

income for the rotation under item (3) is, however, more than the income from the mixture (2) (Groundnut + *tenai*). When *ragi* + groundnut is rotated with groundnut + *cumbu* (item 4) the yield is better than when *ragi* + groundnut is rotated with groundnut + *tenai*. When more than one cereal is grown with the groundnut, a mixture of *tenai* and *cumbu* appears superior to the *tenai* and *ragi* mixture:

These results indicate that for the groundnut, *cumbu* is the ideal partner from among the various cereals which are widely grown, but why this is so is not apparent.

Summary.—The superior performance of the *Saloum* variety is shown. The correct spacing for the spreading variety is 9" × 9" and that for the bunch 6" × 6". The optimum seed rate for the spreading variety is about 60 lb. of kernels per acre and for the bunch 100 lb. per acre in red soils.

It is suggested that the crop previous to the groundnut should be manured instead of manuring the groundnut directly.

Tenai-groundnut, *ragi*-groundnut and groundnut-cotton are beneficial rotations. Mixed cultivation of groundnut and cereals is more economical than to rotate a cereal with the groundnut. *Cumbu*-groundnut is a better mixture than *tenai*-groundnut.

PRODUCTION AND MARKETING OF GROUNDNUT IN THE MADRAS PRESIDENCY.*

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Of the several crops introduced at various times into India, the groundnut must be said to have been of the greatest benefit to the South Indian farmers. All the world over, the United States of America not excepted, it is found, that the groundnut cultivation is only in the hands of the small farmer. The main commercial product, namely the oil, removes no plant food, and, being a legume, the crop has been found to get all its nitrogen, about 90 lb. on the average per acre, entirely from the air. Recent research (unpublished) of Mr. T. Rajagopala Iyengar, M. Sc., has proved beyond doubt that by inoculation with a special organism it is not only possible to increase the nitrogen fixation but also to definitely increase the yield of the crop and improve the quality. This discovery opens up a vast field for increasing the acre-yield of the crop which in Madras, is much above the world average. Madras produces over 1,000 lb. of pods per acre, while the world average is only 700 lb. To get the benefit of the increased production, we should, in addition to widening our market,

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see that the produce is put to an increased variety of uses in our own country.

Of all the groundnut growing countries, Madras may be said to have been a pioneer in developing its cultivation and trade. When in about 1890, there was a sudden fall in acreage due to the deterioration of the old country seed, we were almost the first to start an experimental station at Palur (South Arcot district) in 1905 and study this crop in detail. At that time it was the orthodox opinion, that only light soils were most suited to groundnut cultivation and that there was no possibility of growing a satisfactory crop of it, in the black soils. Our studies on groundnut for 30 years in light soils at Palur, Neduveerapet and Palakuppam have yielded valuable results which may be summarised as follows:—

1. When an enquiry into the deterioration and introduction of a new variety was made by Dr. Barber in 1899, he reported "two or three years ago, some thing like a revolution has occurred in the introduction of a new variety of groundnut. After careful enquiries extending over many thousand acres I was only able to succeed in finding four small patches of the original country seed, together equalling about one acre. The suddenness and the completeness of the change is worth considering." This is what a real improved seed should be able to achieve.

2. With adequate manuring and continuous cropping, the yield of groundnut was not seriously reduced.

3. It was more economical to raise a mixed crop of a cereal and groundnut, instead of rotating the two pure crops in two years.

4. In a fairly fertile gardenland, additions of lime or phosphatic manures had little effect and that even the return to the soil, of all the produce except the oil, did not increase the yield of crop over the no manure plot consistently for several years.

5. A high seed rate was quite essential for increased yields.

6. The time has come for changing the local Mauritius for a better yielding variety.

During this period, it has been a surprise to find that the black soil ryots of the Ceded districts tried this crop for the first time in about 1900 and within the last 35 years the area in the Deccan tract has far outstripped the area in the Southern Districts; while the Southern districts of Madras have been able to increase the area from 2'11 lakhs of acres in 1900 to 11½ lakhs of acres, the Ceded districts have in the same period, increased the area from almost nothing to 19½ lakhs of acres. The net return to the ryots of the Southern district is not more than 250 lb. of pods per acre while those of the Ceded districts ryots is about 750 lb. The method of cultivation,

