

- i. Increasing the shelling out-turn of A. H. 25 (TMV. 1)
- ii. Reducing the duration of A. H. 6481.
- iii. Evolving a high-yielding edible type.
- iv. Imparting white seed-coat to the high yielding bunch and spreading strains already evolved.
- v. Evolving a high-yielding forage type.

A large number of crosses have been made with the above objectives and their progenies are under various stages of study.

9. **Marketing:** (a) *Preparation for the market:* Groundnut pods after harvest are marketed as such or as kernels after decortication. The bulk of the produce leaves the cultivators' hands as nuts in shell but reaches the exporters and millers as kernels, the decortication being done at one of the intermediate stages. Though decortication helps to reduce volume and transport charges it is disadvantageous in that the kernels are easily attacked by insects and undergo deterioration more rapidly than pods. Two methods of decortication are in vogue, namely 'hand' and 'machine' shelling. In hand shelling the pods which are either partially dried or previously moistened with water, are spread in thick layers, over a threshing floor and beaten with sticks and stirred frequently till all the shells break. The kernels are then separated from shells by winnowing. This practice is not favoured by trade as the kernels have a high moisture content which in turn causes rapid deterioration resulting in high free fatty acid content. With the advent of efficient decorticators in the market, hand-shelling is being slowly given up.

The groundnut decorticators used in Madras can be divided into two classes namely the 'grate' and 'beater' types. The makes largely used in the State are Kirloskar's Kalyan (grate type), Dandekar's Sangli and P.S.G's decorticator (beater types). All the decorticators operate on much the same principle. The nuts are fed into an adjustable hopper and pass into a drum where the shells are broken by suitable mechanism which differs in the different types. The kernels and shells then pass through a perforated sieve on to a board where the shells and dust are blown off to one side of the machine by a revolving fan and the clean kernels drop to the other side. In the beater type, a number of steel blades revolve at a high speed in a perforated drum and the combined action of the beaters and the friction between the nuts serve to split the shells and liberate the kernels. In the grate type decorticators the nuts on entering the drum of the machine are rolled against a grate by a set of revolving crushing plates and the shells split due to the pressure exerted.

The out-put of the decorticators varies to some extent upon the speed of working and the condition and size of the nuts and the size of perforations in the sieves or grates. As a rule, speed in working the machines, over-dry condition and large size of nuts result in a high proportion of broken kernels. The speed and moisture content of the nuts have to be regulated if kernels with a low percentage of splits and broken kernels have to be obtained. Moistening of over-dry nuts in summer is in vogue in some tracts. •

(b) *General marketing practices*: Cultivators take more than half the marketable surplus to the markets. The proportion is usually higher in the beginning of the season, varying in different areas from one-fourth to three-fourths of the total. The disposal of the produce, either at the market or in the village, is however, often closely connected with the question of indebtedness. In the village the cultivator may have to sell his produce to the village merchants, from whom he has taken loans, while at the market he may have no option but to sell the produce to his creditor merchant. Sometimes a producer binds himself to sell his produce to his creditor-merchant for a period of five or ten years. The producers usually sell their produce to the creditor-buyer at a lower rate than the existing market rates.

The cultivators sell their produce either as nuts in shell or after converting them into kernels at decorticating establishments. These play an important part in the assembling of groundnut and function as wholesale merchants, commission agents and processors.

When the produce is sold at his village, the cultivator may feel himself to be in a better bargaining position. But the use of false weights and measures by the merchants deprives him of this advantage. When the produce is taken to an assembling market, it has to bear many charges. Most of the charges are payable by the seller. Apart from these, further deductions are made in the form of allowances for quality, impurities and moisture. The total of the market charges may sometimes form a good percentage of the value of goods.

Regulated markets, besides providing greater amenities will offer some relief by eliminating exorbitant charges and malpractices. Such markets organised in the South Arcot district under the Madras Commercial Crop Markets Act, 1933, have helped the cultivators in securing proper prices for their produce and eliminating fraudulent weighments. Now a good percentage of the production in the notified area is being sold through the Market Yards established by the Groundnut Market Committee at the various centres.

Co-operative credit and sale societies in some cases help in the sale of the groundnut produce but their normal activity is in the way of giving loans and advances.

10. *Oil crushing*: A major portion of the groundnuts utilised in this State is crushed for the production of groundnut oil. Various kinds of oil crushing machinery exist in the country. They are wedge press, bullock *Chekku* or *Ghani*, screw press, rotary mills, expellers and hydraulic presses. Of these, the bullock *Chekku* or *Ghani*, rotary mills and expellers account for a large volume of groundnut crushed.

The working of the above types of machinery is described in the following :

(a) *Bullock Chekku or Ghani* : This is the most important type of oil mill used throughout India from very ancient times. The *Chekku* is worked on the principle of pestle and mortar. The mortar is generally made of wood and rarely of granite and is fixed to the ground. The pestle also made of wood is connected to a shaft and is made to revolve round the mortar generally by bullock power. As the bullock moves round and round the *Chekku* the material in the hopper is brought to rub against the pestle and mortar with considerable pressure and as a result the oil exudes out to a container through holes at the bottom. The pressure brought to bear on the pestle is regulated by a lever and weights. The yield of oil in *Chekku* crushing varies from 35 to 39 percent and the quality of oil is said to be superior inasmuch as the seed is pressed more or less cold-drawn and consequently mucilage and albuminous matter are not extracted.

(b) *Wedge press* : This consists of a stout wooden framework inside which planking and bags of oilseeds are arranged so that by hammering wedges in between the adjacent planks the seeds are pressed and the oil drained out.

(c) *Screw press* : This is met with in certain parts of India. The press consists of a number of iron plates which are placed in a horizontal column and worked by a screw and lever. The material for crushing is packed in gunny bags and placed between the plates which are then brought closer and closer to each other by working a wheel attached to the screw with a lever by human labour. The seeds are sometimes preheated before pressing or heated in the process of crushing by keeping a fire underneath the press. As a result of pressure, the oil exudes and drips below into a long metallic receptacle. Extraction by this process is very slow and laborious and the extracted oil has a dark colour.

(d) *Power-driven Chekku* : Sometimes these *Chekku*s are worked by power instead of bullocks. The principle involved in the construction of this is similar to the bullock *Chekku*, improvement however, being effected in speed and efficiency by slight modification in the working and using power.

(e) *Rotary iron mill* : This type of mill is a modern adaptation of the bullock *Chekku*. It is power-driven and consequently, is capable of larger turn-over than the wooden *Chekku*. The rotary mill is constructed entirely of iron and has the shape of the bullock *Chekku*. The main difference, however, is that in the rotary mills both the mortar and pestle revolve. Kernels are fed whole without preliminary grinding or heating and water is added during the process of crushing. The oil flows through a hole in the

mortar into a container from where it is conducted into a settling tank. The yield of oil in rotary mills ranges from 36 to 42. Rotary mills are said to be wasteful of power and their crushing efficiency especially as regards groundnuts, is generally low.

(f) *Expellers*: There are several kinds of expellers though essentially they all work on the same principle. The seed is introduced through a hopper and is carried forward by blades worked on the screw principle into a horizontal cage consisting of metal staves. The material so conveyed to the end of the cage is subjected to torsion force and ejected out after passing through the contracting cone. During this process the oil is expelled through the perforation of the cage. The meal is heated prior to pressing by being allowed to pass through a steam jacket or steam heated kettle. The yield of oil in expellers is about 40 to 44 percent. The oil acquires a somewhat yellow colour on account of the great heat developed during pressing.

(g) *Hydraulic press*: This is either the open or caged type fitted with a number of iron plates between which the meal moulded in the form of a cake and packed in wollen cloth is inserted and pressed by hydraulic pressure. The seed intended for crushing is first crushed in rollers and the meal treated prior to wrapping for promoting free and rapid flow of oil.

(h) *Solvent Extraction Process*: This is mainly used to extract the oil which still remains in the cake after extraction in the different types of oil mills already described. Acetone, benzol, carbon disulphide, carbon tetrachloride are some of the solvents commonly used. The process is not used in India for extracting oil from groundnuts or from groundnut cake.

11. **Storage**: Cultivators usually dispose of their groundnuts apart from quantities retained by them for seed and edible use within three or four weeks after harvesting, although some well-to-do ryots sometimes store nuts for longer periods extending upto three or four months. Nuts used for sowing have to be stored for seven to eight months while some of the nuts for edible purposes may be kept till the beginning of next harvesting season.

The storage is invariably in the form of unshelled nuts. Nuts for sowing are generally stored in earthen pots, mud bins, or in bamboo baskets or other wicker work receptacles which are often plastered with mud and cowdung. Gunny bags are also sometimes used, usually when quantities to be stored are small. After the receptacles have been filled with nuts, their mouths are not sealed as in the case of many other seeds. When bags are used their mouths are stitched and they are piled. Nuts kept in bags are more liable to damage by damp, rats and other storage pests as compared with those kept in tins. The nuts intended for sale are left on the threshing floor for a few days or stored loose, but seldom

in bags. No cover is usually provided. The floors of the rooms in which the produce is stored are generally made of hardened mud and sometimes of cement or stone slabs. The loss is mainly through dryage and damage by rats.

In the assembling markets, decorticating factories and oil mills the produce is usually stored in the form of nuts either loose or in bags. The period of storage may be very short, say about a week or two before being decorticated, or it may be stored for several months in anticipation of better prices. Besides storage in godowns, nuts are often heaped loose or stocked in bags in the open in places where rainfall is not heavy and in seasons when there is little danger of rain. The stacks are covered with tarpaulins. As kernels are more susceptible to damage than pods, nuts are decorticated only a week or two before they are sent to ports for export or mills for crushing. The kernels are therefore stored for comparatively short periods and the total quantity of kernels held in stock at a time is much less than nuts.

In the terminal markets and ports storage is in the form of kernels which are most often packed in gunny bags. Bulk storage of kernels is rarely met with. The pile of bags in the godowns is kept to 4 to 5 feet below the roof to allow free circulation of air, and matting is sometimes spread on the floor to prevent damage from damp. The period of storage of individual lots in most cases may not exceed two or three months. Sometimes it may be necessary to store kernels at ports for longer periods awaiting shipment. It is at these terminal markets and ports that maximum deterioration and damage to groundnut kernels occur.

