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Achievements in Oilseeds Research in the Madras State*

by

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Of the commercial crops grown in India, Oilseeds play a very significant role in the Indian economy, specially after the World War I.

A review of the area and production of the principal commercial crops in India indicates that Oilseed crops are cultivated over an area of 34·3 million acres producing about 6·8 million tons of oilseeds, while all the other commercial crops such as cotton, sugarcane, jute and tobacco, together occupy only 27·2 million acres producing 10·6 million tons.

Among the oilseed crops, groundnut, rape and mustard, sesamum, linseed and castor are the major ones cultivated in India. The area and production in India and in the Madras State are as follows:

Area and Production of Oilseeds in India and Madras State (1961—'62)

Oilseed Crops	India		Madras State	
	Area in thousand acres	Production in thousand tons	Area in thousand acres	Production in thousand tons
Groundnut	15,848	4,682	2,076	1,004
Rape and Mustard	7,598	1,285	1	<0·5
Sesamum	5,561	366	313	40
Linseed	4,211	391	<0·5	<0·5
Castor	1,108	101	30	5
Total	34,326	6,825	2,420	1,049

Annually, about 40 thousand tons of oilseeds, 32·6 thousand tons of oils and 4·84 lakh tons of oilcakes costing 361 million rupees are exported from India as detailed below:

Export of Oilseeds and their products from India—Quantity and value (1961—'62)

Oilseed	Quantity (in tons)				Value of the produce (in million rupees)
	Seed	Oil	Cake	Total	
Groundnut ...	38,137	6,789	4,46,531	4,91,457	206·76
Rape and Mustard	7	194	3,99,097	3,99,298	0·51

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Oilseed	Quantity (in tons)				Value of the produce (in million rupees)
	Seed	Oil	Cake	Total	
Sesamum ...	275	6	210	491	0·39
Linseed ...	1	392	6,904	7,297	3·44
Castor ...	...	24,881	...	24,881	39·95
Others (Niger, Safflower, Olive, Mahua, tobacco and cotton) ...	1,710	345	30,820	32,875	10·14
Total ...	40,130	32,607	8,83,562	9,56,299	261·19

Realising the importance of the crop in the agricultural economy, the State Government undertook research work on oilseeds as early as 1905 at the Agricultural Research Station, Palur and later, in the year 1926 by establishing a research station exclusively for oilseed crops at Palakuppam (near Tindivanam) in South Arcot district. Subsequently in 1930 a separate wing for oilseeds in the State Department of Agriculture was constituted. The then Imperial Council of Agricultural Research and the Indian Central Oilseeds Committee were also responsible for intensified research in the State by offering generous financial assistance in the implementation of several projects on oilseeds.

In this article an attempt has been made to review the progress made so far in oilseeds research in this State and to bring out the achievements in the improvement of the oilseed crops.

Groundnut (*Arachis hypogaea* L.): A comprehensive world collection of varieties and forms of groundnut was made and classified systematically. Forty distinct varieties were described and grouped into 7 main groups and 22 sub-groups based on morphological and economic characters (John *et al.*, 1954).

Six improved strains of groundnut have been evolved and released for general cultivation in the State. Of these, strain TMV. 1, is spreading in habit evolved through mass selection from an African variety "Saloum" and TMV. 2 with bunch habit of growth evolved from a local 'North Arcot bunch' groundnut. Following the pureline method of breeding, strains TMV. 3 (isolated from the west African variety 'Bassi'), TMV. 4 (selected from an American variety 'Carolina') and TMV. 6 - a bold kernelled type with 3·12% sucrose and 29·07% protein suitable for dessert purposes - have been evolved. A bunch type (TMV. 5) with dormant seeds, has been isolated from the progenies of a cross between "Gudiyatham Bunch" and "Native Tanganyika". Increased yields ranging from 25 to 30% have been recorded and an area of 6·71 lakh acres in the State, have been covered by these strains deriving annually an additional quantity of 41 thousand tons of oilseed.

