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Groundnut in Madras and its Economic Importance *

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PART I

Introduction: The importance of plant introduction to the progress of mankind cannot be over-emphasised. The introduction of groundnut into India is an example of such an introduction. Though a crop of recent introduction, it has come to occupy an important place among the agricultural crops in most of the Indian provinces and States. The expansion of the area under this crop has been particularly marked in Madras. The great popularity of the crop can be ascribed to the ease with which it can be raised under varying conditions of soil and climate, the easy marketability of the produce and the attractive money return obtained from it. Its importance as a rotation crop with good soil-recuperative value and as an efficient cover against soil erosion and good forage for cattle are all points which are appreciated by ryots in many districts and are factors for the great increase in the area of the crop.

In recent years, groundnut has attained international status, as one of the chief sources of vegetable oil in the world. Madras the main producing centre for groundnut in India and has built up a substantial export trade in this commodity. During the pre-war years, groundnut export formed nearly nine-tenths of the total exports from Madras. Thus it is evident that groundnut has come to stay as one of the most important commercial crops in this State and as an article of great utility to the common man and to the industrialist.

In this connection it may be mentioned the so-called North American groundnut *(Apiose tuberosa)* and the 'Madagascar' or 'Bambara' groundnut *(Voandezia subterranea)* are entirely different species and are not allied to the ordinary groundnut which is *Arachis hypogaea.*

2. **Origin and History:** (a) *Origin of the groundnut and allied species:* The botanical name of the plant is *Arachis hypogaea* Linn. '*Arachis*' is derived from a Greek word for a leguminous plant and the specific name '*hypogaea*' means below the ground, and refers to the formation of the pods in the soil. The native country or origin of the plant is still a matter of speculation, because it has never been found in the wild state in any country, though its allied species are found in the wild state only in South America.

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

Therefore it may be inferred, that the groundnut must have originated in South America from some allied species. Archaeological excavations in Peru have brought out a good deal of evidence to show that groundnut existed there as a cultivated crop in very early times.

DeCandolle has discussed the subject at some lnegth and indicated the Brazilian origin of the species. Bentham considers that the cultivated groundnut is a form derived from one of the six species growing wild in Brazil. Originally seven species of *Arachis* were enumerated and subsequently another six species were described from South America. Chevalier (1933) however, seems to recognise only the following six species viz., *A. glabrata* Benth; *A. villosa* Benth; *A. marginata* Gardner; *A. paraguariensis* Shod and Hassler; *A. pusilla* Benth; and *A. hypogaea* Linn. Waldron (1919) has postulated that the cultivated bunch varieties are derived from wild Brazilian species such as *A. pusilla* which has an erect habit, and the prostrate ones from *A. prostrata* (*A. africana* Lour.) another Brazilian species which has a spreading habit. Husted (1933 and 1936) has discussed the origin of *A. hypogaea* and does not support Waldron's suggestion of its dual origin, whiie John and others (1951) agree with Husted. Mendes (1947) opines that the cultivated groundnut must be of a tetraploid nature and must have spontaneously arisen by chromosome doubling of the diploid form. He also concludes that this must have taken place in the State of Mato Grosso, Brazil which is generally recognised as the place where groundnut plants are indigenous.

Sampson (1936) says that a wild plant considered to be an ancestral form of the groundnut was collected by M. Gregoria Bondar in the State of Bahia, Brazil and it has been described under the name *A. sylvestris*. Chevalier (1933) has, however, classed it as a sub-species of *Arachis hypogaea* and he considers *A. sylvestris* as the likely connecting link between *A. pusilla* and the commercially grown varieties. Thus Brazil seems to be the most likely home of the groundnut plant.

(b) *History of the groundnut in India:* From Brazil groundnut is believed to have been introduced into the West Coast of Africa by early slave traders, who are thus responsible for its introduction into the United States of America.

According to Lieberherr (1922) the credit for the introduction of this plant into India belongs to Portuguese Jesuit Fathers who followed Vasco De Gama shortly after his first landing on the Malabar Coast in the year 1498. Since there is no word in Sanskrit for the groundnut and since South America was discovered about the year 1500, it is most likely that the plant was introduced into India at the earliest in the first half of the sixteenth century. Whoever be the unknown benefactors who first brought this unique

plant to this country the good done is inestimable. With the introduction of the groundnut as an oilseed in the European markets in 1840, the area under groundnut in Madras was 4,000 acres in 1850 and rose up to 20,000 acres, in 1870. In the beginning, the area was confined to the districts round about South Arcot but later on it extended to other districts as well. In about 1896 the area began to fall off, as the so-called 'indigenous' variety was said to have deteriorated. Messrs. Parry & Co., then introduced the 'Mauritius' from Mozambique (Benson 1914). According to Lieberherr (1928) there was a fall in the area in Bombay also about the same time and the 'indigenous' variety disappeared from the market altogether. In Bombay, during the period 1904 to 1906 the 'Big Japan', a spreading form was introduced (Kelkar, 1911) which is now commercially known as 'Bombay Bold.' About 1910 the 'Spanish' and the 'Small Japan'—bunch forms were introduced into Bombay and these were later on extended to South India.

3. Acreage and Production: (a) *Acreage:* The area under groundnut in the world averaged 19·8 million acres for the quinquennium 1941—'45, the chief producing countries being India (9·1 millions), China (3·2 millions), French West Africa (1·6 millions) and the United States of America (3·0 millions). The Indian acreage represents nearly 46% of the world acreage.

Though groundnut was introduced into India in the sixteenth century, it did not become popular as a cultivated crop till about the beginning of the 20th century. The district of South Arcot in the Madras State was the first place where groundnut was grown on an appreciable scale. As far back as 1850—'51, it was recorded in the Land Revenue Report of the Collector of South Arcot that about 4,000 acres were under groundnut. At the beginning of the 20th century the area in India was in the neighbourhood of 3,00,000 acres, confined entirely to the provinces of Madras and Bombay. Later on other provinces came into the picture and at the present time it is an important crop in Madras, Bombay, Hyderabad and Mysore. The expansion in acreage was rather slow in the first decade of the century but increased considerably in the subsequent decades as shown in the following:

	Thousands of acres
Average 1900—01 to 1909—10	575
,, 1910—11 to 1919—20	1,498
,, 1920—21 to 1929—30	3,643
,, 1230—31 to 1939—40	7,103
,, 1940—41 to 1944—45 (Quinquennium)	8,701

Thus it is seen that the acreage increased by nearly a million acres between 1910 and 1920, over two million acres between 1920 and 1930 and three million acres in the next two decades. The peak area of 10·6 million acres was recorded in 1944—'45.