A special scheme of research on the storage problems of groundnut was worked in Madras, and from the investigations carried out certain very useful results, of importance to trade were obtained. These are :

- i. Groundnuts are better stored as pods (nuts in shell) than as kernels.
- ii. If it is necessary to store groundnuts as kernels for long periods they should be thoroughly dried to bring the moisture content below 5 per cent.
- iii. Groundnut kernels intended for long storage should be obtained by proper decortication so that the percentage of 'splits' and 'brokens' is minimum.
- iv. Only kernels from winter crop (rainfed) should be stored for long periods. Produce from summer crop (irrigated) which has a poor keeping quality and 3 percent higher oil content should be utilised for immediate crushing.

- v. Groundnut kernels should be stored in clean, well-ventilated godowns.
- vi. Kernels should be stacked only on soft bedding material like sand. The bags should not be stacked to more than the height of ten bags. lest the bottom-most bags get caked up.

12. **Disposal of Produce:** Groundnuts produced in India are partly exported to foreign countries and the rest utilised in the country either as seed or for edible purposes or for extracting oil. Before the First World War a major portion of the groundnut produced in India used to be exported; but with the gradual expansion of the oil-crushing industry in the country, a larger proportion is being retained in the country itself as shown in the following:

Average for quinquennium in thousands of tons

Particulars	1909-10	1923-24	1928-29	1933-34	1938-39
	1313-14	1927-28	1932-33	1937-38	1942-43
Production (nuts in shell)	531	1532	2477	2822	3110
Export to foreign countries & Burma.	419	760	1218	1112	910
Retained in the country for seed, crushing etc.,	112	772	1259	1710	2200
Percentage retained in the country.	21	50	51	61	71

With the commencement of the Second World War, important overseas markets were lost. This, together with difficulties in shipping and transport facilities curtailed exports even to allied countries. The extensive demand for vegetable oil stimulated considerably the oil-crushing industry in India and resulted in the utilisation of substantial quantities which otherwise would have been exported outside India.

(a) *Requirement of seed:* The requirements of seeds vary in different areas according to the seed-rate which depends on the variety grown, whether it is grown pure or mixed with other crops, method of sowing, etc. Taking 100 lb. of pods or 72 lb. of kernels as the average seed rate per acre, the seed requirements for 1933-37 amounted to 322,000 tons of nuts in shell representing 12 per cent of the total production during the period.

(b) *Edible purposes:* The use of groundnuts for edible purposes is widely prevalent in India but statistics regarding the actual quantity consumed for this purpose are difficult to collect with any degree of accuracy. Rough estimates show that 188,000 tons or about 7 per cent of the total production are utilised for edible purposes.

(c) *Oil extraction*: With the expansion in the oil-crushing industry in India, increasing quantities are being crushed within the country itself. During the quinquennium 1933—38 the average quantity crushed is estimated to be about 8,40,000 tons of kernels equivalent to 12,00,000 tons nuts in shell or 42 per cent. of the total production. Madras State stands foremost, accounting for more than one third of the total quantity crushed, followed by Bombay and Hyderabad.

(d) *Export*: As stated already a considerable portion of the groundnuts produced in India used to be exported to foreign countries. From a bare 12,000 tons exported in 1900 the quantity gradually increased and in 1938, just before the outbreak of World War II, a record figure of 11,77,000 tons was reached.

In the earlier years of export, the biggest customer for groundnuts was France, which used to take about 80 per cent. of India's exports. Later, other European countries, chiefly Germany, Italy, Netherlands, Belgium and Spain came into the picture. The United Kingdom emerged as an importer of Indian groundnuts in 1933 after the Ottawa Agreement, which granted 10% preference for import of groundnuts from the Empire countries. In the quinquennium 1933—38 France continued to be the principal importer though her share was only about 22 per cent. Netherlands and United Kingdom contributed 20 and 17 per cent. respectively while Germany's share during the period was about 16 per cent.

13. *Uses of Groundnut*: The groundnut plant and its products find varied uses both in day-to-day life and in industries. A review of the numerous uses to which groundnuts can be put are given below:

(a) *Haulms*: Groundnut haulms are fed to livestock either in the green condition or after drying or after converting them into silage. The haulms are fairly nutritious (moisture 7.13%, ash 9.77%, protein 8.3%, ether extractives 1.39%, carbohydrates 38.06%) and cattle relish them. In certain parts of South India green haulms are also applied as green-manure for the paddy crop with beneficial results. The rate of application varies from about 1 ton to 2½ tons per acre depending upon the quantity available. An acre of groundnuts will yield about a ton of green haulms when raised under rainfed conditions and about 2½ tons when grown as an irrigated crop.

(b) *Groundnut shells*: The shell which forms the outer covering of the kernel and protects it from deterioration represents about 20 to 40 per cent. by weight of pods depending upon the variety, seasonal conditions etc. In some localities it finds ready use as fuel. Three tons of these shells are estimated to be equal to

1 ton of coal in fuel value. The shell ash is a valuable manure containing 1.5 per cent. potash and 3 percent. lime. Groundnut shells as such have no appreciable manurial value as do not decompose easily even when composted. However, they are sometimes applied to heavy soils, particularly to paddy lands under wet cultivation to improve the physical texture. Some quantity is also used as diluents in artificial fertilizers. As groundnut shells consist chiefly of crude fibre, they have little feeding value in themselves but frequently serve as filler in stock feeds. Groundnut shells are sometimes used as dunnage material in groundnut godowns.

Experiments carried out in the United States America to determine the suitability of shells for use in the manufacture of paper board show that they are not of much value, since only coarse boards can be produced with the shell. They might be used for the production of alpha-cellulose. Finely ground shells are often used for polishing tin plate. Recently a groundnut shell product is reported to be in use for clearing carbon from aircraft engines. It is also reported that groundnut shells could be processed into fuel, bedding and plastics and also they could be substituted for cork. Groundnut shell can also be used for preparing activated charcoal. Alcohol and acetone can also be produced by fermentation of the hydrolysed shells.

(c) *Kernels*: Groundnut kernel is widely acknowledged as a rich and cheap source of vegetable protein. Its food value can be seen from the analytical figures furnished below: (From "Health Bulletin No. 23. 1941")

Components	Percentage
Moisture	7.9
Protein	26.7
Fat (Ether extractive)	40.1
Mineral matter	1.9
Fibre	3.1
Carbohydrates	20.3
Calcium	0.05
Phosphorous	0.39
Iron	1.6 (mgm)
Vitamin A (International units per 100 gms)	63
Vitamin B do.	380
Calorific value per 100 gms.	349

The figures may vary somewhat from variety to variety and for the same variety grown under different conditions. The protein content ranges from 25 to 33 per cent, carbohydrates from 10 to 20 per cent, and fat from 40 to 50 per cent. Based on protein content alone one ounce of roasted groundnut may contain as much protein as in 1-1/3 oz. of dhal, 1-2/3 oz. of mutton, 2-1/2 oz. of eggs or 8 oz. of milk.

The protein in groundnut is easily digestible and of high nutritive value, approaching that of milk, meat and eggs; it is of the globulin type and consists of two globulins, arachin and conarachin. Conarachin is an excellent protein for growth, whereas arachin which makes up four-fifths of the globulin is very poor. Groundnut is also a good source of phosphorus and a fair source of iron.

Groundnut kernels contain Vitamins A, B (thiamin) and some members of the B₂ group (riboflavine and nicotinic acid). For nicotinic acid (the pellagra-preventive vitamin) it has been found to be a very good source by various workers. Recent work sponsored by the National Peanut Council at Southern Research Institute shows peanut food to be a good source of Folic acid, a B-vitamin which an important role in the prevention of pernicious anæmia.

Though groundnut is high in nutritive value, it would be difficult to take it as the principal ingredient in the diet because of its high oil content. Eaten in large quantities it is liable to cause biliousness. This can be over-come by eating kernels in small quantities at a time, preferably boiled and mixed with jaggery or starchy foods.

It is only in the United States of America that the high nutritive value of groundnuts seems to have been fully recognised. It forms a popular item in the daily menu of American houses. The per capita consumption is as high as 11 lb. per annum (1944 and 1945) whereas in India, which ranks first in the acreage and production of groundnuts, the per capita consumption is as low as 1-1/4 lb. per annum. A very large quantity of groundnuts is consumed in the roasted form or as 'salted peanuts', 'peanut butter', 'peanut candy', 'peanut brittle' etc. In fact, peanut butter is an article of commerce in the United States and its manufacture is one of the biggest food industries of that country. In order to popularise its use among the population recipes for the preparation of dishes and delicacies including groundnut as an essential ingredient have been widely publicised in America. The method of preparation of peanut butter is as follows.

Peanut Butter: Peanut butter is prepared by grinding roasted and blanched kernels to which about 1 to 4 per cent. salt is

added. To obtain a fine-flavoured type of peanut butter selected kernels of Spanish and Virginia varieties are blended. Clean raw peanuts are roasted in cylindrical roasters and then blanched during which operation the kernels are split into halves and the germs and skins are removed. The kernels are then fed into the hopper of a mill for grinding or crushing into butter along with sufficient salt. High grade peanut butter is reported to retain its sweetness and flavour for a long time under air-tight packing. The food value of peanut butter is high and it is also a rich source of vitamins.

In India groundnut is consumed mostly in the roasted form. In Bombay kernels are a favourite food during certain fasting days. In Madras raw kernels are eaten as such or by cooking in salted water. Sometimes chutney is prepared by crushing them with chillies, salt, cumin, etc. and water. A preparation called *Chiwda* used commonly in Bombay and other northern states is made by mixing parched or beaten rice with roasted grams, groundnut kernels and dried fruits. Kernels are also eaten fried and salted, and added in small quantities to a number of dishes in Madras and Bombay. Some of the Indian recipes using groundnut as an ingredient have been indicated by John, (1942).

In Indian medicine the kernels are said to be astringent to the bowels and that they cause flatulence and bronchitis. The unripe nuts are considered a good lactagogue increasing secretion of milk in mothers.

Groundnut milk and Curd: Preparation of milk from fresh groundnut is of recent origin. An exhaustive and useful article about this produce will be found in "Science and Culture", by G. M. Kelkar (1950).

Though groundnut milk is a novel preparation, there is every possibility of the public taking to it as the milk from groundnut compares favourably with that of cows and buffaloes, in nutritive value. Groundnut milk prepared in the Oilseeds Section on the following lines was found to be relished by many.

Kernels obtained by shelling fresh pods are soaked in water for about one and a half hours. The thin, pink seed coat covering the seeds is removed and the seeds are ground to a fine pulp in a grinding stone. Water is added to the pulpy mass, stirred for ten minutes and filtered through a fine cloth. The residue is again treated with water, stirred and filtered to obtain as much of milk as possible. The milk is white in colour, with a very faint odour peculiar to groundnut which, however, can be masked by the addition of a small quantity of ordinary milk or a few drops of flavouring essences.