cropping and harvesting adopted by the Ceded districts ryot are quite characteristic and in keeping with his traditional methods of cultivation of other crops. He adopts drill sowing, uses a much smaller quantity of seed per acre, inter-cultivates the crop with bullock power pulls out the mature crop with about 75% of the pods intact by a special adaptation of his *guntaka*, dries and stacks the crop with the pods for about 3 to 4 months until he gets his leisure, and threshes the crop instead of plucking the pods individually, winnows out the haulms and secures nearly 75% of the produce at less than a sixth of the cost of the South Arcot Ryot. This is almost the American system of cultivation except for this one difference, that while the American farmer finds it economical to allow pigs to fatten on the pods left in the field, the Ceded district ryot collects the same by a few cross-cultivations with *guntaka*. It was an interesting sight to see a ryot taking a stone roller and rolling his baked up groundnut field to force it to yield to his *guntaka*. Extensive experimental work is obviously necessary for suggesting improvements over this method of cultivation. But these practices with certain modifications to suit individual tracts can well be demonstrated in other groundnut areas of the Presidency, where more than half the produce some times goes towards harvesting charges. Organised team work is therefore quite necessary to raise food crops at the lowest cost, suited to different tracts wherein the plant breeder, the bacteriologist, and the agronomist will each contribute his share to improve the efficiency of crop production.

The produce being so dry is able to keep well for a long time and so the Ceded district ryot is not in such a hurry to sell his crop. It is this groundnut that is so largely responsible for supplying a steady foreign market and helping the local oil mills and the soap industry.

The southern district ryot is still unwilling to give up moistening and handshelling the produce in preference to machine decorticating, as he still finds from experience that he gets a better value since what he loses by way of unit value, he gains by the additional moisture which he adds for hand shelling. Machine shelling by itself does not improve the quality of the commercial product. During the harvesting seasons, the arrivals are very heavy and the only aim of the owner of the decorticating factory is to get as much business as possible during the short trade season. Very often the brokers themselves are the proprietors of the factories. As the wholesale purchasers are very keen to avoid breakages of kernels, moistening of the pods is invariably done before machine decorticating.

Further, drying of the kernels is rarely done as at this period there is hardly any space in the factory to dry and store the produce. Purchasing semi-dry produce and decorticating the same and mixing it with the hand decorticated moist seed to equalise moisture content is not an uncommon practice.

Groundnut keeps quite well in the shell for a long time, but it quickly deteriorates after shelling. Even for sowing purposes it is therefore the practice to shell pods just prior to sowing. Broken kernels help to increase the rancidity. Even the bruise on the skin of the kernel is sufficient to admit the easy entry of fungus and bacteria. The presence of a large quantity of moisture accelerates decomposition. It is necessary therefore to exercise a sort of official control and guidance over decorticating factories to secure minimum of breakage without any addition of moisture. Such a measure is reported to have secured absolute freedom from breakages, in other countries. Decorticated nuts suffer from fermentation which increases with the presence of broken kernels, as the free fatty acids in the latter increase during storage and transit. While this is the case with a dry produce, the deterioration is very much greater and more rapid in the case of moist samples. A test was conducted by the author on some export samples of groundnut kernels collected from different exporting firms. Twelve samples were collected from 12 different consignments just before these were loaded in trains for shipment. Each sample was immediately divided into two halves and one, the original, was kept in tins while the other half was dried thoroughly in a steam oven. Both were kept for about 6 weeks and two random samples were kindly analysed by the Government Agricultural Chemist. The dried samples were found to be perfectly good while the undried originals had become highly rancid showing from 17.5 to 101 acid value and were subject to fungus and insects attacks. As all other undried original lots were similar the entire lot was not analysed. This deterioration due to rancidity may be taken to mean at a modest estimate, a loss of about 25% of the value of the crop. If this is the sample that is being constantly received by the purchasers in the consuming centre they will naturally make full allowances for the losses, freights and refining charges, in ordering purchases. Madras Presidency is exporting about Rupees six crores worth of groundnut produce a year and a 25% loss on one item of deterioration during storage in transit would alone account for a loss of $1\frac{1}{2}$ crores of rupees a year. It is however, necessary to analyse a larger number of known samples both at the time of shipment and immediately on arrival at destination to enable us to get a correct estimate of losses on this account.

Export of groundnut in shell avoids moistening and the breakages of kernels and the consequential loss due to deterioration. The main objection is the extra space needed. But the French African possessions send a large quantity of their produce only in shells and China sends a part of her produce in shells to a distant country like America. There is no difficulty of space felt in sending the more bulky copra and cotton. When we remember that we contribute to a third of the world's export of groundnut products, we have a claim for asking for greater consideration at the hands of the shipping firms in the

transport of our produce to avoid loss in storage during transit. Extraction of oil with the shell is said to give a better quality of oil with better keeping quality.