During the quinquennium 1942—'47 the total area under the groundnut in India was 9·7 million acres distributed as shown below :

State	Average ('000 acres) area	Percentage of the total Indian acreage
Madras	3,903	40%
Hyderabad	2,445	25%
Bombay	2,374	24%
Other Provice and States	1.002	11%
Total	9,724	100

Thus Madras which was the first province to take up the cultivation of the groundnut, continues to have the largest area under the crop in India, and accounts for 40 percent of the all-India acreage. The three main centres of production in the State are (1) The central districts of Chittoor, North Arcot, Salem, South Arcot, Tiruchirapalle and Coimbatore, contributing over 28 percent to the Province's total. (2) The Ceded districts of Cuddapah, Kurnool, Bellary and Anantapur accounting for over 34 percent. of the provincial groundnut acreage and (3) the Circars districts of Vizagapatam, East Godavary, West Godavary, Kistna and Guntur, contributing about 28 percent. The area is negligible in the two West Coast districts of South Kanara and Malabar and is practically nil in the Nilgiris.

(b) *Production :* The average annual production of groundnuts (nuts in shell) in the world for the quinquennium 1941—'45 amounted to 7·1 million tons of which India accounted for about 3·3 million tons, China 2·1 million tons, French West Africa 3·2 lakhs tons and United States of America 8·0 lakhs tons. The production in India represented 42·0 percent of world production and 88 percent of the whole of the British Empire. Production of groundnut has been rising more or less steadily and the maximum of 3·9 million tons was reached in 1944—'45. The average production in India during the successive decades of the century is given below.

	Nuts
1900—01 to 1909—10	256,000 tons.
1910—11 to 1919—20	735.000 ,,
1920—21 to 1929—30	1,535,000 ,,
1930—31 to 1939—40	2,798,000 ,,
1940—41 to 1944—45	3,370,000 ,,

It is seen that the production during the decade 1930—'31 to 1939—'40 was more than 10 times that of the first decade.

The production in India during the quinquennium ending 1946—'47 was about 3·5 million tons and was distributed among the producing areas as follows :

State	Production nuts in shell (1000 tons)	Percentage to the total Indian production
Madras	1,618	46%
Bombay	774	22%
Hyderabad	809	23%
Other Provinces and States	317	9%
Total	3,518	100

Madras Province stands foremost in India with 46 percent of the total production in India, followed by Hyderabad (23 percent.) and Bombay (22 percent).

The share of the different varieties in the total production and also the share of the provinces in the production of different varieties during the quinquennium 1933—'37 are given below.

Variety	Estimated production in 1937—38 (tons)	Percentage of the total	Important States with their share
Coromandel	1,574,000	56	Madras (85 percent.)
Bold	506,100	18	Bombay State (39 percent.)
			Hyderabad (26 ,,)
			Bombay (25 ,,)
Peanuts	618,000	22	Bombay (32 percent.)
			Hyderabad (30 ,,)
			Madras (25 ,,)
Red Natal	62,000	2	Madras (50 ,,)
			Central Provinces (31 ,,)
Other varieties	62,000	2	
Total	2,822,000	100	

Madras leads in the production of Coromandel and Red Natal types while Bombay produces more of 'Bold', and 'Peanut' types.

The importance of varieties varies in the different producing areas. Thus in Madras, Coromandel accounts for 82 percent of the production in the State, the share of Peanuts and Red Natal coming to only 10 and 2 percent respectively.

4. Botany: *Description of the plant:* Groundnut belongs to the family *Leguminosae, Papilionatae,* of pod-forming plants, and is unique in possessing the peculiar habit of forming its fruit underground. It is a common misconception that groundnut is formed on the roots of the plant. This of course is entirely erroneous since the flowers from which the fruit develops are borne in leaf axils. The plant is a herbaceous annual. Its stems are spreading, procumbent, or erect according to the variety or form. The leaves are compound, consisting of four oval leaflets. The leaves spread out during the day but close at night and in rainy weather. Flowers which are borne in leaf axils are small, orange-yellow in colour.

When first produuced these flowers have no fruit stalk, but the tubular calyx which encloses the ovary at its base is often 1 to 3 inches in length and is mistaken for the flower stalk. After fertilization the stalk of the ovary develops and continues to grow until it reaches a length of several inches. It takes a downward turn and when it reaches the soil, it pushes the ovary 1–2 inches beneath the surface of the soil. In this position the ovary develops and in about 2 months the pod matures, forming the familiar groundnut of commerce. If the stalk is prevented from penetrating the soil, no fruits are formed. When mature, the pod contains usually 1 – 3 seeds and at times, as many as four (and rarely five seeds) according to the variety. The seeds are generally oval in shape with one end pointed and the other flattened and have white or light rose or red or dark-purple seed coat. The seeds are ex-endospermous and the oil and food material are contained in the cotyledons.

Sub-species and varieties of the groundnut : The various forms of the cultivated groundnut, *A. hypogaea*, can be broadly classified into two groups based on their habit, viz., the bunch type and the spreading type. Waldron (1919) suggested that *A. hypogaea* may be divided into two sub-species, viz., '*fastigiata*' for the bunch and '*procumbens*' for the spreading. Patel and others (1936) who discussed the genetic constitution of the two sub-species, have, however, doubted the necessity for postulating separate origins for the two sub-species. There are however, two so-called new groundnut 'species' viz. *A. nambyquarae* Hohne, and *A. rasterio* Chev. These have large-sized pods with prominent reticulation, and ruptured or partially developed seed-coats (Legmen). Those characters distinguish them from all other varieties of the groundnut. Chevalier (1933) who proposed the sub-species *A. oleifera* Chev. under *A. hypogaea* to include all the cultivated groundnut varieties. ranks these two as two sub-species of *Arachis hypogaea*. Husted (1933) who examined their somatic chromosomes along with those of *A. hypogaea* states that in three 'species' the chromosomes are the same in number and also appear to be the same in size and that the *rasterio* and the *nambyquarae* are sub-species of *Arachis hypogaea*. Luzina, (1935) however, calls them only types and includes them in a basic group which, in his opinion has probably served as initial forms from which all the cultivated and spreading forms have been derived. John and others (1951) have made numerous crosses between the three 'species' viz., *A. rasteiro*, *A. nambyquarae* and *A. hypogaea* and found them to cross freely with one another. Further, there was no marked degree of sterility in any of the crosses which is usually associated with inter-specific hybrids. Also the characters of pods and seeds which distinguish the two new 'species' are found in other forms of *A. hypogaea*, though to a less pronounced degree. Therefore, they were inclined to rank the new 'species' only as botanical varieties of *A. hypogaea*. They studied the characters of the varieties and forms of the groundnut and classified them into groups and sub-groups according to their

affinities. Only five botanical varieties viz., var. *oleifera* (*Arachis hypogaea* sub-species *oleifera* Chevalier), var. *rasteiro*, var. *namby-quarae*, var. *asiatica* and var. *gigantea* are recognised by them. All the cultivated groundnuts are described as forms of var. *oleifera*.