Groundnut curd is prepared by adding a small quantity of buttermilk to boiled groundnut milk and keeping it overnight. The quality of the curd obtained compares favourably with that prepared out of cow's milk. It is worthwhile popularising this method of utilising groundnut kernels.

4. **Oil:** The oil is obtained by expression or solvent extraction from groundnut kernels. The methods of expression or extraction of the oil in vogue have already been described. Cold-pressed oil is pale yellow in colour having a faint agreeable odour and a bland taste like olive oil. Hot-pressed oil is always more deeply tinted. It compares very favourably with olive oil and can be substituted for it.

The average analytical characteristics of the oil are given below: (After Hilditch, quoted in "Wealth of India")

Specific gravity (15°/15°)	0·916—0·921
Refractive index, 15°	1·473
Setting point	0—3
Saponification value	189—196
Saponification equivalent	286—298
Iodine absorption per cent	85—98
Acetyl value	3—9
Combined fatty acids	{ Titre 23°—29°
	{ Melting point 27°—35°
Free fatty acids	{ Acid value 2—6
	{ As oleic acid% 1—3
Unsaponifiable matter (percent)	0·3—1·0
Hehner value (per cent)	95—96
Reichert—Meissl value	0·0—1·6

Groundnut oil belongs to the "non-drying" group of vegetable oils. Its fatty acid composition is as follows: (After Jamieson, quoted in "Wealth of India")

Saturated acids:	Per cent.
Palmitic $C_{16}H_{32}O_2$	8·3
Stearic $C_{18}H_{36}O_2$	3·1
Arachidic $C_{20}H_{40}O_2$	2·4
Behenic $C_{22}H_{44}O_2$	3·1
Lignoceric $C_{24}H_{48}O_2$	1·1
Unsaturated acids:	
Oleic $C_{18}H_{34}O_2$	56·0
Linoleic $C_{18}H_{32}O_2$	26·0

About the chemical composition of the oil Hilditch writes: "The presence of small proportions of arachidic, behenic, and lignoceric acids in addition to palmitic and stearic is characteristic of

this fat. Its glycerides are of the "evenly distributed" class with negligible fully saturated compounds and practically all the saturated acids in the form of mono-saturated di-"oleins". Trisaturated glycerides form about 45 per cent. of groundnut oil and include 25 per cent. of linodeodiolein and about 20 per cent. of triolein".

The oil is soluble in ether, chloroform and carbon disulphide, but only soluble to a slight extent in alcohol.

Groundnut oil is predominantly an edible fat. The oil is extensively used in cookery as a salad oil, and things fried in the oil are reported to have a pleasant flavour. Groundnut oil as seen from its free fatty acid composition is a good source of linoleic acid, the unsaturated fatty acid necessary for proper nutrition and growth. The cold-drawn, raw oil may contain some A and D vitamins which are however removed by refining. The fat is also easily digestible.

Groundnut oil as expressed from kernels is liable to contain mucilage and albuminous matter which produce turbidity in oil and also free fatty acids in varying amounts depending upon the quality of kernels crushed. Though the raw oil could be used as such for cooking purposes, it has got to be refined for use in margarine manufacture, as lubricant, etc., where neutral fats are essential. For margarine manufacture, the oil undergoes decolorisation also. Mucilage and albuminous matter are removed by treating the oil with Fuller's earth while the removal of free fatty acids is effected by alkali refining. For decolorisation super-heated steam is blown through the oil in a vacuum kettle. Treatment with Fuller's earth and alkali refining very often suffice for bleaching the oil also.

The bulk of the groundnut oil produced in the United States of America and European countries is used for edible purposes either as salad oil, or in the manufacture of margarine, lard compounds and vegetable cooking facts along with other vegetables and animal oils and fats. In India, the oil is used for culinary purposes for which the *Chekku* oil is preferred to that obtained in expellers and consequently commands a premium in the market. Considerable quantities are also consumed along with the more costly gingelly oil and rape and mustard oils which are frequently adulterated with groundnut oil. Another important outlet for groundnut oil is the Vanaspathi industry. Vanaspathi is a vegetable ghee substitute and groundnut oil forms the bulk of the raw material used in its manufacture. Some years back this product used to be largely imported from foreign countries but with the increased production of the same product in India, imports have largely ceased. Vanaspathi is manufactured from groundnut oil by hydrogenation. About 1,40,000 tons of oil is reported to be consumed by this industry. Margarine and vegetable ghee though they resemble natural butter and ghee in appearance and texture and may have more or less the same amount of fats, proteins and

calorific value, are totally deficient in vitamins. This deficiency is now being made up by the fortification of the artificial product with the necessary vitamins and minerals.

An indirect use for groundnut oil for edible purposes is in the preparation and preservation of canned sardines. As groundnut oil does not absorb odours and will stand higher temperatures than olive oil, sardines are cooked in groundnut oil and packed in olive or groundnut oil itself. Refined and deodorised groundnut oil has been found to be the best oil for use as a diluent for adding flavour to meat extracts.

Groundnut oil is used only to a limited extent in soap-making, though lower grades of the oil and the 'foots' or residues from the refining process are used in soaps as such or mixed with other oils and fats. The oil saponifies very easily and soap made from pure groundnut oil is of medium consistency, the colour ranging from white to buff. The original odour of the oil persists in the soap. The lather is medium to slow and is close and lasting. Of late hardened groundnut oil is being increasingly used in the manufacture of soap.

Groundnut oil also finds a limited use in the manufacture of cosmetics, shaving creams, pomades, cold creams, etc. The oil is also used in leather dressings and furniture creams. To a small extent it is also used in making candles.

In the manufacture of glycerine also groundnut oil can be used. The approximate percentage of available glycerine in groundnut oil is 9.8. It has also been found that groundnut oil could be made use of in preparing tallow substitutes. Groundnut oil also finds some use in the preparation of compound lubricants. Owing to its poor viscosity and liability to solidification at low temperatures its use by itself as a lubricant is very limited. But it has been reported that refined groundnut oil could be used as a lubricant even for the finest watches. In wool textiles industry it is being substituted to a large extent for costly, high grade olive oil for oiling the scoured wool fibres.

The scarcity of deisel oil during war time, gave considerable impetus to investigations on the possibility of using groundnut oil as a motor fuel in India. Tests carried out in Madras on five different makes of Deisel engines have shown that groundnut oil could be used in place of Deisel oils. The use of groundnut oil for lighting purposes is widely prevalent in India, though it gives only a feeble light.

Groundnut oil resembles olive oil in most of the characters and can be substituted for the latter. The British Pharmacopoea recognises groundnut oil as a substitute for olive oil in the preparation of liniments, plasters, ointments and soaps. This oil also

finds varied uses in the allopathic and ayurvedic treatment of diseases. In veterinary medicine groundnut oil is used as a nutritive, laxative, and emollient.

Groundnut oil emulsion has been used successfully for the control of many pests of plants. The emulsion has also been found to increase markedly the toxicity of the insecticides - derris, nicotine, nicotine sulphate etc.

5. *Cake* : The residue left after the expression of oil from groundnut kernels is called groundnut oil cake or *poonac*. There are two grades of groundnut *poonac* recognised in trade in India. The one is 'expeller' quality and the other the '*Chekku*' quality. The former is obtained when groundnut kernels are crushed in power-driven oil mills while the latter is the residual cake left after the extraction of oil in the indigenous wooden *Chekku* or *Ghani*. The quantity of itak cake obtained and its oil content depend upon the efficiency of extraction of the oil from the kernels. In *Chekku* or *Ghani* extraction about 62 to 65 per cent of the weight of kernels crushed will be left behind as cake, while in expellers about 55 to 60 per cent will be left as cake. *Chekku* cake naturally contains a little more of oil on account of incomplete extraction than the expeller cake.

Groundnut oil cake or *poonac* contains about 7 to 8 per cent nitrogen and is a very good organic, nitrogenous fertilizer. It is one of the richest oil cakes in respect of nitrogen and it also contains 1.5 per cent. P_2O_5 and 1.2 per cent. K_2O . It can be applied as manure for paddy, sugarcane, vegetables, bananas and other fruit trees. In Madras increases in yield ranging from 20 to 40 per cent have been obtained in paddy as a result of applying groundnut cake. To get economic returns 400 to 600 lb. of groundnut cake per acre can be applied in powdered form at the time of transplanting or at the time of first weeding. For sugarcane, an application of 15 to 20 cwts. per acre has been found to give maximum profits. The quantity may be applied in two stages of the crop growth. Groundnut cake also forms an ingredient of the mixtures marketed by various firms for different crops. For manurial purposes 'expeller' cake is generally preferred.

The importance of oil-cakes as a feed for work animals and milch cattle has been widely recognised. Of the various oil cakes used, groundnut cake takes the first rank as it is the cheapest of the oil cakes and contains a good amount of protein which is necessary for the building up of muscles and also for the production of milk. One ton of groundnut cake contains about 1,080 lb. of protein as compared to 407 lb. in cotton seed and 785 lb. in gingelly cake. Being a concentrated feed it is advisable to include only $\frac{1}{2}$ to 2 lb. of groundnut cake per head in the daily feed of cattle. Care should be taken to see that the cake is not rancid or contain too much of oil. Generally, for feeding cattle '*Chekku*' quality cake is preferred to the 'expeller' quality,

Cake obtained when solvents are used for the extraction of oil will be very low in oil content (1 to 2 per cent). Such cakes are used in European countries for producing compound cattle foods, by mixing with molasses, starchy materials etc., Powdered groundnut cake or meal is largely used in United States as a hog feed as it does not cause soft pork as when whole kernels are fed. The addition of groundnut meal to poultry feed stimulates egg-laying and aids in bringing chickens rapidly to marketable size.

Groundnut cake being very rich in protein can very well be used for human consumption, provided the cake is made from clean groundnut kernels under thoroughly hygienic conditions. It is said that groundnut cake reduced to flour will afford a well-balanced and palatable food for infants and adults. It is easily digestible and contains only comparatively small amount of carbohydrates and is therefore recommended as a suitable diet for diabetic persons. Groundnut cake meal also blends easily with wheat and other flours and is consequently made use of by bakers, confectioners, candy makers and ice-cream manufacturers. In European countries, especially in Germany, groundnut cake meal used to be incorporated into invalid and infant foods. In the highly advertised German food 'Nutrose', groundnut cake meal was an important ingredient.

Recent investigations carried out both in England and America have demonstrated the possibility of utilising the protein in groundnut cake for the manufacture of artificial fibres. This synthetic wool-like fibre has been named 'Ardil' in England. The successful development of a silk-like fibre from peanut meal at the United States Southern Research Laboratory in New Orleans, Louisiana, has also been reported.

