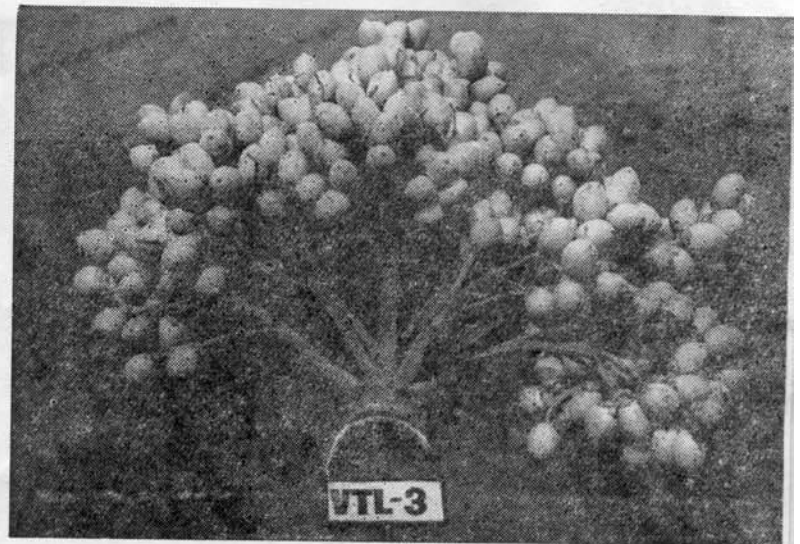


Male and female flowers in a rachillae

THE genetic improvement of arecanut crop is beset with the problems typical of a perennial crop. A long time-gap from one generation to the next stands in the way of a fairly rapid build-up of information on heredity that is very basic to crop improvement. Unlike crops of global importance for which research information is generated at several locations, this crop has to depend exclusively on the findings of the one and only arecanut research station. This crop has got a high degree of cross pollination.

The principles of crop improvement as adopted in arecanut research may be enumerated as follows.

1. Collection and maintenance of indigenous and exotic cultivated types as well as wild progenitors.
2. The natural breeding behaviour of the crop that determines fertilisation and yield on one hand and the genetic make-up of the seed on the other hand.
3. Evaluation of the yield characters and their capa-



A bunch of the Mangala (VTL3) variety

VARIETAL IMPROVEMENT IN ARECANUT

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bility of transmitting themselves from one generation to the next.

4. The selection of mother palms and seedlings on the basis of genetical information obtained from parent-progeny relationship studies.

5. Release of evolved varieties on the basis of trials conducted at several locations.

6. Hybridisation of types for blending of desirable traits such as yield, disease tolerance, dwarfness, etc.

Collection and Maintenance of Germplasm

Arecanut is adapted to the warm humid tropics where rainfall is high and the climate is equable. The maximum amount of crop diversity is observed in the near-east countries like Indonesia, Malaysia, Philippines and particularly on the chains of archipelagos strewn across the Pacific ocean. Apart from the cultivated species of *Areca catechu* a large number of wild uncultivated species are also found thriving in these regions.



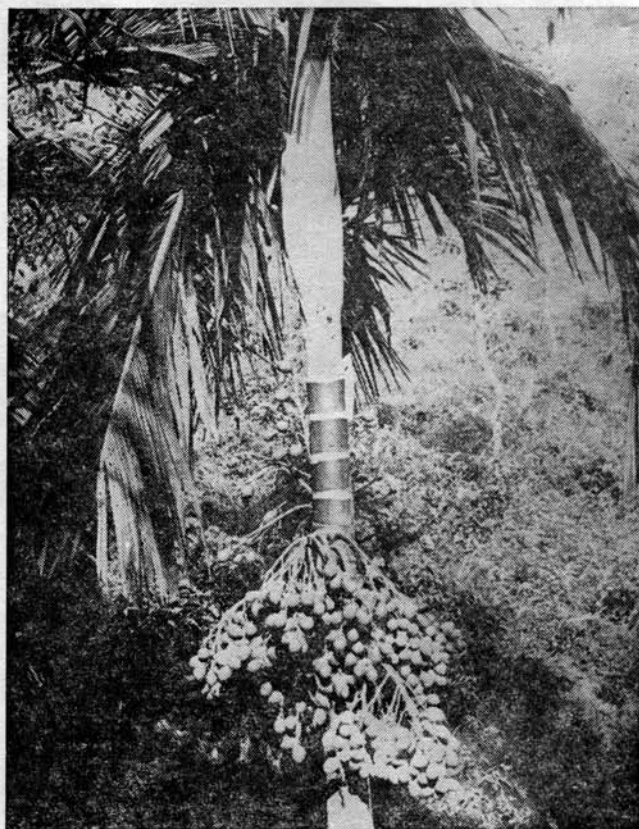
Hirehalli dwarf—a 20-year old tree

Hence this part of the world merits the status of the centre of origin, in spite of the fact that India is the one country where arecanut growing and industry have been rooted in tradition and culture.