Further work on the evolution of strains possessing special attributes such as high oil content, high shelling outturn and drought resistance, are in progress. The available germ plasm of the cultivated varieties being limited, greater variability in the breeding material has been introduced utilising the wild species of *Arachis* in hybridization.

In order to establish the relationship between the different components of yield and the final yield to help in fixing the criteria for initial selection, correlation studies were undertaken. The results indicated a positive and significant correlation between the ratio of the average length of primaries to the height of main axis and the weight of pods (Seshadri, 1962). Correlation between yield and certain other morphological attributes and also between the yield components were established by Dorairaj (1962).

In the agronomic aspect, experiments carried out at the Agricultural Research Station, Tindivanam showed that ploughing 4–6 times with either the country plough or the improved plough resulted in higher yields (Seshadri, 1962). A spacing of 9" either way for the spreading and 6"×6" for the bunch varieties has been found to be the optimum for the rainfed crop. A seed rate of 75 lb. of kernels for the spreading and 100 lb. for the bunch types has been fixed. For raising an irrigated crop of bunch groundnut, 80 lb. of seeds for a spacing of 12" either way and 120 lb. for a spacing of 9"×6" have been advocated (Bhavani Shanker Rao and Srinivasalu, 1957). Further experiments disclosed the benefits of adopting wider spaced rows and thicker sowing in the row. Spacings of 24"×3" and 18"×4" gave increased yields of 22 and 9·7 per cent respectively over a normal spacing of 9" either way for the spreading groundnut. The wider spacings facilitate easy inter-cultivation by implements and result in a saving of about Rs. 10–14 per acre (Bhavani Shanker Rao *et al.*, 1959).

Manurial experiments on the rainfed crop have shown that cattle manure at 2½ tons, superphosphate at 1 cwt (20 lb. P_2O_5) and ½ cwt of muriate of potash (35 lb. of K_2O) gave the maximum yield, while 5 tons of cattle manure, 1½ cwt of superphosphate (30 lb. P_2O_5) and ¾ cwt of muriate of potash (50 lb. of K_2O) were found to give economic returns from an irrigated crop (John *et al.*, 1948; Krishnaswami, 1961). Experiments conducted to determine the duty of water for the groundnut crop cultivated in the black soils indicated the requirement as 156 acre inches. It was also indicated that irrigating the spreading groundnut every 10th day after the first flowering gave the highest yield (Bhavani Shanker Rao and Srinivasalu, 1955).

At the Agricultural Research Station, Tindivanam, two hand hoeings and weedings have been found to be superior to one hand hoeing and weeding as the former practice facilitated better production of flowers and pods (Seshadri, 1962).

Trials on the continuous cropping of groundnut with and without manuring were carried out at Palakuppam. Continuous cropping of groundnut without manuring reduced the yield by about 22 per cent particularly in years of low

and ill-distributed rainfall (Anon., 1935). A similar result was obtained at the Agricultural Research Station, Palur (Kulandaisami and Avudainayakam, 1927).

Patel (1935) has reviewed the results of rotation experiments of groundnut and cereals at the Agricultural Research Station, Palur. He has concluded that *cumbu (Pennisetum typhoides)* is ideal for mixed cropping with groundnut. Root studies carried out at the Agricultural Research Station, Hagari have shown that groundnut-*tenai (Setaria italica)* mixture as compared with horsegram-*tenai* and *pillipesara-tenai* is an ecologically sound combination, in view of the fact that the root system of groundnut and *tenai* have separate feeding zones. Mixed cropping trials have revealed that groundnut crop suffers reduction in yield when grown as a mixture, the maximum depression of 50 per cent being observed when grown with *cholam* and the minimum depression of 19 per cent with *tenai* (John *et al.*, 1943). Seshadri *et al.* (1956) have indicated that groundnut when raised as a mixture with cotton, red gram and castor was found to be more remunerative than as a pure crop. Trials to test the effect of growing groundnut on the succeeding crop of cereals and *vice versa*, have shown that cereals following groundnut recorded significant increase in yields ranging from 43-124 per cent over cereals grown year after year (Seshadri *et al.*, 1954).