The high protein content of the oil cake, the absence of an impetus on the part of the Indian cow keeper to improve the milk yield of his cow and his partiality for gingelly and coconut cakes have been responsible for not feeding milch cows with groundnut cakes. The country cows particularly do not appear to respond very well to feeding with cakes. But the reduction of the protein content in the groundnut cake by the milling of the nut with the shell is likely to make the cake cheaper and it has been found that the presence of the shell has no injurious effect on the animals. It is just possible that it may even add to the digestive value. Feeding trials of cakes made this way to local cows and bullocks is likely to lead to useful results.

The feeding of cattle with cakes and recovering a good portion of the manurial ingredients in the dung and thus indirectly manuring the soil with cakes must be tested in our experimental stations, and the same made a special item of propaganda, before contemplating any action to stop the export of cakes which is often a subject of agitation.

The keeping quality of oil is largely dependent on the seed. If the seed is rancid the oil also becomes rancid, the rancidity increasing during storage. Latest scientific methods of refining, deodorizing, and hydrogenation have brought about profound changes in the oil industry and the groundnut oil has been pre-eminently useful in forming either a substitute for or adulterant with all other oils and fats. By the process of hydrogenation it has been found possible to harden this oil and this fat is least liable to rancidity. It is therefore essential that we take up the oil production ourselves adopting the latest improvements and export the solid fat to consuming centres and thus save the enormous losses that we incur every year. Research on an extensive scale is indicated in carrying out this programme and the volume of trade and the extent of national loss that we incur every year are the justifications for the proposal.

The world's production of groundnut is about 5 million tons a year of which India's share is $3\frac{1}{2}$ million tons. Allowing for the estimated quantity of about half the produce being consumed in the country she is still able to contribute about 40% to the world's trade in groundnut and about 18% to the world's trade in total oil products. Though, with this exceptional advantage, India has still been hesitating to place a duty upon the export of cakes, America has barred the import of outside groundnuts by a heavy import duty while France has given a special protection to her African possessions with the result that our trade with France has dwindled from 80% in the quinquennium before the war to about 30% since 1926. The United Kingdom has never been using very much groundnut, except some cake but she has

recently increased her purchase of groundnut and has developed the margarine production considerably. We are thus seriously losing our trade, due to faulty methods of production and trade with the result that the consuming countries of Europe are trying to meet their requirements from their own possessions and colonies where they are making special attempts to increase production. This falling of exports is likely to seriously affect our trade and consequently reduce our prices still further. But it should be an opportunity to utilise the period of low prices to develop the industrial side in our own country and produce soaps, butter and ghee substitutes, both for export to other centres and for increasing the local consumption. It is not possible to punish adulteration of butter and ghee, when the demand for these is much greater than the supply without finding a way to meet the increased demands. Research work to make butter, ghee and other oil substitutes appears to be the most urgent need.

Recently an American Scientist got up about 135 preparations out of groundnut and selected 14 recipes out of them and got up a five course luncheon, which were served to 10 food specialists. It is reported that each one without exception was enthusiastic over the menu and said it was the most satisfying luncheon, she or he had ever eaten. He goes on to observe "that by reason of its superior food value, the peanut product has become almost a universal diet of man and I think I am perfectly safe in the assertion that it will not only be a prime essential in every balanced dietary but a real necessity. Indeed I do not know of any one vegetable that has such a range of food utilities." It is good for our economists to consider if such a valuable food of man, beast and soil should be so lightly disposed of in our country.

Mr. T. Adinarayana Chettiar, Bar-at-law, in his recent book on *Co-operative Marketing of Agricultural Produce in South India*, depicts vividly the plight of the poor agriculturist in the hands of the wily middleman. The institution of warehouses under the joint auspices of the Agricultural and Co-operative Departments has given some relief, but the tendency to copy the rules and methods of the *Taragu Mandi* should be consistently checked by the warehouse officer, who should help the ryots to avoid storage losses. Though an agricultural officer may not have such a keen knowledge of markets, which is only necessary for speculative purposes, his claims for the management of the warehouses rest upon an intensive desire to help the ryots, coupled with a knowledge of handling produce satisfactorily and avoiding storage losses. But nothing spectacular is possible until a warehouse is able to arrange for a full consignment of direct shipping to the consuming centre which alone will assure substantially better prices. Enforcing the Commercial Markets Act in all the groundnut market centres will rectify a large number of evils connected with weights, samples, allowances and a host of other defects in the trade,

and a system of public auctioning will induce the ryots to improve his produce. We have recently been able to do similar work at Rasipuram with success where the local system of cotton picking was very defective. Intensive propaganda combined with personal advice was done by the distribution of leaflets, specially prepared on the subject and the *kappas* gathered by the improved method was collected by the co-operative society was put in public auction and secured better prices than the local market rates.