(b) *Systematic classification of groundnut varieties and forms:* A large number of groundnut varieties and forms are met with in the various groundnut-growing countries of the world. The first systematic classification of the groundnut was attempted by Van-der-Stok (1910). He divided the types cultivated by the people of Java into two main groups, namely the long duration and short duration. These groups were also said to differ markedly in their growth habit, branching and size and colour of leaflets. The cultivated varieties which mostly belonged to the short duration bunch group were further divided into three groups based on their pod size, nature of kernels, testa colour and shelling outturn. Chevalier (1933) after classifying some of the races and the varieties of the groundnut, mainly on the basis of pod and seed characters came to the conclusion that classification could be done satisfactorily only by an examination of the live material. Hayes (1933) has divided the varieties into ten groups utilising systematic grading of characters. Luzina (1935) after examining a large collection of 300 specimens from all over the world in the Institute of Plant Industry, Leningrad says, that in spite of the great number of specimens the collection is poor in varieties and that the want of sufficient knowledge of the biological properties of the available material makes a clear classification of the cultivated species of *A. hypogaea* impossible at present. As a result of preliminary study he distinguishes three basic groups comprising of ten types, five in bunch and five in prostrate groups including all cultivated types. From a detailed study of the large collection of varieties and forms maintained at the Agricultural Research Station, Tindivanam, John, Narayana and Seshadri (1951) grouped them into seven main groups comprising of five varieties and twenty-three forms as shown in the classification chart (Appendix I). Growth habit, testa colour and size and nature of kernels and pods are considered to be characters of chief classificatory value by them. They also found that many forms, though received under different names were actually identical.

5. Development of the Plant: *Germination:* Groundnut seed is nearly spherical or oblong with a smooth seed coat. The micropylar end near the chalaza is shortly beaked. Water is absorbed by the seed coat and reaches the primary axis through the micropyle. Part of the moisture directly passes on to the cotyledons. The seed swells about 3 times the size by absorbing about 50 percent. moisture by weight. The embryo then becomes active. The radicle just behind the micropyle begins to elongate. The seed coat increases in size slightly, but it gives way to the pressure of the growing radicle and is therefore ruptured or broken around the

radicle. Part of the membranous tegmen is carried in small bits by the radicle which grows rapidly and takes a positively geotropic bend. The first signs of germination namely the beginning of the emergence of the radicle occurs on the third day under optimum conditions of moisture. As the radicle elongates, the plumule also grows within the cotyledons, though not rapid so by as the radicle. The lateral roots appear in about a week after the first emergence of the radicle. They always appear in four rows corresponding to the four protoxylem groups behind which the lateral roots take their origin. Under optimum conditions of soil moisture, germination in the field is noticed on the fifth day in the bunch and on the seventh day in the spreading varieties and forms. The hypocotyl elongates rapidly pushing out the cotyledons above the ground at which stage the beginnings of a shoot are discernible. In the initial stage, the main axis makes slow growth while the first pair of primaries growing out of the cotyledons make comparatively rapid growth. The germination in groundnut is completed by about the tenth day. Quicker and better germination is obtained in the bunch types than in the spreading and other forms.

Growth: (a) *Root:* Studies of the root system in the groundnut were made in different varieties at the Agricultural Research Station, Tindivanam. Ten days after sowing the seed, when germination was complete and the lateral branches of the stem became differentiated, the tap root penetrated to a depth of about 30 cms. from the surface of the soil and the primary, lateral roots were prominent, while the secondaries were just visible. Root nodules are absent at the stage. When the plant is a month old and flowering has commenced the root system is further developed and presents a matted appearance with the intertwining roots. The primaries spread out fully and the secondaries became numerous. A few nodules are formed but they are undersized. A month later, the growth of the root is almost complete, the primaries and secondaries developing fully, and tertiaries just forming. The tap root at this stage is about 60 to 80 cms. in length, going down almost vertically with slight bends along its course. The total length of the root system is almost twice that at the previous stage. Most of the primary laterals are located within the first 15 cms. of the tap root i.e., the region of the primary laterals lies within the first six inches of the soil. Upto a length of 25 to 30 cms. the laterals remain more or less near the surface of the soil but thereafter they follow a decidedly downward course. The number of nodules which have by now attained their full size and are found mostly within the upper six inches of the soil increases four-fold. The hypocotyl is usually 3 cms. to 6 cms. in length and 0·5 cms. to 0·8 cms. in thickness. Numerous small and fine roots varying in length from 3 to 10 cms. develop in the hypocotyl region during the later stages of the growth of the plant.

Vider-spaced plants have generally a longer tap root and a larger number of primary laterals, secondaries and tertiaries than closely planted ones. Among the different varieties studied, it was observed that the spreading varieties and forms had a better-developed root-system than the bunch varieties and forms. The root system of the improved strain A. H. 25 (TMV. 1) which is high yielding and drought-resistant is found to have the longest tap root with the largest number of lateral roots and is superior to the cultivated form 'Local Mauritius'.

(b) *Shoot:* Plant measurements were made at fortnightly intervals commencing from the first flowering on 24 representative varieties and forms of the groundnut grown under rainfed conditions at the Agricultural Research Station, Tindivanam. This study was carried out for three consecutive seasons and showed that growth was greatly influenced by rains. A well-distributed South-West monsoon is essential for good plant growth. The short-duration bunch types suffer most in the absence of early rains while the long duration spreading types revive if the North-East monsoon rains are received in time. Absence of North-East monsoon showers arrests the growth of plants in the later stages with the result that the spreading types get no benefit from their longer duration. The total number of nodes is generally low in the non-branching bunch types and high in the spreading types which are extensively branched. A. H. 45 (Hebbal Groundnut No. 1) among the bunch types and A. H. 1 (Local Mauritius) among the spreading types have the least resistance to drought as seen by the quick fall in growth rate in the absence of rains. A. H. 25 (TMV. 1) the high yielding drought-resistant strain is seen to have the poorest plant development among the spreading types. A study of the rate of growth indicates that the twenty-four varieties and forms studied can be grouped into four distinct classes.

i. Bunch group — poorly branched and growth completed by the fourth fortnight after flowering (Gudiyatham Bunch)

ii. Spreading group — moderately branched and growth continues till the fifth fortnight after flowering (Local Mauritius)

iii. Well-branched types with much higher growth rate than the former group. Growth is over by the sixth fortnight after flowering (var. *rasteiro*)

iv. Growth rate low in the first two fortnights after flowering but thereafter continuous till arrested by low soil moisture. Characterised by very high growth rate (var. *gigantea*)

(c) *Flowering:* Flower production, as in plant development is profoundly influenced by rainfall. A well-distributed rainfall is more helpful than heavy rains received at irregular intervals. In the

bunch types flower production starts about the 25th day and continues for a month. In favourable seasons a second feeble flush is also noticeable. In the spreading forms there are distinct waves, the first starting from the 28th day and lasting for a month and the second wave of about a month's duration starting after a break of a fortnight. If the South-West monsoon is weak, flower production is late and feeble in the earlier stages and the two waves of the spreading types may merge into one. If the North-East monsoon fails, the second way may be feeble or absent. The flowering in the bunch types is seem to rise sharply while it is spread out in the spreading type. In the other types flowering is heavy and profuse and continues for a much longer period, with marked decrease during periods of deficient rainfall. The 24 varieties and forms studied for the flowering phase may be divided into four distinct groups viz.,

i. The common bunch forms — Gudiyatham Bunch

ii. The common spreading forms — Local Mauritius

iii. Intermediate semi-spreading forms — Native Tanganyika

vi. Very long duration types where flowering is late and continues till the very end — var. *rasteiro.*