Groundnut cake meal has also been found useful in the preparation of vegetable adhesives. Groundnut cake protein glue is already being used in the production of commercial ply-wood by some of the ply-wood factories in India. Its other uses may be in making laundry starches, sizing for paper and textiles, gummed tapes and in the manufacture of plastics.

'Arden' a commercial preparation of the groundnut, rich in the globulin 'arachin' when iodinated and fed to milch cows has been found to increase milk production by 35 per cent. and fat production by 54.1 per cent.

14. **Conclusion, with suggestions for improvement and development:** At present there is acute shortage of vegetable oils and fats in the world and the total supply available is said to be less than 75 per cent. of the quantity consumed before the war.

Most countries are devising ways and means to meet this shortage. India being the most important oilseeds-producing country in the world, should produce a sufficient quantity to meet her growing internal demand and also supply the requirements of other countries and thus maintain her reputation for oilseeds in the international markets. Restrictions on export of oilseeds to meet internal demand would affect agricultural economy and curtail foreign exchange which India needs at the present moment to obtain her requirements of capital goods. Undue restrictions on export may also drive away customers to obtain their requirements from other sources. Thus India may lose her trade in oilseeds in foreign markets and thereby become a loser in the long run.

The Panel on Oils and Soaps Industries constituted by the Government of India, after a detailed study of the problem has recommended increased production for various oilseeds based on the actual internal needs and export demand. In respect of groundnut, they have suggested an increased production of 5.4 million tons of pods for the whole of India for which the acreage will have to be increased to 12.6 millions acres if the existing methods of cultivation are continued. Recently the Central Planning Commission has fixed a target of 60 per cent. increased production over the present production for oilseeds to attain self-sufficiency. The share of Madras in the effort at increased production of groundnut has been fixed at 2.5 million tons.

To produce more groundnuts in this State, to meet the internal demand and to have a surplus for export purposes, it will be necessary to extend the existing area by more than 80 per cent. This would no doubt affect the production of food crops which are urgently needed to meet the food requirements of the State.

The present acreage of groundnut in Madras could be increased by 20 per cent without encroaching on the area under food crops. This can be achieved by introducing groundnut as a rotation crop in modan lands of Malabar and in the wetlands of most districts especially in the Cauvery, Godavari and Kistna deltas. Realising the importance of the crop, cultivators in these localities have already taken to its cultivation. Provided sufficient inducement and encouragement by way of water supply, supply of good seeds and loans for digging wells are given, the target of 20 per cent. increase over the existing area under groundnut will not be difficult to attain.

The average yield of groundnut in Madras is low (being 931 lb. per acre) when compared to the yields obtained in China, Mauritius and other countries. Therefore, attempts should be made to increase the acre yields in the existing areas and thus step up

production. The best way of increasing the yield of groundnuts would be to adopt scientific methods of cultivation on the following lines.

- i. Using high-yielding drought resistant strains evolved by the Oilseeds Section which are capable of giving more than 20 per cent. increased yields.
- ii. Adopting economic seed rates as it would result in maximum yield from the crop and ensure uniform quality of produce.
- iii. Judicious manuring of the groundnut with cattle manure (about 10 cartloads) and ash or with superphosphate (2 cwt.) and potassium sulphate (1 cwt.) over a basal dressing of cattle manure (5 cartloads).
- iv. Timely control of insect pests and diseases affecting the groundnut crop.
- v. Proper handling of the produce after harvest and efficient storage to prevent loss due to deterioration and damage by insects.

These instructions when followed by groundnut growers can increase the production by more than 40 per cent. Thus by a two-pronged drive for extension of the area and intensive cultivation on scientific lines it should be possible to attain the target of 60 per cent increase in the existing production of groundnut in the Madras State.

As regards the research work for the improvement of the groundnut crop only the fringe of the numerous problems connected with its cultivation and utilisation has been touched, particularly in India. Madras State being the most important groundnut-producing centre in the world, it should take a leading part in the study of these problems. In this connection it may not be out of place to mention that the attention so far given to the groundnut either by the State or the traders in this country is not in keeping with its international importance. It is high time the authorities realised the great importance of groundnut and did something immediately to intensify research on crop improvement and utilisation aspects with adequate technical staff, equipment and other facilities. If we are to make any real progress in improving the crop, there should be a special wing in the Agricultural Department of the State in charge of a qualified specialist to control and guide this important work. It is my earnest hope that those interested in the advancement of our country should strive to strengthen the research work on this very useful plant, which rightly deserves to be called the 'Wonder Plant of the Century.'

APPENDIX I
Classification of Groundnut varieties and forms

Characters of Classificatory value

Habit of growth (1)	Testa colour (2)	Kernels, nature of (3)	Size of pods (4)	Type (5)	Other allied and synonymous forms (6)	Similar types described by previous workers (7)
<i>Forms under Arachis hypogaea var. oleifera</i>						
Erect	Rose	1-3	Tiny	Type erecta.	Spanish 10, Macspan, Casilda 5, Florida II, III and IV	'Manchurian' type of Luzina.
Bunch	Light rose	1-2	Very small	Volette		
"	"	1-2	Small	Gudiyatham bunch	Valencia white, Sanjose (Philippine) Reconquista 6	'Spanish' type of Luzina
"	"	1-3 occasional	Medium	Java 2.	North Carolina Peanut, Javs 1, 3, 4, 5; Spanish (Philippine); Improved Spanish 213, Akola 24.	'Java' type of Luzina.
"	"	1-4	Small	Corrientes 1	Cordoba 2	
"	"	1-4	Medium	Tennessee White.		
"	Rose	1-3	Big	Akola 10	Valencia Peanut, Bunch Mozambique Spanish Bunch (Salisbury Virginia Bunch (Tanganyika) Tennessee Red, Cordoba 4, Monteco Seros, 7, 8.	'Valencia' type of Luzina.
"	Red	1-2	Small	Small Japan		
"	"	1-4	Medium	Kumavu		
Bunch	Dark purple	1-4	Medium	Corrientes 3		
"	"	1-4	Big	Porto Alegre		
Semi-spreading	Rose	1-2	Small	Gumitam Budda		
"	"	1-2	Medium	Spanish (Bombay)		
"	"	1-3	Medium	Native Tanganyika	H. G. 1, Virginia White Bunch	This approaches Luzina's 'African' type.
"	"	1-3	Big	Virginia Bunch (Salisbury)		

APPENDIX I—*contd.*

Characters of Classificatory value						
Habit of growth (1)	Testa colour (2)	Kernels, nature of (3)	Size of pods (4)	Type (5)	Other allied and synonymous forms (6)	Similar types described by previous workers (7)
Spreading	White	1-3	Medium	Philippine White		
"	"	1-2	Very small	Longa	Esol.	
"	"	1-3 (3 occasional)	"	Wild Falcon A	Wild Falcon B	
"	"	1-2	Small	Local Mauritius	Sogathur, Mozambique, Mauritius Gooty.	
"	"	1-3	"	Bassi	Zaria, Gambia, Phillip-pine Pink.	
"	"	1-3	Medium	Big Japan	Kalahasti, Virginia, Runner, Carolina, Chiba, 63, Chiba 73, Transvaal, West African, Madagascar, Barbados, Ceylon, Rufisque Senegal, Senegal, Local Pondicherry.	
Spreading	Rose	1-3 (3 occasional)	Big	Texas	Rangoon, Virginia, Running Peanut, Mauritius Virgini, Jembo Runner.	Nearly answers the description of the 'Peru' type of Luzina.
"	"	1-3	Big	Mesumbika.		
<i>Other varieties of Arachis hypogaea.</i>						
Semi-spreading	Rose	1-4	Small	Kurumani	Var. asiatica.	Identical with the 'Khasgar' type of Luzina.
"	(Testa ruptured)	1-2		Var. nambyguarae		
Spreading	do.	1-2	Big	Var. rasteiro.		
Trailing	Rose	1-2	Small	Var. gigantea.		

APPENDIX II

Note on Groundnut strains under distribution in Madras State

T. M. V. 1 (A.H. 25): A mass selection isolated from the West African form 'Saloum'. Plants vigorous with spreading habit of growth. Gives more than 25 per cent increased yield over the local (Local Mauritius). The strain is also drought-resistant. *Leaflets* small, dark green, *Pods* medium sized, 1-3 seeded, 3-seeded very occasionally. *Beak* prominent. *Veins* not distinct, *Constriction* shallow, *shell* medium thickness. *Kernels* medium, rose, oblong, somewhat plump, dormant. *Duration* 135 days.

Average acre yield of pods	1,450 lb.
Proportion of kernels to pods	73.5%
Weight of 1 M. M. of pods	1 lb.-4 oz.
Weight of 1 M. M. of kernels	2 lb.-11½ oz.
No. of kernels per pound	959
Oil content of kernels	49.0%

T. M. V. 2 (A.H. 32). A mass selection from the 'Spanish' type grown extensively in North Arcot, Guntur and other districts of Madras State. A short duration (105 days) type with bunch habit of growth. Cannot stand long periods of drought. *Leaflets* large, light green. *Pods* small 1-2 seeded, *Beak* distinct, *Veins* distinct, *constriction* shallow to medium, *shell* very thin. *Kernels* very small, light rose rounded plump, non-dormant.

Average acre yield of pods	1,025 lb.
Proportion of kernels to pods	76.7%
Weight of 1 M.M. of pods	1 lb.-5½ oz.
Weight of 1 M.M. of kernels	2 lb.-13¾ oz.
No. of kernels per pound	1,470
Oil content of kernels	49.4%

T. M. V. 3 (A.H. 698). A pure line isolated from the West African form 'Bassi'. Plants vigorous with spreading habit of growth, gives more than 30% increased yield over the local (Local Mauritius). *Leaflets* small, dark green. *Pods* small 1-3 seeded, 3-seeded very occasionally. *Beak* not distinct (rounded) *Veins* distinct, *Constriction* shallow, *shell* very thin. *Kernels* small, rose, rounded not plump, dormant; *Duration* 135 days.

Average acre yield of pods	1,450 lb.
Proportion of kernels to pods	76.8%
Weight of 1 M.M. of pods	1 lb. 6½ oz.
Weight of 1 M.M. of kernels	2 lb. 12 oz.
No. of kernels per pound	1,150

T. M. V. 4 (A.H. 334). A pure line isolated from the American form 'Carolina'. Plants vigorous with spreading habit of growth, gives an average increased yield of 30% over the local (Local Mauritius). *Leaflets* small, dark green. *Pods* medium sized, 1-3 seeded, 3-seeded many; *Beak* prominent; *Veins* not distinct; *constriction* shallow to medium; *shell* thin. *Kernels* medium to small, rose, elliptic, not plump, dormant. *Duration* 135 days. Comes up well even under irrigation and hence recommended for irrigated cropping during summer (Feb-July).