The Arecanut Research Station (CPCRI Regional Station, Vittal) had embarked on the collection and maintenance of world germplasm from the days of its inception. The exotic collections of this station include cultivable types and wild species amounting to about forty types from all over. The cultivated indigenous types also amounted to about twenty in number. While evaluating the types the range and variability of useful traits have received attention.

The Natural Breeding Behaviour

The first inflorescence to open appears at tenth node when the collar of the palm attains a man's height. The inflorescences, botanically termed as spadix, are produced on the leaf axils, originating at the same sequence as that of the leaf. The upper limit of such many-tiered spadices that transform into fruit bearing bunches could be as high as seven. The male flowers are born on the ribbon like rachillae in two rows. The female flowers are confined to the basal portion. A spadix accommodates about 0-600 female flowers and 15,000-48,000 male flowers. Some varieties that are typical of bearing small nuts are found to bear female flowers as many as 1500



Apart from being precocious, 'Mangala' yields 70 per cent more than the local (South Canara) type

per spadix. Each male flower has got six fertile stamens. They mature, open and liberate pollen for about eleven days. The female flowers in the spadix are yet to mature by then. The pollen liberated is hence left to find entry in female flowers of alien trees, or rarely in the female flowers of older spadices of the same tree. The copious amount of pollen liberated travel in wind and traverse up to a kilometre distance. Cross pollination as above is the normal mode of the species and possibly the more favoured one.

Intense bee activity is also found in the areca garden. Nectar oozes out from the point of attachment of male flowers soon after their shedding. Bees who primarily forage for the pollen also collect nectar. However, they are not found to trip the female flowers. That opens to doubt as to the role played by bees in the pollination. The female flowers remain receptive up to six days. In spite of a good pollen dispersal system, yield in arecanut is often retarded due to low fruit set. Only about 30 to 60 per cent of the female flowers get set. The rate of fertilisation can be modified to an extent by assisted pollination.

The Yield and Characters

The yield in arecanut is influenced by the number of fruit bearing bunches that range between two and seven, female flowers per bunch (0-1500) and a good percentage of set (30-60 per cent) and also management



Hirehalli dwarf

practices and environment. These are the characters directly related to yield. The number of leaves, age at first bearing, girth at collar are other characters that are indirectly connected with yield. The transmittability of these characters from parent to offsprings, and their true worth as indicator of yield have been tested by heritability studies. When heritability of a number of characters is high, the performance of a palm possessing these characters is a good indication of its value both as a mother palm for direct selection as well as for breeding.

Several sets of mother palms reputed for high yield performance have been monitored for their progeny performance. Their performance was found unpredictably non-uniform and at random. The regression between yield of mother palms and mean yield of progeny has been found low. This confirms a very poor heritability of yield as a character. This means that selection of mother palms based on yield alone will not elevate the progeny yield. It has been examined on the biometrical records as to what other characters, directly or indirectly related to yield, have got high heritability. It has been thus found that (i) age at first bearing,

(ii) the number of leaves at the time of planting, (iii) girth of collar one year after planting, and (iv) number of nodes three year after planting had significant positive correlations with yield. This finding has been of immediate practical application in selection at mother palm level and seedling level.

Selection of Mother Palms

The age at first bearing is an important character not only on the basis of high heritability and phenotypic/genotypic correlation with yield. The performance of different set of palms having diverse pre-bearing periods has been empirically worked out. This data indicate that precocious types continue to maintain their lead in yield over the late types, for the years to come (Table I).

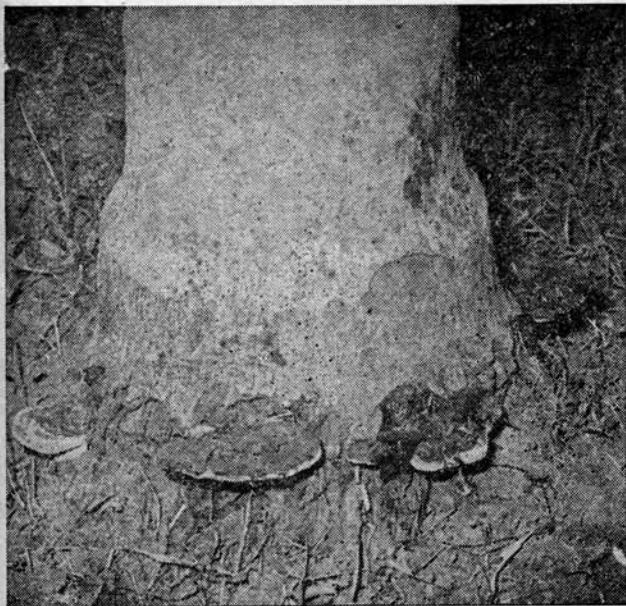
TABLE 1. YIELD PATTERN OF PALMS COMING TO BEARING AT DIFFERENT AGES

Age of first bearing	percentages frequency of palms	Mean nut yield in different years				Total
		I	II	III	IV	
5	62	109	211	255	305	880
6	32	—	139	148	208	495
7	4	—	—	58	95	153
8	1	—	—	—	34	34
9	1	—	—	—	—	—