(d) *Fruiting:* The fruiting phase in groundnut, in common with other phases is largely influenced by the seasonal rainfall. A well-distributed rainfall in the early stages is necessary for good flower production. For good pod-setting, bright sunshine is essential. The fertilised pegs require sufficient soil moisture for their growth and subsequent development underground. The climatic conditions seem to be contrasting. But in reality the weather conditions obtaining at the end of the South-West monsoon are alternate spells of dry and wet weather. As the early plant growth and the first flush of flowering are over by the South-West monsoon period, the alternate spells of dry and wet periods are ideal for the fruiting phase. To get this benefit, it is necessary that the sowings are done early in the season. Observations over a number of years have shown that early sowings result in high yields in groundnut.

Groundnut varieties and forms therefore exhibit characteristic differences in growth, flowering and fruiting behaviour. The rainfall and its distribution has a considerable influence on every phase of development of the groundnut plant.

6. Culture: *Climate:* Groundnut is essentially a tropical plant. It is cultivated in almost all tropical and subtropical countries lying between 45° N and 30° S latitudes and up to an altitude of about 3,500 feet. It is adaptable to a variety of climatic and soil conditions. It cannot, however, withstand frost, severe drought or

water stagnation. In tracts with heavy and continuous rainfall as in the West Coast, groundnut puts on excessive vegetative growth, resulting in very low yields and prolonged duration of the crop. Groundnut comes up well in tracts receiving 25 to 50 inches of fairly well-distributed rainfall. Good rains at sowing time help proper germination and good stand while well-distributed rainfall during crop season ensures good vegetative growth of plants, increased flowering and proper development of pods. The prevalence of bright and sunny weather at harvest time will facilitate harvesting and drying operations and improves the quality of the produce. Heavy rains and wet weather at harvest time interfere with proper drying of the produce, making it mouldy and discoloured.

Soils: Although groundnut is now grown on all types of soil such as sandy, sandy loam, loamy and black soils, it thrives best in light, sandy loams. Stiff and heavy clay soils are unsuited for groundnut cultivation, as they become hard during dry weather, thereby interfering with the penetration of the gynophore (stalks of pods) in the soil during crop growth, and also makes the harvest (removal of nuts from the soil) difficult on account of the sticky, hard texture of the soil. On the other hand a loose texture of the soil facilitates the easy penetration of the gynophores, development of the pods and the subsequent lifting of the mature nuts from the soil.

The effect of the total rainfall and its distribution on the groundnut crop largely depends on the nature of the soil on which it is raised. If the soil is sandy and well-drained, even a comparatively heavy rainfall does not do any appreciable damage to the crop and the resulting produce. But in soils retentive of moisture such as clay loams, good yields are obtained even with low rainfall.

Seasons: Groundnut is generally raised as a rainfed crop with the aid of monsoon rains from June to December, and to a lesser extent as an irrigated crop during the summer months from February to July. Since the bulk of the groundnut crop is grown with the aid of rains, the time of sowing in the different areas is mainly determined by the receipt of monsoon rains and to a lesser extent by the nature of the soil and the variety cultivated. In the important groundnut-growing tracts in India, groundnut is sown from June to August. Tracts which receive the benefit of early South-West monsoon rains such as Pollachi and Vizagapatam areas in Madras can take up the sowing as early as April or May. In Tirunelveli and Ramanathapuram districts, where the monsoon showers are received rather late in the year, the sowing of groundnut is delayed till September or even October.

Forms: The cultivated forms differ in duration, habit of growth, size and shape of pods, size of seed, colour of seed-coat etc., They can be broadly classified according to their habit of growth into two main groups, namely, the 'bunch' or 'erect' and the 'runner' or 'spreading'. In the bunch type, the branches grow erect and the pods appear in a cluster confined to the base of the plant. In the 'runner' or 'spreading' type, the primary branches trail along the ground. The growth habit of the plant influences the agronomic practices, such as seed rate or spacing, inter-cultivation operations and method of harvest. The 'erect' or 'bunch' varieties are generally of short duration, coming to maturity in 3 or 4 months, whereas the 'spreading' varieties take 4 to 6 months depending upon the region of cultivation, soil and rainfall. In tracts with heavy and continuous rainfall, and when grown under irrigation, the duration of the crop gets prolonged.

The bunch type cannot stand long periods of drought and is suited to tracts where there is a short period of well-distributed rainfall. The yield from this type is also low. Another serious draw back of this type is that it has non-dormant seeds. If at the time of maturity there is continuous wet weather a good percentage of pods begin to sprout in the soil, causing considerable loss to the cultivator. The spreading type is a comparatively heavy yielder. It is able to withstand drought to a considerable extent and its seeds can remain dormant for about $2\frac{1}{2}$ months. Among the cultivated varieties there are a few with an intermediate type of growth. During the course of genetic work carried on at the Agricultural Research Station, Tindivanam, two distinct, true-breeding types representing the extreme forms of habit have been isolated. One is an 'erect' type allied to the bunch, with the branches growing quite erect, almost parallel to the main axis and not oblique as in the bunch type. The other is what has been called the 'trailing' type with branches radiating from the centre and trailing on the ground throughout their entire length. This latter type has an unusually long main axis and branches, with a vigorous growth. John and Seshadri have considered it a new variety and described it as var. *gigantea*.

The four main commercial types of groundnut under cultivation in India are: the 'Coromandel,' the 'Bold,' the 'Peanut' and the 'Red Natal.' These are marketed under different trade names in different parts of the country. The first two belong to the 'spreading' group while the latter two belong to the bunch group. Of these, the 'Coromandel', the 'Peanut' and the 'Red Natal' are extensively cultivated in Madras. Their main characteristics and regions of cultivation in Madras are given in the following table:

Main features of commercial types of groundnut in Madras

Name of type	Shelling out-turn percent	Number of kernels per lb.	Weight of pods lb.	Weight of pods oz.	Per Madras measure; kernels lb.	Per Madras measure; kernels oz.	Per-centage Oil	General description and regions of cultivation
1. Coromandel or Mozambique or Mauritius	77	1000—1250	1	6	2	12	49·0	Spreading; 4½ months duration, 1–2 seeded small pods, kernels small elongated, rose; nut plump occupies 80% out of ground nut area in Madras. Grown in almost all districts.
2. Peanut—or Spanish or Khandesh.	78	1300—1550	1	6	3	0	49·0	Bunch, 3½ month duration, 1–2 seeded small pods, kernels small rounded, light rose, plump, occupies 10% of the groundnut area in Madras-Guntur N. Arcot, Kurnool, Ramanapuram.
3. Red Natal or small Japan or Lal Boria or Pollachi Red.	79	1100—1450	1	6	3	0	49·0	Bunch; about 110 days duration; 1–2 seeded small pods; kernels small to medium, rounded, red, plump.