Average acre yield of pods	1,425 lb.
Proportion of kernels to pods	75.5%
Weight of 1 M.M. of pods	1 lb.-4½ oz.
Weight of 1 M.M. of kernels	2 lb. 11½ oz.
No. of kernels per pound	940
Oil content of kernels	50.4%

T. M. V. 5 (A. H. 6481). A selection from a cross between the local bunch and 'Native Tanganyka'. Has a bunch habit of growth with short duration (110 days). Gives more than 15% increased yield over the local bunch. *Leaflets* medium, green; *Pods* medium, 1-2 seeded; *Beak* prominent; *Veins* prominent. *Constriction* shallow, *Shell* medium thickness. *Kernels* medium, rose, elliptic, somewhat plump, dormant.

Average acre yield of of pods	1,250 lb.
Proportion of kernels to pods	76 0%
Weight of 1 M.M. of pods	1 lb. 4½ oz.
Weight of 1 M.M. of kernels	2 lb. 13 oz.
No. of kernels per lb.	1,058
Oil content	49%

Note:— M. M. = Madras measure.

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A Note on the Behaviour of Three Inter-Racial Hybrids in *Gossypium Arboreum* L.

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Introduction: Since 1937, detailed studies were undertaken at Coimbatore towards a comprehensive understanding of the effects, and basis of the phenomenon of heterosis in all the four cultivated species of *Gossypium*; (Santhanam, 1951; unpublished*). This note records the observations made on three inter-racial hybrids in *G. arboreum* L. during 1950 - '51 in continuation of this programme of work.

The cultivated cottons of the Old World group fall under either of the two species *G. arboreum* L. or *G. herbaceum* L. The former is separated into six geographical races, *burmanicum*, *indicum*, *bengalense*, *cernuum*, *soudanense* and *sinense* (Silow, 1944; Hutchinson, 1947).

Materials and Methods: The following parent types figure in the crosses studied now:

1. NR 5 (*G. arboreum* race *bengalense*) — A selection from Khandesh cotton obtained from Jalgaon (Bombay).
2. Burma C 19 (*G. arboreum* race *burmanicum*) — A variety obtained from Burma.
3. Cernuum Garohills (*G. arboreum* race *cernuum*) — A variety of hill cotton obtained from Garohills district in Assam.
4. N. M. Dollar (*G. arboreum* race *sinense*) — A reselection from Million Dollar of China obtained from Bombay.

The yield and quality attributes of the parent types are included in Table I.

The following three inter-racial crosses were studied for their F_1 behaviour as compared with the constituent parental attributes.

1. NR 5t x Cernuum (*bengalense* x *cernuum*)
2. Burma C 19 x Cernuum (*burmanicum* x *cernuum*)
3. N. M. Dollar x Cernuum (*sinense* x *cernuum*)

The F_1 hybrids and the respective parent types were raised in replicated plots adopting the randomised progeny row design of Hutchinson and Panse (1937). The total variants were seven and the experimental area comprised of single-row plots of five holes each, replicated 4 times with 18 degrees of freedom for error.

Observations were recorded on final growth in terms of height (c.m.) and number of nodes produced, position of first sympodial node, flower and boll production; yield of kapas (gm.), combed halo length (m.m.), lint index in gm. (weight of lint obtained from *kapas* sample containing 100 seeds) and seed index (weight of 100 seeds in gm.).

The experimental results were analysed statistically and the numerical differences in values between the first generation hybrids and corresponding parents tested for significance (Fisher 1938).

Plot totals were used for the analysis of variance of flower and boll production and yield of *kapas*. In the case of other attributes mean values per plant were worked out and analysed.

The differences of the F_1 values from the average of the constituent parental values was studied in comparison with the difference of F_1 from the 'higher' parent. Heterosis was finally interpreted on the basis of significant transgression of the 'dominant' parent.

Experimental results: The results of observations are furnished in Table I.

TABLE I.
Performance of inter-racial hybrids in *G. arboreum*.

(1)	Mean values			Diff. of F_1 from higher parent	Critical Diffce.	Signifi- cance for heterosis
	F 1 hybrid	Ovule parent	Pollen parent			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
I. Height in cm. :						
1. NR 5 x Cernuum	46.6	40.5	34.2	+ 6.1	15.9	No
2. Burma C 19 x ,,	40.0	31.6		+ 5.8		No
3. N. M. Dollar x ,,	58.8	55.1		+ 3.7		No
II. Nodes :						
1. NR 5 x Cernuum	22.7	22.2	21.7	'F' test not satisfied		
2. Burma C 19 x ,,	22.8	24.2				
3. N. M. Dollar x ,,	22.8	23.4				
III. First sympodial node :						
1. NR 5 x Cernuum	6.2	6.6	7.1	'F' test not satisfied		
2. Burma C 19 x ,,	7.1	7.3				
3. N. M. Dollar x ,,	6.1	5.7				
IV. Flower production :						
1. NR 5 x Cernuum	32.7	32.8	11.5	- 0.1	9.8	No
2. Burma C 19 x ,,	41.3	42.8		- 1.5		No
3. N. M. Dallar x ,,	32.9	22.8		+ 9.2		No
V. Boll production :						
1. NR 5 x Cernuum	22.3	16.1	6.8	+ 6.2	9.9	No
2. Burma C 19 x ,,	29.0	23.0		+ 6.9		No
3. N. M. Dollar x ,,	21.8	11.1		+ 10.7		Yes
VI. Yield of kapas in gm.						
1. NR 5 x Cernuum	41.9	34.6	10.8	+ 7.3	19.7	No
2. Burma C 12 x ,,	49.2	23.3		+ 25.9		Yes
3. N. M. Dollar x ,,	43.8	15.9		+ 27.9		Yes
VII. Halo length in m. m. :						
1. NR 5 x Cernuum	18.8	14.7	19.8	- 1.0	1.8	No
2. Burma C 19 x ,,	20.1	19.0		+ 0.3		No
3. N. M. Dollar x ,,	22.0	21.8		+ 0.2		No
VIII Lint index in gm. :						
1. NR 5 x Cernuum	3.57	4.24	2.63	- 0.67	0.48	No
2. Burma C 19 x ,,	2.98	2.79		+ 0.19		No
3. N. M. Dollar x ,,	3.09	2.24		+ 0.46		No
IX. Seed index in g. m. :						
1. NR 5 x Cernuum	5.72	5.87	4.56	'F' test not satisfied		
2. Burma C 19 x ,,	5.02	5.29				
3. N. M. Dollar x ,,	6.51	7.52				

In final growth reckoned as height, although all the three F_1 hybrids have recorded uniformly higher values than either parent, the level of statistical significance has not been reached. The total number of nodes produced at maturity, the parent types and hybrids do not differ from one another. Similarly in the case of first sympodial node also, the 'F' test is not satisfied.

Among the productivity characters studied, consistent trends towards increase in F_1 are observed in the number of bolls produced and yield of *kapas*. The N. M. Dollar x Cernuum F_1 hybrid exhibits significant heterosis in both boll production and *kapas* yield, while the Burma C 19 x Cernuum hybrid shows significant transgression in the latter attribute only.

Heterosis effects are not observed in halo length, lint index or seed index.

Discussion: The parent types utilised in these crosses represent four different geographical races within *G. arboreum* L. However, of the nine attributes studied in the three inter-racial hybrids and respective parents, heterosis effects are observed only in yield characters in two of the hybrids, viz. Burma C 19 x Cernuum and N. M. Dollar and Cernuum. The intra-species differentiation in *G. arboreum* has been shown to be of a low level due to the late establishment of divergent selection trends and the incomplete and sometimes transient geographical isolation (Hutchinson and Silow, 1947). Hence it is probable that there exists low genetic diversity between the parents in most of the characters studied excepting the productivity attributes, thus accounting for the general absence of significant heterosis effects in the former. Yield being the most important character subjected to continuous and conscious as well as unconscious selection pressure, it is quite likely that the parent types have accumulated different complexes of modifier genes favourable for high yield. Still another feature to be considered is the influence of environment on the expression of heterosis effects in crosses between parent types new to the place of study. Further studies have been programmed in this direction.

Summary: Observations were made on three inter-racial hybrids in *G. arboreum* L. for heterosis effects, if any, in nine attributes.

The *sinense* x *cernuum* and *burmanicum* x *cernuum* first generation hybrids exhibited significant heterosis in yield of *kapas*, while the former showed significant transgression in boll production as well.

Low level of intra-species differentiation in *G. arboreum* and influence of environment new to the parents involved are suggested as possible causes for the non-significant levels of heterosis expression.

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A Note on Fruit-Cracking in Arecanut

The arecanut palm is susceptible to many pests and diseases and remedial measures have been evolved in the case of a few. Nambiar (1949) mentions a phenomenon characterised by the cracking of fruits on the tree, known as *Anduodakke roga* prevalent in Mysore. This is noticed in Ponnani taluk of Malabar District also, where it is known as *Achikeeral*.

Preliminary surveys conducted in three representative gardens show that fruit-cracking occurs to the extent of about three per cent in the Ponnani taluk. The trees showing the symptoms are generally very healthy. When the nuts are half to three-fourths mature, they crack at the tips and split longitudinally towards the base exposing the kernals which also sometimes crack and as a result become malformed. All the nuts in a bunch and all the bunches on a tree in turn succumb to the cracking which occurs on the same tree year after year. From a random survey made in three gardens comprising 2,350 trees it was noted that the affected trees are not confined to any particular level, situation or soil which is typical lateritic loam having sufficient drainage throughout. The age of the trees also does not appear to have any influence on its incidence, as it varies from 12 years to 25 years.

Measurements were made of 20 trees at random for girth of stem at three feet above ground level, and three feet below the crown, number of fronds and maximum cross-sectional width of the nuts including the pericarp and that of the kernels from which the thickness of the rind (pericarp) was arrived at, in the case of both affected and healthy trees.

These measurements showed that the affected trees had a better development in growth and number of fronds, but the fruits in two out of the three gardens had thinner rinds and a greater development of the kernels.

