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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.

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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 forcepts, 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 the 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^5 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 brokens 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 exhorbitant 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 frame-work 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 *Chekkus* are worked by power instead of bullucks. 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 though 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 deseribed. Acetone, cenzol, 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 though 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 throughly 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 1913–14	1923–24 1927–28	1928–29 1932–33	1933–34 1937–38	1938–39 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 utlisation of subtantial 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 percent 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.

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 nnder 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 dhall, 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 B_2 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-$\frac{1}{4}$ 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 lactgogue 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 watar, 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")

	Per cent.
Saturated acids:	
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 $C_{24} H_{48} O_8$	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 predominently 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

alorific value, are totally deficient in vitamins. This deficiency is ow being made up by the fortification of the artificial product with he 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 sme use in the preparation of compound lubricants. Owing to its poor viscosity and liability to solidification at low temperatnres 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 subtituted 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 ital 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 appled 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 mik. 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 ½ 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 hygenic 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 merkets. 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 cutomers 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 encoroaching 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. Usinghigh- 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					Other allied and synonymous forms	Similar types described by previous workers
Habit of growth (1)	Testa colour (2)	Kernels, nature of (3)	Size of pods (4)	Type (5)	(6)	(7)
Forms under Arachis hypogaea var. *oleifera*						
Erect	Rose	1-3	Tiny	Type erecta.		
Bunch	Light rose	1-2	Very small	Volete	Spanish 10, Macspan, Casilda 5, Florida II, III and IV	'Manchurian' type of Luzina.
,,	,,	1-2	Small	Gudiyatham bunch	Valencia white, Sanjose (Philippine) Reconquista 6	'Spanish' type of Luzina
,,	,,	1-3 occasional	Medium	Java 2.	North Carolina Peanut, Java 1, 3, 4, 5; Spanish (Philippine); Improved Spanish 213. Akola 24.	'Java' type of Luzina.
,,	,,	1-4	Small	Corrientes 1		
,,	,,	1-4	Medium	Tennessee White.	Cordoba 2	
,,	Rose	1-3	Big	Akola 10		
,,	Red	1-2	Small	Small Japan		
,,	,,	1-4	Medium	Kumavu	Valencia Peanut, Bunch Mozambique Spanish Bunch (Salisbary Viginia Bunch (Tanganyika) Tennessee Red, Cordoba 4, Montoso Seros 7, 8	'Valencia' type of Luzina.
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—*cotnd.*

Characters of Classificatory value					Other allied and synonymous forms	Similar types described by prvious workers
Habit of growth (1)	Testa colour (2)	Kernels, nature of (3)	Size of pods (4)	Type (5)	(6)	(7)
Spreading	White	1-3	Medium	Philippine White		
,,	,,	1-2	Very small	Louga	Baol.	
,,	,,	1-3 (3 occasional)	,,	Wild Falcon A	Wild Falcon B	
,,	,,	1-2	Small	Local Mauritius	Sogathur, Mozambique. Mauritius Gooty.	
,,	,,	1-3	,,	Bassi	Zaria, Gambia, Philippine Pink.	
,,	,,	1-3	Medium	Big Japan	Kalahasti, Virginia [Runner, Carolina, Chiba,63, Chiba 73, Transvaal, West African, Madagacar, Barbados, Ceylon, Rufisque Senegal, Senegal, Local Pondicherry.	
Spreading	Rose	1-3 (3 occasional)	Big	Texas	Rangoon, Virginia, Running Peanut, Mauritius Virgini, Jembo Runner.	
,,	,,	1-3	Big	Masumbika.		Nearly answers the description of the 'Peru' type of Luzina.
Other varieties of Arachis hypogaea.						
Semi-spreading	Rose	1-4	Small	*Kurumani*	Var. asiatica.	Identical with the 'Khasgar' type of Luzina.
,,	Red (Testa ruptured)	1-2		*Var. nambyquarœ*		
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 I 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 yeld 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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