Preparatory cultivation: Generally two to six ploughings with the wooden, or any improved plough is considered sufficient to work the soil to fine tilth, though in certain dry tracts, the land is ploughed only once and thereafter the local tyned harrow is run twice, followed by the local blade harrow. These are however, mere variations, the ultimate object in all cases being that the soil should be well worked and in the best condition possible.

Manures and Manuring: Cattle manure and ash are the manures commonly applied to this crop. The dosage of these vary widely, depending upon the availability, nearness of the field to the village, price, etc. They are usually applied at the rate of 5 to 10 cartloads per acre just before sowing time. Where the soil is sandy and not very retentive of moisture, it is customary to apply tank silt at the rate of 30 to 50 cartloads per acre once in 3 to 5 years. Sheep and cattle penning is also in vogue in some of the drier

districts. Wherever groundnut crop is rotated with other crops, it is common to apply the manure to the crop preceding groundnut, and in such cases the groundnut crop is raised without any direct manuring.

The response of groundnuts to fertilizer applications has been studied at a few experimental stations in India. In the black cotton soils of Bombay and Madhya Pradesh nitrogenous manures are reported to have no effect on the yield of the groundnut. At the Akola Experiment Station in Madhya Pradesh a definite response to the application of potassium sulphate was obtained. On the Hebbal Farm in the Mysore State a combination of potassic and phosphatic manures was found to be the best application to red sandy loams fairly rich in potash but poor in nitrogen. In Burma, in light sandy loams, alkaline, and poor in all essential elements of plant food, nitrogenous manures alone have been reported to have enhanced the yield. The manurial experiments conducted in recent years at the Agricultural Research Station, Tindivanam have shown that in light, sandy-loam soils, groundnuts respond to applications of of potash and phosphoric acid, but not to nitrogen. In the same station, application of cattle manure every year to plots continuously cropped with groundnut, gave marked increase in yield over unmanured plots. The differences in yield were more marked in years of deficient rainfall, thereby showing the efficacy of the application of cattle manure in ensuring better moisture supply to the crop. In America fertilizers recommended for the groundnut specify a low nitrogen, medium potash and high phosphoric acid content.

Groundnut grown in lime-deficient soils, is reported to result in defective filling of the pods. A moderate application of 500—600 lb. of lime to such soils has been found to rectify the defect.

Rotation and Mixtures: Groundnut being an important money crop of the dryland farmer, no definite rotation in its cultivation is practised with the result that the same land is sown to the crop year after year. No appreciable reduction in yield has been observed or reported from any of the groundnut tracts. This may be due to the fact that groundnut is a leguminous crop and is able to enrich the soil by means of the root nodules spread over the entire root system and also by the large quantity of shed leaves which get incorporated in the soil during harvesting operations. However, in certain tracts other crops are grown mixed or in rotation with groundnuts. Where systematic rotation is practised, it has been the experience of the ryots that any crop following groundnuts generally yields well.

Rotations vary in different producing areas depending upon a number of factors, such as soil types, solvency of the ryot, etc. In Madras, the groundnut is generally rotated with cereals, like

cumbu, cholam, tenai and varagu in dry lands. In favourable situations, groundnut is followed in the same year by maize, varagu, cholam, cotton in the cold weather or by gingelly as in South Arcot and Chingleput. In Guntur, sometimes a three-year rotation is followed, viz.,

1st year-groundnut followed by maize or horsegram.

2nd year-cholam alone or cholam followed bengalgram.

3rd year-tobacco or chillies.

In garden lands groundnut is rotated with ragi or cotton. In wetlands where it is raised under irrigation in summer it follows a crop of paddy.

The beneficial effect of raising cereal crops in rotation with groundnut have been reported by different workers. At the Hebbal Farm in Mysore, the yield of ragi has been increased by about 30 percent. by growing it in rotation with groundnuts. In the rotation experiments conducted at the Agricultural Research Station, Tindivanam cholam, cumbu and varagu grown in rotation with groundnut have recorded the following average increase in yield over the pure crops grown without rotation.

Average of three seasons

		Bunch series	Spreading series
Cholam after groundnut	...	124·3 percent.	85·4 percent.
Cumbu after groundnut	...	48·8 ,,	51·6 ,,
Varagu after groundnut	...	119·4 ,,	12·0 ,,

The small size of the average holding of the Indian ryot from which he has to eke out his livelihood is the chief reason why he does not practise systematic rotation. It is for the same reason that the practice of growing groundnut mixed with other crops has been widely adopted. Different crops are grown mixed with groundnut in different parts of the country depending upon the season, the soil, etc., Cereal crops like cholam, cumbu, tenai and varagu oilseed crops like castor, gingelly, safflower and niger and pulses like redgram, fieldbean, etc., are all grown mixed with groundnut.

Of the many mixtures in vogue, groundnut-redgram and groundnut-castor seem to be the more common ones. The crops grown mixed with groundnut are either confined to rows some distance apart or are sown broadcast over the groundnut field. The advantages of growing crops mixed with groundnut have been recorded by different agricultural workers in this country. At the Palur Research Station, 'groundnut-cumbu' mixture has been found to be the ideal one. At the Agricultural Research Station, Hagari (Bellary) 'groundnut-tenai' mixture has been found to be an ecologically sound combination because the root systems of these two crops have separate feeding zones. At the Agricultural Research

Station, Guntur, 'groundnut-cotton' mixture gave the best monetary return. At Dharwar (Bombay) groundnut and cotton sown in alternate rows gave better returns than either cotton or groundnut sown in separate blocks. It has been reported from Uttar Pradesh that it is more profitable to grow groundnuts in between rows of redgram.

With a view to study the economics of growing a pure crop of groundnut as against its mixed cropping with other crops like cumbu, cotton, redgram, castor, tenai and cholam an experiment was carried out at the Agricultural Research Station, Tindivanam for three seasons. The salient points that emerged out of the results of the experiment are:

i. The groundnut crop suffers a reduction in yield when grown as a mixture with other crops. The maximum depression in yield (50 percent) was observed when grown with cholam and the minimum depression in yield (19 percent) when grown with tenai.

ii. Mixed cropping or groundnut with other crops is more remunerative than raising a pure crop of groundnut. Mixed cropping of groundnut with cotton, castor, redgram and cholam is more profitable than with other crops tried.

iii. No appreciable effect on the quality of the groundnut produce has been observed as a result of mixed cropping.

Seeds and sowing: Groundnut pods intended for seed are generally taken from a well-matured crop. The produce is harvested in sunny weather and dried in the sun for about 7 to 10 days taking care that the pods are not trampled on while spreading or turning on the drying floor. Good, healthy pods which are not split, broken or diseased are hand-picked and stored as nuts in shell, in containers of bamboo or wicker baskets plastered with mud and cowdung, in mud pots or mud bins, wooden boxes or gunny bags depending upon the quantity to be stored. The containers are generally kept raised so that they may not absorb moisture from the floor or be attacked by white ants and vermin. It is also customary to close the mouth of the containers like baskets, mud pots, etc. with mud or cowdung plaster after filling the top with a layer of sand and ash to keep out ants and other insects. A layer of ash is also spread on the floor for the same purpose. The pods when stored in the above manner keep their viability for about one year.