An interesting observation made in the course of study is that splitting of the peduncle by a sharp knife so as to form a clean slit four to five inches in length along the length of the peduncle in the middle and running through its entire thickness considerably brings down the number of cracked fruits. The splitting is done when the nuts are about half-mature, that is about five months after the bunch has emerged from the enclosing spathe. The same effect is also noticed when the peduncles are forcibly bent so as to effect partial crushing of the tissues. Presumably the flow of the sap is partly arrested in these processes. The contributing causes of the cracking would appear to be hyper-nutrition or a sudden flush of water after a period of drought or restricted water supply which upsets the rhythm of development as between the pericarp and the tissues within. Such disharmony in growth between the pericarp and kernel may result also when the normal ratio between the chromosomal complements of these parts get upset by genetical causes (Uttaman 1949). These points have to be confirmed by further trials and it is hoped that the observations recorded herein would help future investigators in this field.

Our thanks are due to Sri P. Uttaman, Assistant Paddy Specialist, for help and criticism.

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Research Note

A Gigas Form of the Coconut

(*Cocos nucifera* Linn., var. *typica* Nar. f. *gigantea*)

The coconut palm has been cultivated by man from very ancient times and many so-called varieties are found in the tropical countries of the world. Narayana and John (1949) made a systematic study of the coconut and described five distinct varieties and eleven forms of the coconut. Var. *typica* or the ordinary, tall-growing coconut is the most cosmopolitan variety met with in all coconut-growing countries of the world and comprises nine recorded forms. Of these, f. *gigantea* originally obtained from the Andamans has many outstanding features exhibiting what may be called 'gigas' characters; it is a majestic palm with massive proportions, looking very much bigger than the ordinary coconut tree of the same age. The origin of this form is not known. However, it is not a representative of the general population of the coconut trees in the Andamans and is possibly an isolated type.

The following are the measurable characters of f. *gigantea* (age about 26 years) as compared with those of ordinary var. *typica* of the same age and situation at the Coconut Research Station, Pilicode, South Kanara.

Characters of f. *gigantea* and var. *typica*.

	f. <i>gigantea</i>	var. <i>typica</i>
	(Single tree)	(Mean of No. of trees)
1. Age at first flowering	8 years	10 years
2. Girth of trunk at base	114 cms.	73 cms.
3. Length of trunk	10.16 metres	7.41 metres
4. No. of leaves in the crown	35	24.
5. Length of leaf (mean)	6.11 metres	4.30 metres
6. Length of petiole (mean)	1.52 metres	1.19 metres
7. Longevity of leaf in days (mean)	856	706
8. Length of spathe (mean)	1.18 metres	1.07 metres
9. Mean production of female flowers per tree, per year	199	320
10. Mean production of male flowers per spadix	5077	4062

	<i>f. gigantea</i>	var. <i>typica</i>
	(Single tree)	(Mean of No. of trees)
11. Setting percentage (mean) (i. e. percentage of the number of nuts set to number of female flowers produced)	13.13	20.28
12. Yield of nuts per year (mean)	26	64
13. Quantity of water or milk in tender nut	500 c.c.	300 c.c.
14. Weight of unhusked nut	1786 gms.	1134 gms.
15. Weight of husked nut	878 gms.	454 gms.
16. *Volume of unhusked nut	6900 c.c.	2264 c.c.
17. *Volume of husked nut	800 c.c.	465 c.c.
18. Thickness of husk	1.29 cms.	1.21 cms.
19. Copra content per nut	180 gms.	159 gms.
20. Percentage of oil in copra	67.1	71.6
21. Yield of juice (toddy) per day per palm	nil	899 c.c.
22. Size of pollen grains	53· μ	54· μ
23. Percentage of fertile pollen grains	76.01	95.27
24. Size of stomata (L x B)	41·x 18· μ	43·x 17· μ
25. Number of stomata per sq. mm.	180	151

Note: * Under Pilicode conditions the size of the nut is much less than in the Andamans.

It will be seen from the table that *f. gigantea* is much larger-sized in all the vegetative characters than var. *typica*. Particular attention is drawn to the girth of the trunk, the length of the leaf and the petiole. Also the volume and weight of the husked and the unhusked nut, the quantity of milk in the nut, the copra content, the production of male flowers and the number of stomata per sq. mm. are more in *f. gigantea*. In all these characters, *f. gigantea* has much higher values than var. *typica* proper. Therefore it may be taken as an instance of gigantism. Many instances of gigantism in plants consequent on polyploidy have been recorded by Darlington, Chandrasekharan and others. At the same time it is also known that gigantism is not always a result of polyploidy. Hayes (1915) mentions an instance of a gigas form of tobacco brought about by gene mutation. To decide this the chromo-some number of *f. gigantea* was determined by examining the

metaphase plates of pollen mother cells. But the number is 16 only (n), the same as in the ordinary var. *typica*. It is therefore, inferred that f. *gigantea* is not a polyploid and that the phenomenon of larger size is only a different phenotypic expression of the same chromosome complement brought about possibly by a change in the genic make-up consequent on cross pollination which is of common occurrence in the coconut, and it is likely that the dominant factors for increased size co-exist in this form.

In this connection, it may be stated f. *gigantea* is not an economic form. It will be seen from the table that the number of female flowers produced, the setting percentage, the yield of nuts and the percentage of oil are all lower in f. *gigantea* than in var. *typica*. The quality of copra also is inferior to that of var. *typica*. The yield of juice or toddy is practically nil. This is because the spathe is so tough that it cannot be 'beaten' and tapped so as to induce the flower of juice, as in the ordinary coconut. But one outstanding feature of f. *gigantea* is that it is highly resistant to pests and diseases and, therefore, it can be made use of in crossing work to produce resistant progenies.

This form of coconut, however, does not seem to have been studied by any previous worker.

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The Agricultural Five-Year Plan

A meeting of the students and officers of the Agricultural Research Institute was held in the Freeman Hall on 5th March 1952 between 5 and 7 P. M. Seventy officers and ninety-five students were present. Very keen interest was evinced in the five-year plan, especially by the students.

The Principal, Sri P. D. Karunakar, introduced the subject, sketching the broad outlines of the five-year plan. Sri S. V. Doraiswami Iyer, Lecturer in Agricultural Economics then explained the plan more particularly, from the economic aspects pertaining to Agriculture. After this introduction, the members of the audience were called upon to take part in the discussion, a student alternating with an officer in offering their remarks, criticisms and suggestions on the plan. One of the speakers was a District Agricultural Officer, who happened to be visiting the Institute, at this time and he spoke on the aspect of the implementation of the plan.

A summary of the main remarks and criticisms that were brought out during the discussion, is given below :—

Practically all the speakers stressed in fact that the co-operation of the people, was vitally necessary for the success of the plan. In fact it was stated that without such co-operation, the plan would be wrecked. The people, mainly those administering the plan, as well as those for whom the plan is administered [namely, the men in the street, have to be of high character and possessed of missionary zeal. Since the amount involved is colossal, coming to nearly 1,500 crores, if there is any corruption in the administrators, the money will be wasted and the plan will not work.

Co-operation of the masses is perhaps even more vitally necessary and this largely depends upon selling the idea to the masses. There is always a mental resistance to any proposal that emanates from the Government, good, bad, or indifferent. Naturally, this plan will also meet with resistance, unless the masses understand what it is all about; and are fully convinced that it is for their benefit. Any amount of legislation and force cannot bring success to the plan. In our democratic republic, the Government will have to carry the masses with them by education in the plan, and never by compulsion.

Agricultural Price Policy: There was considerable criticism regarding the proposal in the plan to increase food production to the desired level *pari passu* with increase in production of commercial crops by adjustment of prices and by affording various facilities such as water, manure etc. The criticism was that the facilities offered are equally applicable to commercial crops, as for grain crops. The price incentive on the other hand would work towards creating further inflation in the country, over and above what exists at present. There was also a suggestion of physical planning of crop patterns by legislation. This action, it was argued, can be achieved only in a totalitarian country. The psychological aspect of people's reactions to legislation for anything and everything should also have serious consideration. There is a fear, an active and real fear, that legislation for such purposes as in the case of social subjects, is operable only in a totalitarian Government.

Redistribution of land: Considerable doubt was expressed as to the ability of the administration to gauge the minimum economic holding. It was expressed that a unit of economic holding is now determined upon Western standards. In India it is entirely different, since the ryot owning a small area works in the land when work is needed; at other times he either hires himself out or attends to some cottage industries. This fact of his extra emoluments other than from the land is usually lost sight of, in determining the unit of economic holding under Indian conditions.

Granting all the above, the proposal of the plan is for redistribution of land to those having small holdings by (a) redistribution of land beyond a certain ceiling to be hereafter fixed by the Government; (b) redistribution of land newly reclaimed. All these proposals were condemned on account of the fact that such redistribution can never possibly be contiguous to the present holdings. It can be only at some distance from the present holdings. Hence the time spent in going from one piece of land to another has to be reckoned in the economics of such farming.

The third proposal for increasing the holding is that of collective farming. Perhaps this came in for more criticism than any other proposal of the five-year plan. It was stated that collective farming has never been a success anywhere in the world except to some extent in Israel. Israel, it was pointed out, cannot be taken as a model of collective farming, since various conditions, such as fear of external aggression, flow of money from Jewish sympathisers, etc., all demanded this pattern of life in that country. Even under a totalitarian Government this idea of collective farming was found unworkable. It was also pointed out that in the hearts of Indians, the love of land and the love of possession of land has developed perhaps to a greater extent than in any other nation. It is common knowledge that most of the murders committed in rural areas arise out of disputes about land. That being so, asking the farmer to cultivate his neighbours' lands for the good of the State is more Utopian than practicable.

Village Councils: Again, it is proposed to legislate for compulsory cultivation of fallow lands, to force the farmers to adopt scientific methods of cultivation, develop their farms into efficient units of production, agree to sell seeds and grains to Government, ensure adequate wages and terms of employment to the Agricultural workers employed. The village councils are to be vested with legislative authority, to enforce these points. It was the general opinion of the house that this action smacks of totalitarian methods. Agriculture in our country is not a profession, but a way of life and when legislation is used to channelize it, it means that the State is interfering in the peoples' way of life. There was an unanimous opinion that no State can stand divided against its people. Hence the house wished to warn the Government against the use of force and interference in the way of life of the people.

Controls: It was the opinion of the house that controls must go. Gandhiji had the correct idea in maintaining that if all controls were removed, after a certain period of suffering the country will adjust itself. In support of this, it was stated that one has only to go just outside the borders of a rationed area to obtain any amount of rice of a superior

quality and not very much higher in price than the control rates. It is also open for anyone to observe how the railway trains are used for transportation of rice into rationed areas. One has to travel in the line from Madras to Waltair in a day-time passenger train to see the number of people (most of them without tickets) carrying on their heads, bags of rice. If there is so much rice available in the country for black marketing, there is something wrong with the idea of insufficiency of food grains and the necessity for controls.