The consistently superior yield of palms coming to first bearing early, as seen from the above, coupled with the fact that this character has a high heritability, shows the advantage of collecting seed-nuts from such palms. By confining selection of seednuts to palms coming to harvest in the fifth year of transplanting, a yield increase of 8 to 15 per cent can be obtained.

Based on the standards fixed for seedling selection in arecanut it has already been indicated that by rejecting those seedlings that fall short of a minimum of five leaves at the time of transplanting and culling of those which do not measure up to 20 cm girth at collar after one year of growth and four nodes after two years of growth, a yield increase of 20 per cent can be obtained.

In spite of uniform standards adopted for selection of mother palms, certain palms have been found to have remarkably high yielding progenies. This ability to transmit high yield irrespective of heritability and the uncertainty of male parent in an open pollinating system is due to a phenomenon termed 'prepotency'. While studying the progeny performance of such prepotent palms in comparison to the ordinary ones, the yield differences between the two sets have been found contributed by the percentage of seed set. It, therefore, appears that in arecanut palm 'prepotency' is due to the ability of the palm to transmit high set to its progenies with high fidelity. Since percentage of set has been also found to have a higher heritability than yield this has



Anabe-roga (*Ganoderma lucidum*)

been also reckoned as an important criterion of selection.

The Evolved Varieties

An accession among exotic types that was striking in several respects and in conformity with the accepted selection criteria was 'VTL-3.' While the local varieties required about five years to flower this introduction flowered in three years. This had a larger number of female flowers per bunch. Apart from being precocious in flowering it was a heavy bearing tree. About 70 per cent more of yield has been recorded by 'VTL 3' in comparison to Local (South Canara). This is the type that has been released under the popular name 'Mangala'.

A unique feature of this type is the short stature (semi-dwarf) and the smaller internodal distance. The height of a ten year old palm was about 65 cm. The internodal distance was only 5.5 cm. The local types, in comparison, registered a height of 315 cm and internodal distance of 16 cm. Other distinguishing features of 'Mangala' are the partially drooping crown and well spread leaves that accommodate more number of leaflets. The leaves are a shade darker in greenness. The crinckling of leaflets at the tip is another easily identifiable marker character. The fruit is dark orange coloured, with a mean volume of 59.23 cc and weighing 48 gm. The kernel weighs about 11.55 gm. The market preference of the kernel of this type has been also rated good.

'Mangala' has got a highly extended male phase that overlaps with the female phase. This may lead to a high rate of natural selfing.

The advent of 'Mangala' timed well with the reviving of arecanut industry which was showing a sagging trend due to various reasons. This type has since

cast a spell on the arecanut cultivators and the task of promoting a new arecanut variety in succession to 'Mangala' will be an exacting one. Although many other selections are now rivalling 'Mangala' in the yield front the dwarfness of 'Mangala' is exclusive to itself. The multi-tiered well-laden bunches on a not too tall palm is a pleasing sight. Besides, dwarfness affords facile manual operations of spraying and harvesting.

The type of Indonesian collection no 6. ('VTL 11'), is one that has been doing well. Its yield expectancy is marginally higher than that of 'Mangala'. It is a semi-tall type whose height will be around 200 cm at 10 years of age. This variety is now under consideration for release.

TABLE 2. MEAN CHARACTERISTICS OF SOME EXOTIC TYPES OF ARECANUT (RECORDED AT 7TH YEAR)

VTL No.	Origin	Height (cm)	Girth at collar	Inter nodal length	No. of leaves	No. of female flowers	No. of bunches	Kernel weight
3	China	65	36	6.5	8	210	7	14.3
5	Ceylon-1	174	46	7.5	10	372	6	8.8
11	Indonesia-6	207	39	10.5	8	466	5	13.0
12	Saigon-1	240	35	7.0	9	294	4	12.2
17	Singapore	242	52	9.0	9	889	2	16.3

Other valuable materials identified on the basis of long-standing performance of yield and nut characters are 'Mohitnagar', 'Singapore ('VTL 17') and 'Saigon' ('VTL 12'). The Mohitnagar type performs uniformly well in Bengal. The 'Singapore' type is a heavy bearer. The 'Saigon' nuts stand out as roundish and very bold with a very thin husk and a large kernel.