The seeds of most of the bunch types are non-dormant i.e. they germinate if sown about 10 to 15 days after harvest, while the seeds of all the spreading types are dormant and require about 2 to 3 months resting period before they can be used for seed purposes. The pods are as a rule hand-shelled to avoid injury to the kernels.

Seeds intended for sowing are shelled only just before sowing time as the kernels when stored are easily attacked by ants and other insects. The seeds are hand-picked to remove all shrivelled or diseased kernels

Sowing of whole nuts without shelling is seldom done as in this form it requires a considerable amount of soil moisture and a longer time for germination. It is also wasteful as the pods generally contain more than one seed and thinning may be necessary later on to give optimum spacing of plants in the field.

Dibbling the seed in furrows behind the wooden plough is the most common practice in the major groundnut-producing areas in India. In the Ceded districts, however, a three to six-tyned seed drill with 9½" to 11" spacing between coulters is used for sowing and the seed covered by working a *Guntaka*. A spacing of 1 foot to 9 inches for the spreading type and about 9 inches to 6 inches for the bunch type is found to be the optimum. When groundnut is raised in rich soils receiving good rainfall or under irrigated conditions a wider spacing upto 1 to 1½ feet may be necessary.

The seed rate depends upon the growth habit of the variety i. e., bunch or spreading type, the economic spacing for the tract and the size of kernels of the variety used. On an average about 100 lb. of kernels per acre will be required for the bunch types and about 80 lb. for the runner types in ordinary soils, where groundnut is raised as a rainfed crop. Under irrigated conditions the seed rate may be reduced by about 20 percent. Lower seed rate will result in thin stand and consequent reduction in yield.

Inter cultivation: Normally two hoeings and weedings are given to the crop, the first about 3 weeks after sowing at the time of first flowering and the second about a month later. No hoeing and weeding is done after the plants have flowered and pod formation has started as the operation would disturb the pod stalks that have entered the soil, and thus interfere with pod development. Inter-cultivation is generally done with hand hoes. Where sowing with seed drills is in vogue, intercultivation with implements such as small blade harrows is common. In localities where the bunch variety is grown in rows, ploughing is sometimes given to earth up the plants as this is said to facilitate easy penetration of the pegs and increase pod formation.

Harvest: The harvest of groundnut should be done when the crop is fully mature and in bright weather, to facilitate speedy and proper drying of the produce. The outward signs of maturity are the yellowing and withering of the leaves. The confirmatory test, however, is to pull out a few plants here and there and see if the majority of pods are mature and free from extra moisture in the shells, crack when pressed and show distinct development of colour in the testa. The development of a dark tint inside the shell is also an indication of maturity.

Harvesting is the most costly item in the cultivation of groundnuts. The method of harvest adopted depends upon the variety cultivated and the moisture conditions of the soil. Bunch varieties are invariably harvested by pulling out the plants. If there is sufficient moisture in the soil, all the pods come away with the plants. If the soil is fairly hard and not loose, the plants are lifted by working a harrow or using a hand-hoe. After the plants are uprooted the pods are removed immediately from the plants by hand, or the plants allowed to dry in the field or on the drying floor and the pods removed by beating against a bar. In the runner types the fields have to be dug with mammatties, ploughed and harrowed before the vines are gathered and the pods hand-picked from the soil. Various kinds of implements are used in different localities. In the Ceded districts the practice is to work a blade harrow called *Pedda Guntaka* drawn by two or more pairs of bullocks. The blade of the harrow cuts the soil below the depth at which pods the buried. The vines are first removed and later the detached pods from the soil are picked, if necessary, by throwing the soil into ridges and furrows by working a smaller blade harrow "*Bodha Guntaka*" whose interspace between the beam and the blade is blocked by tying ropes. This operation is generally carried out twice in two opposite direction. In certain tracts smaller guntakas or wooden ploughs to which a mammatty blade is attached are used for uprooting the plants. The pods are stripped from the vines immediately after harvest in rainy tracts, while in the drier areas they are heaped up after drying, and the pods removed later by beating with a flail or stirring of the vines. Gathering the detached pods from the soil by gleaning with hand is also common in some localities. In certain parts of Tiruchirapalle, Tanjore and South Arcot districts, where groundnuts are grown in garden or wet lands under irrigation, it is usual to allow the field to dry and then irrigated and pull out the vines and finally plough up the land a number of times when the pods float and are gathered. The pods so gathered are dried soon after harvest, lest they get mouldy due to the presence of excessive moisture.

Yield: The yield of groundnut (nuts in shell) is found to vary considerably in different parts of India. This is due to a number of factors such as the variety grown, nature of the soil, season and the cultural and manurial treatments given to the crop. Spreading varieties generally yield much more than the bunch varieties and the yields under irrigated conditions are nearly double those of rainfed crops. Of the different environmental factors, rainfall and its distribution during the growing season seem to affect the yield to the maximum extent. When the rainfall is moderate and well-distributed, good yields are obtained on all types of soils. But when rains are deficient or badly distributed, soils capable of retaining moisture for longer periods like black cotton soils give comparatively higher yield than the other types of soils. On the other hand, excessive rains reduce the yield in such soils much more than in lighter and well-drained soils.

The yield per acre worked out for the important groundnut tracts in India for the quinquennium 1942 – 43 to 1946 – 47 are given in the following :

Province or State			Average yield in lb. per acre (Nuts)
Provinces :			
Madras	...	...	931
Bombay	...	...	764
Central Provinces	...	...	627
United Provinces	...	...	1,065
East Punjab	...	...	522
Orissa	...	...	891
States :			
Hyderabad	...	...	722
Mysore	...	...	546
Baroda	...	...	544

The out-turn per acre is comparatively more in Madras, than in any other State in India. While the yield per acre obtained in India is comparable to the out-turn in Africa and United States of America, it is less than that obtained in China (1,630 lb.) and in Mauritius (2,230 lb.)

Quality : The term "quality" as applied to groundnut has different connotations to the farmer, the merchant or the miller who is appraising it. To the farmer a good quality groundnut may mean one which is resistant to pests, diseases and drought and gives heavy yield. The merchants value shelling out-turn and natural test weight (volume weight relationship) of pods and kernels most. To the crusher, the oil and the free fatty acids contents are the most important factors, because on them depend the ultimate yield and quality of the oil.