Finance: Considerable criticism was expressed against the method of financing the plan, the main one being that the greater the loan raised the greater will be the inflation in the country. It was also expressed that the subscription to loans depend upon the acceptance of the plan by the people. There was considerable doubt whether this would be a success in the context of the fact that the plan is riddled with totalitarian methods. If a loan is obtained from foreign countries, it was the opinion of the house, that the Government will be mortgaging the country and selling out the birthright of the people.

Sri Ramunni Menon, I. C. S., Chief Secretary to the Government in introducing the chapter of "The Plan and the People" quoted Thoreau that, "That Government in the best which governs the least" This axiom is true for all times.

The only one point that received the approbation of the house was that the unit of implementation of the plan was the village. There was a general agreement that this was the correct view.

The Principal, summed up the arguments and concluded the meeting at about 7 P. M.

News Letter

Madras Uganda 1 Cotton as Mixed Crop with Rainfed Paddy: The area under rainfed paddy in Chingleput district is about 1½ lakhs of acres and the paddy crop in this area often fails due to the precarious rainfall. Madras Uganda 1 cotton tried as a mixed crop with rainfed paddy at the Rice Research Station, Tirurkuppam was a success as the crop when dibbled in lines 16' apart gave an acre yield of 109 lb. of kapas, when the paddy crop completely failed. The cultivation of this crop mixed with rainfed paddy will ensure a steady income, even in seasons when the paddy crop proves a failure.

Cotton in Rice Fallows. A simple method to improve germination: Growing the early Punjab variety of cotton after harvest of paddy in Tanjore, South Arcot, and Chingleput districts have proved to be profitable. It is advisable to sow the cotton seeds within a week after the harvest of paddy taking advantage of the existing moisture in the soil. A tip to improve germination and population of plants is described below:

Secure cylindrical wooden pegs six inch long, $\frac{3}{4}$ inch in diameter (2½ inches in circumference) with one end prepared to a conical shape up to one inch. Make depressions up to a depth of one inch with the conical end, six inches apart in rows, spaced two feet apart. Drop two to three good cotton seeds in each depression and cover the seeds with a handful of wet loamy soil (Vandamannu).

Do not cover the seeds with the soil from the paddy field itself if it happens to be clay as covering the seeds with such a sticky soil tends to produce a cementing action by which the emergence of the germinated seeds is inhibited.

Results obtained: By covering with wet loam 93 per cent of the holes had plants on the fifth day of sowing whereas only 49 per cent of the holes had plants when the clayey soil of the paddy field was used for covering. Thus 44 per cent extra stand is obtained by practising the above method of sowing which will materially contribute to extra yield as well. Hence, ryots growing cotton in rice fallows are requested to practise the above mentioned method of sowing with benefit to themselves, in the shape of extra stand and additional yield that will accrue from this.

An improved juicy-stalked "Talaivirichan" Cholam selection (A. S. 7657). "Talaivirichan" cholam is one of the major varieties of cholam grown in this State grown chiefly in the districts of North Arcot, Chittoor, South Arcot, Eastern portions of Salem, North eastern portions of Tiruchirappalli and the hilly tracts of Vizagapatnam and East Godavari. As the Tamil name indicates, it has loose panicles. The stalks of this variety are very coarse, insipid and pithy and are not relished by cattle so that the straw is generally used only for thatching or as fuel.

By hybridisation, it was possible to evolve a type of Talaivirichan with sweet and juicy stems. In yield trials conducted at the Millet Breeding Station, Coimbatore, its grain yield was better than the standard strains, Co. 3, of this variety. Its straw yield was equal to the standard but it had the advantage of being juicy.

This juicy-stalked Talaivirichan cholam (A. S. 7657), was analysed for its juiciness and sweetness in comparison with existing strains of Talaivirichan cholam with pithy stalks (viz.) Co. 2 and Co. 3. The data obtained are presented below.

Selection No.	'Juice extraction' percentage on weight of canes	Percentage of total sugars on weight of canes
1. A. S. 7657 (Extracted juicy type)	22.5	0.93
2. Strain Co. 2	10.0	0.47
3. Strain Co. 3	7.5	0.37

It will be seen that the straw of A. S. 7657 is more juicy and sweet than the usual *Talaivirichan* cholam. This selection is undergoing further yield tests and feeding trials at the Millet Breeding Station, Coimbatore.

Increasing the acre-yield of ginger: From an observational trial with 900 lb. seed-rate per acre of ginger (100 pieces of rhizomes weighing two lb., planted in each bed, 20' x 3' and 100 pieces weighing three lb. planted in each bed, (20' x 3') carried out at the Agricultural Research Station, Ambalavayal, Wynaad, it has been found that the seed-rate of 1,350 lb. per acre give an increased yield of about 3,500 lb. per acre over the yield obtained by adopting the lesser seed rate, or a net increased yield of over 3,000 lb. per acre. The acre yield of ginger by adopting the seed rate of 1,350 lb. per acre was 12,400 lb.

Increasing the acre yield of Elephant yam: From the yield data of corms obtained by planting materials of different sizes, ranging in weight from less than one lb. to about three lb. each, it is found that the seed materials of three lb. in weight develop considerably larger corms than smaller seed material. While the mean weight of corms from seed materials of about three lb. in weight was 17.6 lb., that from seed material of about two lb. in weight was only 8.8 lb. It is therefore found that an acre yield of about ten tons of corms can be obtained by planting seed material, each about three lb. in weight, giving a spacing of 4.5 feet both ways.

Weather Review — For May 1952

RAINFALL DATA

Division	Station	Total rain-fall for the month	Departure from normal in inches	Total since January 1st in inches	Division	Station	Total rain-fall for the month	Departure from normal in inches	Total since January 1st in inches		
Orissa & Circars.	Gopalpur	1.7	-0.4	4.3	Central Contd.	Coimbatore A.M.O.*	0.1	-1.7	1.7		
	Calinga-patnam	2.9	+0.3	5.0		Coimbatore	0.4	-2.4	1.9		
	Visakha-patnam	4.6	+2.6	5.4		Tiruchirapalli	0.4	-2.2	2.7		
	Arakuvalley*	4.2	0.0 @	11.3	South	Naga-pattinam	0.2	-1.4	6.8		
	Anakapalle*	4.3	+2.3	8.3		Aduthuari*	0.2	-2.7	6.3		
	Samalkot*	2.9	+1.5	3.0		Pattukottai*	0.7	-1.4	5.2		
	Kakinada	4.9	+3.4	8.7		Madurai	1.0	-1.7	6.1		
	Maruteru*	1.7	+0.3	2.1		Pamban	0.6	-0.4	10.1		
	Masulipatnam	3.5	+2.2	4.0		Koilpatti*	0.1	-2.4	5.7		
	Guntur*	3.5	+0.9	4.1		Palayam-cottai	1.6	0.0	6.5		
	Agri. College, Bapatla*	8.3	+7.2	8.4		Amba-samudram*	0.7	-1.8	11.4		
	Agri. College Farm Bapatla*	7.4	X	7.6		West Coast	Trivandrum	12.9	+4.1	19.1	
	Rentachintala	3.8	+1.3	4.7			Fort Cochin	11.6	-0.1	21.9	
	Ceded Dists.	Kurnool	15.0	+13.2	15.3		Kozhikode	6.8	-2.1	10.1	
Nandyal*		1.76	+15.7	18.2	Pattambi*		3.4	-4.4	6.3		
Hagari*		4.3	+2.5	4.9	Taliparamba*		2.1	-5.2	6.2		
Siruguppa*		6.4	+4.2	7.4	Nileshwar*		4.7	-4.7	5.6		
Bellary		3.6	+1.7	4.5	Pilicode*		2.1	-6.1	3.4		
Cuddapah		9.3	+7.8	9.3	Mangalore		4.4	-3.3	6.5		
Kodur*		8.1	+5.6	8.3	Kankanady*		3.3	-5.3	5.8		
Anantapur		3.2	+1.2	3.2	Mysore & Coorg. Hills		Chitaldrug	2.4	-0.5	3.4	
Carnatic	Nellore	14.9	+13.8	14.9		Bangalore.	3.7	-0.5	4.3		
	Buchireddipalem*	11.1	+9.0	11.1		Mysore	3.8	-1.8	6.6		
	Madras (Meenam-bakkam)	15.3	+14.3	16.1		Mercara	4.5	-0.7	10.4		
	Tirurkuppam*	11.4	+8.8 @	12.3		Kodaikanal	2.6	-3.8	15.9		
	Palur*	1.3	-3.2	3.1		Coonoor*	0.6	-3.5	16.2		
	Tindivanam*	2.9	-1.2	6.8		Ootacamund*	1.4	-4.5	6.2		
	Cuddalore	1.0	0.0	3.5		Nanjanad*	1.9	-3.4	9.2		
	Central	Arogyavaram (Chittoor Dt.)	2.4	-0.2		3.8					
		Vellore	3.9	+1.6		4.5					
		Gudiyatham*	2.8	-0.7	2.9						
Salem		2.5	-2.1	3.7							

- Note:—**
1. * Meteorological stations of the Madras Agricultural Department.
 2. @ Average of nine years' data for Tirurkuppam and seven years' data for Araku Valley is given as normal.
 3. Average of ten years' data is taken as normal.
 4. X - The farm was started only last year.

Weather Review for May, 1952

A 'low' extended over West Rajasthan on 3-5-52 and on the next day it moved away north-eastwards across the hills of the Punjab (I). Again on 5-5-52 a well-marked trough extended from the Punjab (I) to Chota-Nagpur and Orissa, which moved eastwards and got filled up on the following day. Another shallow trough appeared off the Konkan-Kathiawar Coast on 7-5-52 and became less marked soon after. A shallow low with its associated cyclonic circulation extending upto 3000 feet above sea level appeared over the Southwest Uttar Pradesh on 8-5-52. On the next day a trough extended from North-west Rajasthan to Chota Nagpur. This formed part of a Western disturbance which lay as an extended trough from Baluchistan to North Madya Bharat and passed away eastwards across upper Assam on 12-5-52, leaving a well-marked trough over Chota Nagpur, which got filled up on the succeeding day.