Harvesting the crop even a week in advance of full maturity affected the oil content (Patel and Seshadri, 1934). The experiments conducted on problems connected with storage indicated that groundnut should be stored as pods rather than as kernels, with moisture content of less than 5%. Among the different dunnage materials, dry sand to about a foot depth covered over by clean gunny *purdah* appeared the best. The produce from the winter crop did not deteriorate rapidly as the produce from the summer crop. For storing small quantities of kernels for seed purposes, mud bins appeared to be suitable (John 1945 & 1949; Narayana, 1954). Kernels of the 'Peanut' and 'Red Natal' varieties stored in gunnies lined with polythene, maintain low acid values even in the final stages of storage. The 'Peanut' variety with initial moisture content has not developed much acidity while the 'Coromandal' with comparatively low initial moisture content was noted to develop a higher acid value. As regards the containers, the galvanized iron drum and mud pots were found to be inferior to the gunny bag and gunnies lined with polythene (Ramanathan *et al.*, 1962).

The development of root system in the bunch, spreading, semispreading and trailing types was studied by Seshadri *et al.* (1958.) The differences in the root system of the different types have been brought out and the possible relationship to drought resistance and spacing has been established.

Narasinga Rao (1936) found that the total water requirement was the highest for "Saloum" (a long duration spreading variety) while the "Gudiyatham bunch" (a short duration variety) required the minimum. The role of different nutrients in groundnut was studied in detail by Gopalakrishnan and Nagarajan

(1958). Deficiencies of nitrogen and phosphorus resulted in low yield and where phosphorus was deficient, a low shelling outturn was recorded. A significant influence on the flower production was recorded in plants arising from seeds presoaked with mono and dibasic phosphates (Gopalakrishnan *et al.*, 1961). Bhavani Shanker Rao *et al.* (1956) found that ethylene chlorhydrine and extract of non-dormant groundnut seeds were useful in breaking seed-dormancy. Later work proved that storing the kernels of the spreading variety at 40° — 50° C for a period of 12 days resulted in breaking the dormancy and the practical application of this finding led to the use of the rainfed season's produce for raising the subsequent summer crop. In an aquous extract of the seeds of strain TMV.2 the existence of a concentration of a hormone with an IAA equivalent of 10·75 (538 ppm) was indicated (Nagarajan and Gopalakrishnan, 1957; Venkateswaran and Gopalakrishnan, 1959).

Soil application of trace elements was found to be preferable to foliar application. Among the trace elements, boron, when applied at 10–15 lb. per acre in the form of borax or boric acid increased yield upto 30 per cent (Gopalakrishnan *et al.*, 1958; Gopalakrishnan and Veerannah, 1962).

Patel *et al.* (1936) studied the inheritance of the habit of growth in groundnut and showed that spreading behaved as dominant. Characters like branching and 1–2 or 1–3 seeded nature of the pods were shown to be governed by a single gene, while duration, hairiness, fading of flowers and seed dormancy were found to be incompletely dominant. Duplicate factors govern the inheritance of pigmentation and colour of seed coat, while the purple crescent on the standard petal was found to be governed by a factor that expressed in the presence of a factor for stem colour (Patel *et al.*, 1936; John *et al.*, 1948 and Seshadri, 1962).

Results of intensive cytological investigations in the genus *Arachis*, are available in the scheme for research on the cytology of groundnuts worked at the Agricultural College and Research Institute, Coimbatore. Diploid (2n=20) and tetraploid (2n=40) species have been identified, and a study of their meiosis led to an understanding of the nature of polyploidy, probable origin and the basic chromosome number for the genus.