It is, however, seen that these qualitative characters even though varietal in nature are to a great extent influenced by seasonal and environmental factors. The range in values of some of the important qualitative characters observed in four pure lines when grown under different climatic and soil conditions in different parts of India is given in the following :

Variety	Habit of growth	Duration in days	Range of values		Oil percentage
			Shelling percentage	No. of kernels per pound	
Spanish	Bunch	105	67 – 80	1047 – 1620	47·2 – 54·7
Hebbal—1	Bunch	120	65 – 80	807 – 1160	45·9 – 55·6
Bassi	Semi-spreading	130	66 – 77	755 – 1210	45·2 – 55·8
Carolina	Spreading	140	66 – 77	875 – 1213	45·0 – 55·5

The important characters are discussed below :

(a) *Shelling out-turn :* The percentage of kernels to pods by weight or shelling out-turn is important because in the terminal markets where groundnut is purchased by exporting firms transactions take place only as kernels. Whatever may be the yield of nuts the final valuation of the produce is on the basis of kernels.

Shelling out-turn or shelling percentage is found to differ in different varieties and in the same variety in different years. It is governed by a number of factors, viz., thickness of shell, the development of kernel inside and the nature of the constriction of shell between seeds, etc., and the distribution of flowering during the cropping season. Bunch varieties like Spanish and Red Natal in which the shell is thin and kernels are plump and completely fill the cavity of the pods, generally possess a high shelling percentage (between 77 and 80 percent. as in Gudiyatham Bunch and Small Japan) when compared to the spreading varieties which are mostly thick-shelled and give only low shelling percentages of 60 to 75 percent. (var. nambyquarae and Carolina). Shelling percentage is also comparatively low in varieties having deeply constricted pods. When the rainfall is low and badly distributed at the fruiting period or when the precipitation at this time is rather heavy the shelling percentage is low. The produce from an irrigated crop has generally a lower shelling percentage than the produce from a rainfed crop. The effect of the nature of the soil, however, on this character is negligible.

(b) *Natural test weight:* The natural test weight or the weight per unit volume of pods (nut in shell) is utilised in assessing the degree of maturity and development of kernels when groundnut pods are disposed off by volume. This factor is also found to be considerably influenced by rainfall and its distribution at the flowering and pod-forming period. Varieties with small pods have generally higher natural-test-weights (Local Mauritius) than those with larger pods (var. nambyquarae) because the small pods pack more compactly in any container.

(c) *Size of kernels:* The size of kernels expressed as number of kernels per unit weight is utilised by trade in fixing trade standards of commercial varieties, particularly, in regard to produce marketed for edble purposes. It is, however, seen that even in the same variety this character is subject to variations due to environmental factors.

(d) *Percentage of oil:* Oil content of kernels is much emphasised particularly in overseas markets in valuing groundnut kernels. This character is to a large extent influenced by the degree of maturity of the kernels and also the distribution of rainfall during the production phase of the crop. It is only when the kernels are well developed that the maximum oil content is obtained. Studies made in the Oilseeds Section show that harvesting the crop even a week in advance of proper maturity affects the oil content of kernels. The oil percentage is generally somewhat higher when the crop suffers from want of water rather than when it has excess of it. Spreading varieties generally contain slightly more oil (50 percent. by chemical extraction) than the bunch varieties (49 percent.).

(e) *Free fatty acids :* Free fatty acid content is important in judging the keeping quality of the produce especially when the oil extracted has to be utilised for edible purposes. When the free fatty acids content is high the oil has to be refined before use and refining is a costly process, and it results in higher yield of acid oil suitable for soap making only. Consequently produce having a higher free fatty acids value is discounted by exporters. About 2·5 percent. of free fatty acids is usually allowed in groundnut kernels by trade. The high free fatty acids content of South Indian groundnuts shipped to foreign councries has been estimated to result in considerable financial loss (about 55 laks of rupees annually).

Studies on different aspects of free fatty acids content of kernels done in the Oilseeds Secton have shown that it is not a varietal character but is largely influenced by weather conditions prevailing at the maturity period of the crop or at the harvest time. Heavy and continuous rainfall at the period of maturity and wet and cloudy weather at harvest which interfere with drying operations tend to increase acidity. High free fatty acids content of commercial groundnuts has also been traced to the following causes :

i. Harvesting pods when not fully mature

ii. Incomplete drying before storing

iii. Damping produce before shelling or marketing, and

iv. High percentage of damaged and broken kernels.

(f) *Colour of pods and kernels :* Attractive colour for pods and kernels is an important characteristic when the produce has to sold for edible purposes. Light golden yellow colour of pods and rose colour of kernels are considered best. However, the colour is influenced by the nature of the soil and the rainfall conditions at maturity. Produce of sandy loam soils is always clean and of good colour whereas pods from black or clayey soils will have dull colour with soil particles sticking to them. In some foreign countries artificial bleaching of pods is resorted to, Rainfall at the harvest time often spoils the appearance of both pods and kernels.

Eflect of climate and soil on the yield and quality of groundnuts : It is recognised that the yield as well as the qualitative characters of the groundnut like shelling percentage, natural test weight, size of kernels, percentage of oil and free fatty acids are influenced by climatic and soil variations, but practically nothing is known regarding the extent to which they are influenced. In order to gather information on these aspects, six groundnut pure lines were grown for three consecutive seasons in about thirty Agricultural Research Stations distributed throughout India. Samples were received from

each of these centres and analysed in detail for the various characters. In 27 Research Stations one or more of the pure lines gave significantly increased yields over the local varieties and have become popular. Important conclusions drawn from the study of qualitative characters are the following :

i. All characters studied are seen to be influenced by the rainfall and its distribution during the growth of the crop.

ii. The nature of the soil and its capacity to retain moisture comes into prominence only when the rainfall is excessive, low or badly distributed.

iii. Characters such as natural test weight of pods and kernels and size of kernels though highly infiuenced by environmental conditions are essentially varietal in nature.

iv. Shelling percentage is also varietal and influenced by environments.

v. Oil content which is a varietal character is also found to be fluctuating even up to 7 percent. from season to season.

vi. Free fatty acids content is purely environmental in nature dependent upon seasonal conditions at the time of harvest and subsequent handling of the produce.

Cost of production : The cost of production is fairly high for the groundnut crop on account of the fact that a heavy seed rate is required to be used and considerable labour is required to be employed for harvesting and threshing. The cost of cultivation of the spreading variety of groundnuts grown under rainfed conditions for the pre-war and post-war periods in South Arcot District is as under :

Particulars			Prewar Rs.	Postwar Rs.
Cost of cultivation :				
Ploughing		...	6	10
Manures and manuring		...	7	24
Seeds and sowing		...	6½	31
Hoeing and weeding		...	3	18
Harvesting and threshing		...	10	32
Drying and storing		...	1½	4
Land assessment		...	1	1
Rent on land		...	10	40
	Total	...	45	160
Value of produce :				
1,000 lb. of pods @ 20 lb. per rupee	50		@ 5 lb. per rupee	200
2,500 lb. of haulms @ 1,250 lb per rupee	2		@ 500 lb. per rupee	5
Total	52			205
Net profit per acre	7			45

In the Ceded districts where labour-saving implements are used, there is marked reduction in the cost of cultivation by nearly one-third.