Markedly unsettled conditions were observed in the South-East Bay of Bengal on 14-5-52, when strong monsoon conditions prevailed. This developed into a deep depression centred at 08:30 Hrs. I. S. T. on 15-5-52 about 60 miles South-West of Port Blair. But this weakened on the following day thus lessening the chance of the advance of the monsoon along the Malabar Coast, and lay as an extended trough over the Bay of Bengal, but again concentrated into a depression on 19-5-52 with its central region near latitude 14° N. and longitude 87° E., moved towards the West and rapidly intensified into a cyclonic storm on 21-5-52, centred at about 120 miles ENE of Madras at 08:30 Hrs. I. S. T. This further moved towards NNW, close to the coast off Masulipatnam, weakened on 23-5-52, lay as a trough over the West Central Bay of Bengal on 25-5-52 and became unimportant on the next day. Under the influence of the cyclonic storm, the South-West monsoon temporarily advanced along the West Coast on 19-5-52. Further widespread rains with locally heavy falls occurred in coastal Andhradesa and the adjoining districts of Rayalaseema and North Tamilnad, and relieved the distress and water famine in those areas. All the tanks in those areas got filled up, either partly or fully, and some breaches occurred in the tanks of Ponneri taluk due to very heavy rains.

An advance of the monsoon was taking place along and off the Malabar Coast on 28-5-52. The Bay of Bengal branch of the monsoon was also active. The former temporarily weakened on 30-5-52 while the latter continued to be active. Under the influence of the monsoon widespread rains occurred along the West Coast during the last week of the month.

A shallow trough appeared off the Konkan - Kanara Coast on 30-5-52 and weakened on the next day.

During this month eleven western disturbances, with their associated secondaries passed over North and North-West India.

Day temperatures were generally above normal over the region, except some parts of Coastal Tamilnad, upto 19-5-52 with slight fluctuations on 14-5-52. Thereafter under the influence of the cyclone in the Bay of Bengal, the heat wave, especially in Coastal Andhradesa and Rayalaseema subsided and temperatures were considerably below normal over the whole region upto the end of the month. Rentachintala recorded the highest maximum of 113° F on 15-5-52 followed by Cuddapah 112° F on 1st and 2nd May 1952.

The noteworthy falls and the zonal rainfall for the month are furnished below.

Noteworthy rainfalls during May, 1952

S. No.	Date	Name of place	Rainfall in inches for past 24 hour
1	13-5-52	Kozhikode	2.8
2	22-5-52	Madras (Nungambakkam)	9.6
3	22-5-52	Madras (Meenambakkam)	7.5

S. No.	Date	Name of place	Rainfall in inches for past 24 hours
4	22-5-52	Nellore	7.0
5	22-5-52	Buchireddipalem	5.5
6	22-5-52	Kakinada	2.2
7	22-5-52	Vizakhapatnam	2.2
8	23-5-52	Kurnool	6.5
9	23-5-52	Cuddapah	3.8
10	23-5-52	Nandyal	11.6
11	23-5-52	Ongole	3.5
12	28-5-52	Nagercoil	2.9
13	29-5-52	Fort Cochin	2.5

ZONAL RAINFALL

S. No.	Name of zone	Average rainfall	Departure from normal	Remarks
1	Orissa and Circars	4.13	+ 1.80	Above normal
2	Ceded Districts	8.44	+ 6.49	Far above normal
3	Carnatic	8.27	+ 5.93	Far above normal
4	Central	1.79	- 1.10	Below normal
5	South	0.64	- 1.48	Far below normal
6	West Coast	5.70	- 3.01	Far below normal
7	Mysore and Coorg	3.80	- 0.90	Below normal
8	Hills	1.63	- 3.80	Far below normal

Agricultural Meteorology Section,
Lawley Road P. O., Coimbatore, }
Dated: 9-5-1952.

M. B. V. N., C. B. M. & M. V. J.

Departmental Notifications
Gazetted Service—Transfers and Postings

Name of Officers	From	To
Sri Balasubramaniam, T. N.,	Sugarcane Inspector, Samalkot,	Addl. D. A. O., (Manure Scheme), Mathurai
„ David, M. J.,	Sugarcane Inspector, Nellikuppam,	Addl. D. A. O., (Manure Scheme), Nellore
„ Gopalan Nair, T.,	On leave,	Banana Res. Officer, Aduthurai
„ Hanumantha Rao, D.,	Special D. A. O. (Crop Sampling) Vijayawada,	J. L. A. Agrl. College, Bapatla
„ Kannian, K.,	Asst. in Cotton, Coimbatore,	Asst., Cotton Extension Officer, Guntur
„ Kalyanasundaram, N. V., (On leave),		Addl. D. A. O., (Manure Nellore
„ Krishnan, L.,	J. L. A., Agricultural College, Bapatla,	Addl. D. A. O., (Manure Scheme), Pattukottai
„ Kasim Adeni, Md.,	On leave,	S. L. A., Agricultural College, Bapatla
„ Narayana, G. V.,	On leave,	Oilseeds Specialist, Coimbatore
„ Parthasarathy, S. V.,	Asst. Physiologist S. R. S., Anakapalle,	Sugarcane Specialist, Anakapalle
„ Ranga Brahma Rao, T.,	Dy. D. A., Eluru,	Dy. D. A., Guntur
„ Rama Rao, V.,	On leave,	Special D. A. O. (Crop Sampling), Vijayawada
„ Rajaratnam Chetty, S.,	Asst., Marketing Officer, Cuddapah	Agronomist, Siruguppa
„ Ramachandran, S. V.,	Agronomist, Siruguppa,	Addl. D. A. O., (Manure Tinnevely
„ Ranganathaswami, G.,	Fertilizer Inspector, Eluru	Addl. D. A. O., (Manure Scheme), Kakinada
„ Raghunatha Reddy, K.,	F. M., S. R. S., Gudiyattam,	Addl. D. A. O., (Manure Scheme), Tanjore
„ Suryanarayana, M.,	S. L. A., Agricultural College, Bapatla,	Dy. D. A., Eluru
„ Sayeed, P. M.,	Asst. in Oilseeds, A. R. S., Nileshwar,	Superintendent, A. R. S., Nileshwar
„ Subramaniam, K. H.,	Sugarcane Inspector, Pugalur,	Addl. D. A. O., (Manure Scheme), Trichinopoly
„ Somayajulu, P.,	P. A., to D. A. O., Kakinada,	Addl. D. A. O., Eluru (Manure Scheme), Eluru ,
„ Thangavelu, T. K.,	Technical Asst., D. A.'s Office, Madras,	Asst. Marketing Officer Cuddapah

Name of Officers	From	To
„ Venkataraman, S. N.,	On leave,	State Marketing Officer Madras
„ Vaidyanathan, M.,	Teaching Asst., in Agrl. Coll, Coimbatore,	Addl. D. A. O., (Manure Scheme), Guntur
„ Thomas, K. C.,	On leave,	Addl. D. A. O., (Manure Scheme), Vijayawada

Subordinate Service

Name of Officers	From	To
Janab Abdul Basheer, Md.,		Soil Conservation Asst. Alur
„ Azimuddin, A.,	A. D., Vellore,	Seed Dev Asst., Nellore
Sri Balasubramaniam, K. M.,	Asst., in Paddy, Coimbatore,	Asst., in Paddy, Mangalore
„ Bhaskara Rao,	Addl., A. D., Conjeevaram,	Special A. D., Kaikalur
„ Dakshinamurthi, T. S.,	P. A., to D. A. O., Coimbatore,	F. M., A. R. S., Sathyamangalam
„ Doraiswami, K. N.,	Seed Dev. Asst., Nilakottai,	A. D., Vellore
„ Ganeshamurthi, N.,	A. D., Coimbatore,	P. A., to D. A. O., Coimbatore
„ Janardhana Rao, K.,	A. D., Tenali,	Teaching Asst., in Agri. Bapatla
„ Koteswara Rao, K.,	Seed Dev. Asst. Vijayawada,	Teaching Asst., in Agri., Bapatla
„ Koyamu, K.,	F. M., A. R. S., Nileshwar,	Coconut Nursery Asst., A. R. S., Pattambi
„ Kalimuthu, M.,	A. D., Mathuraj,	A. D., Lalgudi
„ Kanakachala Rao, K.,	A. D., Kaikalur,	Special A. D., Masulipatam
„ Kameswara Sarma, V.,	Addl. A. D., Gudivada,	A. D., Kaikalur
„ Madhava Rao, T.,	A. D., Gudivada,	A. D., Gudivada
„ Madhavados Lakshmana Rao,	---	Special A. D., Avanigadea
„ Majaddudin, Mq.,	Entomology Asst., Coimbatore,	Asst. in Paddy, A. R. S., Coimbatore
„ Nillat, V.,	On leave,	F. M., A. R. S., Nileshwar
„ Narayana Reddy, B.,		Soil Conservation Asst., Guntaka
„ Pappaiah, B. P.,	A. D., Polavaram,	A. D., Kovur
„ Padmanabha Nambiar, K. P.,	Pepper Asst., A. R. S., Taliparamba,	Fruit Asst., Model Orchards, Mangalore

Name of Officers	From	To
„ Pulluri, P.,		Special A. D., Avanigadda
„ Ramanujalu Naidu, T.,	On leave,	A. D., Narasapur
„ Radhakrishna Menon, K.,	A. D., Alathur,	Addl. A. D., Pattambi
„ Rajagopalan,	Addl. A. D., Patambi,	A. D., Alathur
„ Rajagopalan, V. T. R.,	Dairy Asst., Cuddalore,	Dairy Manager, Agrl. College, Coimbatore
„ Ramachandra Rao, M.,	P. P. A., (Mycology), Anantapur,	P. P. A., (Entomology), Anakapalle
„ Ramachandra Rao, T.,	Addl. A. D., Chilamathur,	Addl. A. D., Kaikalur
„ Raghava Rao, K. V.,	Addl. A. D., Avanigudda,	Addl. A. D., Avanigudda
„ Sobhanadri, N.,	Teaching Asst., Agrl. College, Bapatla,	Special A. D., Vijayawada
„ Seshadri, T. V.,		A. D., Chittur
„ Sangameshwara Sarma, S.,	F. M., Anakapalle,	Teaching Asst. in Agri., Bapatla
„ Shanmugasundaram, B.,	A. D., Conjeevaram,	A. D., Kumbakonam
„ Sivasankaran, S.,		Seed Dev. Asst., Koilpatti
„ Suryanarayana, J.,	A. D., Narasannapeta,	Teaching Asst., in Agri., Bapatla
„ Suryanarayana Sarma, D.,	Entomology Asst., Wynad,	Entomology Asst., Coimbatore
„ Shanmugam, S.,	A. D., Anantapur,	P. P. A., (Mycology), Anantapur
„ Satyanarayana Raju, V.,	A. D., Eluru,	Engineering Supervisor, Chittur
„ Sundara Singh,	A. D., Adoni,	do.
„ Srirama Rao, P.,		Special A. D., Gannavaram
„ Subba Rao, V.,		Special A. D., Gudivada
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