The interspecific hybrids in *Arachis* have been economically exploitable. Backcrosses of the allotriploid (*A. hypogaea* x *A. villosa*) to *A. hypogaea* as female parent produced only tetraploids but it was significant that all the hybrids differed in morphological characteristics from each other providing a wealth of material suitable for selection from the economic point of view. A study of the F_2 population raised from a single backcross F_1 has shown a wide range in the expression of the major characteristics which are contrasted in *A. hypogaea* and *A. villosa* (Raman, 1960). In general, there is a trend towards greater resemblance to *A. hypogaea* with the resistance to 'Tikka' leaf spot introduced. The derivatives of the synthetic tetraploids offer greater scope for selection due to their greater variability in attributes desirable from the economic point of view.

Thus, the role of allotriploidy as an intermediate stage in experimental gene transfer from related diploid species to the tetraploid *A. hypogaea* is made explicit (Raman and Kesavan, 1963, Gopinathan Nair, 1963).

Hybrids between the seed fertile species, *A. hypogaea* and *A. moticola* could be easily produced. They were more vigorous than the parents with larger leaves and flowers. Fertility was high but in the F_2, semispreading and trailing plants with 1–2 kernels per pod and thin shells were observed, which assure the possibilities of selection for economically superior types (Raman, 1958; Varisai Muhammad, 1960).

Practical control measures against the major insect pests and diseases affecting the groundnut crop in the State were evolved under the scheme for research on pests and diseases of groundnut implemented during 1943–47 (John, 1947). *Surul Poochi (Stomopteryx nerteria)* could be controlled by setting light traps for every 1·7 acres or by dusting DDT 5 per cent. The use of DDT and tobacco decoction was found to control groundnut thrips. Fumigation with chlorosol proved extremely effective in controlling the bug *Aphanus sordidus*. For the control of 'Tikka' leaf spot disease *(Cercospora personata)* Bordeaux mixture at $\frac{1}{2}$ and $\frac{3}{4}$ per cent applied at triweekly intervals was found to be effective and increasing the yield by about 40 per cent.

Sesamum *(Sesamum indicum* L.*)*: Three improved strains of gingelly with high yield and oil content have been released for general cultivation in the State. Strain TMV. 1 (a medium duration type of 85 days evolved by mass-selection), suited for cropping both under rainfed and irrigated conditions, records an oil content of 50%. Strains TMV. 2 and TMV. 3 were evolved by hybridization, former from a cross between 'Nagpur white' and 'Sattur' and the latter between 'Tindivanam local' and the wild gingelly from Malabar. Strain TMV. 2 is suited for cold weather cropping and is characterised by the presence of six to eight loculed capsules and dull white seeds. These record an oil content of 50 per cent.

Inheritance studies of characters such as colour on the outer surface of the corolla, colour of anthers, colour of the ring at the base of the style, number of flowers at the axil, loculed nature of capsules have been determined by John (1934).

Hybridization between the different species of *Sesamum* was attempted as early as 1950. In the crosses, *S. prostratum* (n=16) x *S. laciniatum* (n=16) and *S. occidentale* (n=32) x *S. radiatum* (n=32) and their reciprocals, high crossability has been noticed and the hybrids proved fertile. In the crosses, *S. indicum* (n=13) x *S. laciniatum* (n=16) and *S. indicum* x *S. prostratum* (n=16), partial setting was obtained. In the combinations, *S. occidentale* (n=32) x *S. indicum* (n=13) and *S. occidentale* x *S. laciniatum* (n=16) where the chromosome number of the parents differ, setting has been observed giving rise to both shrivelled and normally developed seeds which do not germinate. Complete failure resulting in the dropping off of the crossed flowers has also been noticed in crosses, *S. indicum* x *S. occidentale*, *S. laciniatum* x *S. occidentale* and *S. laciniatum* x *S. radiatum* where

species with the lower chromosome number was used as the ovule parent (Ramanathan, 1950). The hybrid *S. indicum* x *S. laciniatum* though vigorous in growth, is completely sterile. By treatment with colchicine a fertile amphidiploid, *S. lacinientale* possessing characters intermediate between the cultivated and wild species, has been synthesised (Aiyadurai *et al.*, 1962 and 1963).