Seeds and sowing and harvesting are the two most costly items which account for nearly half the total cost of production. Still, under existing conditions of high prices prevailing for groundnut, it is profitable to grow the crop. But in course of time as the price levels tend to come to normal it may not be possible for the groundnut grower to meet the high cost of production and compete with other countries in foreign markets. Therefore it is necessary to think out ways and means of reducing the cost of cultivation. Cost of seed may be beyond the control of the grower as it is dependent upon other external factors. But economy may be effected by using optimum seed rate and sowing the seed with seed drills. The use of seed drills would regulate the seed rate and at the same time help in sowing a larger area at lesser cost. Wherever conditions are favourable either the local or the mechanical seed drill may be used for sowing groundnut.

In the matter of harvesting and threshing there is ample scope for reducing the labour charges. The use of the blade harrow (either the indigenous Guntaka or H. M. Guntaka) has been found to be very efficient for lifting the groundnut plants, leaving a minimum of detached pods in the soil. The operation is done quicker and at comparatively less cost. Even in the matter of threshing i. e. separating the pods from the vines considerable saving in labour costs can be effected by the use of machines. Machines for threshing, cleaning and bagging have been put on the market by foreign manufacturers and with certain modifications it should be possible to utilise them for large-scale threshing of groundnut. The average holding of the cultivator in our country being very small and the cost of such threshing machinery being prohibitive, there may not be immediate scope for their large-scale introduction. But such machinery may be purchased by the big growers or Growers' Co-operative Societies, and hired out to members. In this connection, it may be of interest to mention that special combines have been designed in the United States of America for harvesting and threshing of groundnuts simultaneously and these machines have considerably reduced the man power required for these operations.

For the purpose of adapting foreign machinery to Indian conditions and for testing the efficacy of the indigenous implements with power traction, a special scheme for carrying out large-scale trials of various types of machinery for groundnut cultivation is under the consideration of the Government.

7. Pests and Diseases: (a) *Pests:* The important insect pests affecting the groundnut crop in Madras are the red-hairy-caterpillar *(Amsacta albistriga)*, the leaf miner or Surulpoochi

(Stomopteryx nerteria) the groundnut bug *(Aphanus sordidus)* thrips *(Scirtothrips dorsalis)*, Verpoochi *(Sphenoptera perotetti)* aphids and termites.

Red Hairy caterpillar : This pest occurs in a serious form in particular localities in South India, viz., South Arcot, North Arcot and Tiruchirapalle. It is reported to do considerable damage to the crop not only in Madras but also in Hyderabad and Mysore with the onset of the heavy rains of the South-West monsoon. The moths emerge from the pupae buried in the soil, and lay their eggs in large numbers on the leaves of groundnut and other cereal crops. The red-hairy-caterpillars that hatch out from these eggs feed voraciously on the leaves and defoliate the plant. In years of bad attack, entire fields are laid bare. The control measures adopted are (i) digging out of the pupae from shady places of the field (ii) ploughing with an inversion plough and exposing the pupae (iii) hand-picking and destruction of the moths which are very sluggish and which emerge in large numbers soon after the heavy rains in July—August (iv) collection and destruction of egg masses and (v) trenching round the attacked field to trap the caterpillars and prevent their migration to other fields.

A pest act is in force in certain taluks of Tiruchirapalle, South Arcot and North Arcot districts where this pest is endemic.

Surul poochi : This occurs in a pest form in years of deficient and badly distributed rainfall. The moths which are small and grey in colour lay the eggs on the leaves of groundnut plants. The creamy-white larvae mine into the leaves and later web them together and feed on the green matter. In years of severe infestation the entire plant appears dried up. The life-cycle of the pest being very short, even up to four broods have been noticed in one season. Dry weather favours the appearance and progress of the pest while heavy rains destroy it. The moths are attracted to light in large numbers.

Investigations carried out on this pest under the Indian Council of Agricultural Research 'Scheme of Research on Pests and Diseases of Groundnut' show that the yield of the groundnut crop is reduced upto 25 percent. in years of severe infestation of the pest. Light traps (ordinary hurricane lights) are effective in reducing the infestation of the pest up to a distance of 50 yards from the light, and working at this rate, it will be necessary to set up a light trap for every 1·7 acres of the crop. Among the insecticides tried D. D. T. (5 percent.) is very efficacious in preventing the incidence of the pest.

Groundnut Bug has been reported to cause appreciable damage to groundnuts in Bombay. The bugs appear in large numbers and suck the oil out of the kernels both in the field and on the drying floor and occasionally from stored material.

Verpoochi : The larvae of the beetle is found to burrow into the stem of the groundnut plant close to the soil surface or into the

tap root and kill the plants. The attack is generally more in the irrigated than in the rainfed crop. Effective control measures are yet to be worked out.

Thrips have been observed to affect the crop in the early stages. The incidence of this pest is severe during dry periods and disappears with the advent of heavy showers as in the case of *Svrul-Poochi.* Spraying tobacco decoction or dusting of Gammexane have beed found to be effective in controlling the damage by this pest. Aphids and termites are only minor pests of groundnut.

A number of insect pests have been noted to damage stored groundnuts. They are: the caterpiller pests, *Corcyre cephalonica, Ephestia cautella;* the beetle pests - *Tribolium castaneum, Necrobia rufipes, Oryzaephilus surinamensis, Carpophilus dimidiatus.* Observations on these pests carried out under the 'Scheme of Research on Storage of Groundnuts in Madras show that most of them are seasonal and the damage done especially to stored groundnut kernels is considerable. Prophylactic measures such as clean flooring, periodical cleaning and proper aeration of the godowns have been found to considerably reduce the infestation and damage by these pests.

(b) *Diseases:* The important diseases of the groundnut crop are Tikka leaf spot *(Cercospora* Spp.*)* Wilt *(Rhizoctonia bataticola), Sclerotium rolfsii,* and the clump or bunchy top.

In Tikka the fungus attacks the leaves causing brown spots. The leaves gradually turn yellow and ultimately wither and get shed. Humid conditions are found to favour the incidence and spread of the disease. Trials carried out under the Scheme of Research on Pests and Diseases of Groundnuts in Madras have shown that of the serval fungicides tested, spraying with Bordeaux mixture (¾ per cent.) and dusting sulphur (300 mesh at 15 lb. per acre) reduce infection of the crop considerably, and increase the yield of the crop.

The wilt disease occurs in a spasmodic form mostly in the crop raised in summer months under irrigation. In the affected plants the leaves and branches droop at first and finally get dried up completely. Soil and seed treatment trials carried out at the Agricultural Research Station, Tindivanam showed that plots treated with 'cattle manure and potash' had the least percentage of wilt affected plants.

The Clump or Rosette or Bunchy top disease appears mostly in the irrigated crop. The symptoms of the disease are arrested growth of the plant and reduced size of leaves and internodes giving the characteristic clump appearance to the plants, and the insect vectors responsible for the transmission of the disease are certain species of aphids.

(To be continued)