Work on all these lines will be largely helped and hastened by legislation especially when a trained set of demonstrators go about the country and explain the serious losses that the ryots incur every year due to inefficient methods of cultivation and wasteful methods of marketing. This step will be particularly helpful if followed by a system of state aid of some sort, and when once real progress has been achieved, the groundnut cultivator will not grudge a small cess to further develop the industry.

Market standards for each tract should be established and radio service to quote daily prices arranged so that, with a knowledge of freights, there will be a fair competition among the purchasers, while the producer will not also accuse the trader of exploitation as he himself would be conversant with the current market and freight rates.

Discussion.

Mr. G. Jogi Raju remarked that in Vizagapatam, as a result of vigorous propaganda, advocating sowing of groundnut in every furrow instead of in every alternate furrow, the seed rate had been increased by about 50 %, with a resulting increase in yield of about 19%. He further added that the crop which was of recent introduction in that tract was becoming greatly susceptible to insect attacks, and said it might be necessary to extend the operations of the Pest Act to that district also to keep the pests in check.

Rao Sahib T. V. Rajagopala Achariar opposed the opinion of Mr. Jogi Raju, about the necessity for increasing the seed rate to get a good yield, and instanced the Ceded Districts where with a low seed rate of only 15 or 20 lb per acre, good yields were obtained. He also wished to know from Dr. Patel, with regard to his opinion that groundnut is not responsive to manures, whether it was a fact with *lime* also, as there was a belief that groundnut is a *lime* feeder. Referring to Mr. Raghavachariar's paper, he wished to know why moistening the nuts was done by the ryots, before shelling them by the hand-shelling method. He was also of opinion that machine shelling would throw many labourers out of employment.

Mr. G. Jogi Raju remarked that, he could understand how low seed rate, with less plants per acre will give good yield, provided sufficient time is given for normal and full development of pods. Such a condition was not possible in Vizag, where harvest should be finished soon, to get the land ready for the next crop; in such localities a higher seedrate will give a larger number of plants and even after rejecting the immature pods, from each plant it will be possible to get a good yield of well developed pods.

Mr. T. Paramanandam said that ever since its introduction into Guntur, groundnut has almost proved a pest; it has ousted out the two important crops

of the district, tobacco and chillies, and there was a belief that groundnut has been responsible for the attack of 'thrips' on chillies, which crop has consequently suffered. Ryots also believed that groundnut spoiled the texture of the soil.

Dr. Patel replying said that he agreed with Mr. Jogi Raju that higher seedrate gave a higher yield and quoted the experience of America and Mysore on the point. He then observed that lime was not necessary in normal average soils. Answering Mr. Paramanadam he said this was the first time he heard of groundnut spoiling the texture of the soil.

Mr. K. Raghavachari observed that seed rate depended upon a number of factors. In the Ceded Districts, the ryot sows his crop with a drill and then intercultivates it, so that he has to use a low seedrate, because a high seedrate will leave very little space for intercultivation; another point was that the greater the rainfall, the greater was the seedrate. In Kollegal and Palur, where rainfall is heavy even a seedrate of 100 lb is used. Answering Mr. Rajagopalachari, he said, that ryots moisten the seed, so that the kernels do not split. This practice introduces moisture which is favourable for fungus and mould attacking the kernels.

SOME RECENT MANURIAL EXPERIMENTS IN RICE*

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Introduction. The principle of manurial trial or in fact the principle underlying any form of agronomic experiment is to get a bigger yield per unit area. We only measure the end result of the treatment and we had no clear idea until recently as to how this increased yield is brought about. Developmental studies on the rice plant undertaken in Coimbatore have shown that the two important attributes to yield are (1) the number of tillers or ears per plant and (2) the number of grains per ear. A proper understanding of the influence of environment which includes the different forms of manurial trials, on these two developmental phases of the plant is extremely important. A number of experiments have been conducted recently in the rice stations and while the fuller details of these experiments are published in the station reports an outline of the salient features are given in this note.

Spacing and Manuring. Several experiments have been conducted in the research stations in the past with different spacings and with different manures. The two treatments were, however, not combined, to find out their interaction. This has now been done for three seasons in Coimbatore, Pattambi, Maruteru and Berhampore representing four different types of soils and cultivation practices. The seedlings were planted with different spacings with and without manurial application to the transplant field. I shall state here only the final conclusions reached. The optimum spacing varies with the different tracts. While it is about 4½ to 6 inches in Berhampore and

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