On the agronomic aspect, the optimum spacings of the crop raised under rainfed and irrigated conditions have been determined as 9"x9" and 12"x12" respectively (Seshadri *et al.*, 1956) and an optimum seed rate of 5 lb. per acre is recommended for the rainfed crop. Sowing in late February or in the first week of March has been found to be the best for summer cropping (Seshadri, 1957). In the manurial trial, higher yields ranging from 20 to 31 per cent were recorded in the treatments N 30 K20; N 30 P20 and N30 P20 K20. The oil content in treatments receiving P20 and K20 have been found to be higher. For the irrigated crop a dose of 30 lb. of N in the form of ammonium sulphate over a basal dressing of 2½ tons of cattle manure has been found to be the optimum (Krishnaswami, 1961).

Aiyadurai and Krishna Marar (1950) studied the development of capsules. Maximum development in size takes place in nine days from the date of opening of the flower though it continues to increase gradually upto the 24th day. A steady increase in the dry weight of husk (of capsules) is seen upto the 21st day after flowering beyond which there is a decline. In the dry matter of the seed, increase is observed upto the 27th day with the maximum activity taking place between the 12th and 24th day. On the 27th day from flowering, capsules have recorded maximum dry matter production and oil content. Active synthesis of oil has been found to take place between the 12th and 24th day after flowering.

Castor *(Ricinus communis* L.*)*: Four improved strains of castor have been evolved of which three are annual with a duration of 6–8½ months recording an acre yield of about 750 lb. of beans and 50–55% oil content (Seshadri and Varisai Muhammad, 1952). The perennial castor strain, Co.1 is characterised by bold seeds with 59% oil content and yields from 2 to 4 lb. of beans per plant (John and Narasinga Rao, 1942). Of these strains TMV.3 and Co.1 have been evolved by pureline selection while TMV.1 and TMV.2 by hybridization. These occupy about 61 per cent of the total area under castor in the State. Eight ornamental castor varieties with attractively coloured panicles have also been isolated from the progenies of crosses and a few of these combine high yield and high oil content. Investigations are under way for the exploitation of hybrid vigour in this predominantly cross-fertilized crop and for the evolution of short duration annual and perennial strains suited for the plains.

The method for maintenance of vigour and purity of the strains, consists of growing the strains in isolated blocks, selecting outstanding plants true to type, comparing their performance in progeny row trials and pooling the produce of the lines that yield more than the general mean (Seshadri and Varisai Muhammad, 1952).

An optimum spacing of 3' × 3' for a pure crop of castor has been advocated (Seshadri and Varisai Muhammad, 1951). Studies on the defoliation in castor indicated that it decreased the general vigour of the plant, delayed the flowering and reduced the duration and yield. Plants defoliated at monthly intervals recorded 63·2 per cent decrease in yield while plants defoliated at fortnightly intervals showed a reduction in yield by 79·7 per cent over the control (Anon., 1954). Manurial experiments have revealed that application of 1½ cwt of ammonium sulphate (30 lb. N) over a basal dressing of 2½ tons of cattle manure resulted in economic monetary returns (Aiyadurai *et al.*, 1961). Harvesting castor heads when one or two capsules show signs of drying, drying them in the sun and extracting the seeds immediately has been found to be the best method. This practice not only ensures high oil and low free fatty acids content but also gives a high percentage of germination (Seshadri and Varisai Muhammad, 1955).

A distinct relationship between duration and development of root system was obtained. The root development was at its best between 6" and 9" of the soil. At the end of the third month of sowing, a spread of more than 15 feet of the primary laterals was noticed (Anon., 1954).

At the Agricultural Research Station, Tindivanam, the percentage of natural cross pollination has been found to range from 5-14 (Seshadri and Varisai Muhammad, 1951). The mode of inheritance of echinate nature of stem and petiole, colour of stem, gland and fruit, spiny nature of fruit, nature of epicarp, nature of stalk of capsules and branching of the stalk has been determined by Seshadri and Varisai Muhammad (1951). Of these, the echinate nature of stem and petioles, nature of epicarp and branching of stalks of capsules have been shown to be monogenic and incompletely dominant. The pigmentation in the stem has been shown to result from complementary gene action. Purple pigmentation on the spines of capsules was found to be dominant over its absence due to a single factor difference (Aiyadurai *et al.*, 1957).

The relationship between the waxy bloom coating and jassid infestation has been studied by Seshadri and Seshu (1956). Recent investigations indicate that the triple bloom varieties attract the least number of jassids (Dorairaj *et al.*, 1953).

A review of the acre yield and production of oilseeds in the country reveals that Madras leads all the other States in the yield of groundnut. It also stands high above the Indian average in the acre yield of sesamum and castor. The yield per acre of the major oilseeds of the State are as follows :

Oilseed		Average yield per acre (1960–'61)	
		India in lb.	Madras State in lb.
Groundnut	...	662	1,083
Sesamum	...	147	286
Castor	...	204	373

This high level of production in the State is mainly due to the use of improved strains and adoption of recommended agronomic practices. The impact of the various developmental projects like the oilseeds development scheme and the Package Programme for groundnut and gingelly on the yields is also obvious.

The improvements made so far do not seem to be adequate to meet the special demands of the varied soils and climates of distinct zones of the State. During the Third Five Year Plan period as many as ten research projects on the improvement of oilseed crops are in progress in this State. The integrated scheme for the intensive breeding of groundnut worked at the Regional Research Station, Tindivanam aims at evolving improved strains of groundnut possessing dormant seeds, bold kernels suited for dessert purposes and high shelling outturn. Another scheme for improving the Pollachi Red groundnut suited for the Pollachi tract (Coimbatore District) has been in operation since 1956. An improved strain (AH. 6279) is to be released shortly.

A programme of improvement of minor oilseed crops like safflower and niger is in operation at the Agricultural Research Station, Kovilpatti and Hosur. An improved selection of safflower (N. 852) has been found suitable to the black soil tract of the southern districts.

A coordinated manurial trial to fix up the optimum economic dose of N. P. K. for the monsoon and summer crops of groundnut and projects on the study of the bionomics and control of the red hairy caterpillar and cheap and effective remedial measures of the virus disease of groundnut are also in progress in the State. At Coimbatore, research on the physiology of growth, deficiency, nutrient uptake, trace element requirements and response to soil fertility is also in progress in the sesamum crop.

It is now proposed to intensify breeding work on groundnut at a centre in the North Arcot district with a view to evolving a superior strain to TMV. 2 now in large scale cultivation in the district. A scheme for the improvement of sesamum and groundnut for winter and summer seasons for the Cumbum valley in Madurai district and for the districts of Tirunelveli and Kanyakumari has also been proposed. To the semi-arid region of Tiruchengode in Salem district which is peculiar in its agro-climatic conditions suitable strains in groundnut and sesamum are needed. The irrigation projects in the State have created new problems in the pattern and period of cultivation. To begin with investigations on the evolution of a groundnut strain suited to the special needs of the lower Bhavani project have been proposed. Exploitation of the wild species of *Arachis* and *Sesamum* for the transference of useful genes into the cultivated varieties is a growing field, and it has been proposed to intensify work in this line of study.

Thus progress of the investigations on the research problems enunciated for being implemented during the fourth plan period and the results of the schemes under operation in the current plan will go a long way in contributing to the stabilisation of higher output of oilseeds in this State.

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