In India the type that is popular in the Bombay market is the 'Srivardhan' type. It has got bold round nuts and well shaped 'chali' (dried kernel) with a marble feel. The white core of the 'chali' is more in this type and that fetches a premium price.

A Dwarf Mutant and its Breeding Value

According to the visual estimates of the height attained by arecanut palms the types can be broadly classified into tall, semi-tall, and semi-dwarf. The height ranges between 60 cm to 360 cm as recorded at the seventh year of age. The height is more or less determined due to the internodal distances or in other words the length between successive annular rings. The typical semi-dwarf type is 'Mangala' ('VTL 3'). The 'Thirthahalli', 'Mohitnagar' and 'Local' (S. Canara) are the tall types. 'Srivardhan', 'Ratnagiri', 'VTL 17', and 'VTL 12' are the semi-tall types.

An extreme case of dwarfness is identified in a spontaneous mutant 'Hirehalli Dwarf'. In this case a seven-year old tree may have 20 cm long trunk or less. At present dwarfness alone is the desirable trait identified in this type. A lot more is desired of it in the yield

(CONTINUED ON PAGE 37)

30 cm width and of required length are recommended in alternate rows of areca palms. It is preferable to open the channels prior to the planting of seedlings. The depth and width may also vary depending upon the local situations, depth of water table, soil conditions, depth of root zone, etc. A main channel will have to be provided as an outlet for the accumulated water to drain out of garden. Under certain conditions of topography and soil there are possibilities of collecting water in the planting pits.

If the soil is impermeable or if it is of hard laterite in nature, drainage of water from such pits becomes very difficult. To overcome such situations each pit will have to be connected to the adjacent drainage channels by providing sub-channels for facilitating the easy flow of water into the drainage channel.

In certain localities due to poor structural nature of the soil deepening of channel becomes impracticable and in such places earthen pipes may be used as an underground drainage system. Earthen pipes of

about 15 cm radius and 60 cm length with perforation giving a slope of $\frac{1}{1000}$ to $\frac{2}{1000}$ mm may be buried in the required depth. A gap of 2 to 3 mm may be provided in the joining regions of two pipes in order to facilitate the accumulated water to flow out. In some areca growing locations there may not be any possibility to provide drainage due to lack of soil depth. Gradual raising of gardens by the application of fresh earth from external source is the only way out in such situations.

CONTINUED FROM PAGE 33

DISEASE PROBLEMS

have shown that Redonil and Alliot are promising.

It is well known that anabe, if diagnosed early, can be tackled effectively. But so far this has been a major handicap in controlling the disease. Recent research is to concentrate on the development of a sensitive serodiagnostic or biochemical method to identify the potentially infective soil or palm in initial stages of infection. Field trials are presently in progress in a heavily infected garden at Hirehalli, Karnataka have indicated encouraging results with captan (0.2 per cent) as soil-drench.

Yellow leaf disease has so far eluded a solution because of its complex nature and lack of knowledge on etiology. However, proper management of the diseased palm seems to be the only solution for the present for this, as well as other diseases of unknown etiology to minimise the losses.

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VARIETAL IMPROVEMENT

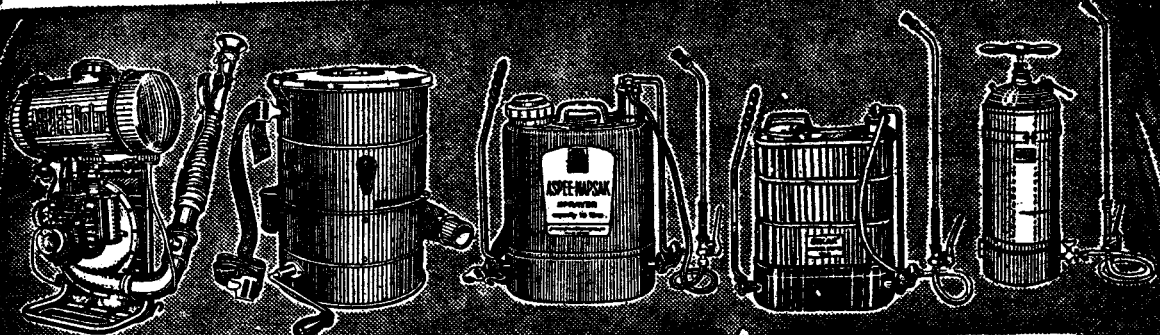
front. It is, however, considered to be a valuable breeding material with a scope for improving its yield by hybridisations. How this type and its hybrids in several combinations of crosses would react to disease situations with special reference to Yellow-leaf disease may have to be watched with interest. This is because, this disease is posing a threat to areca cultivation in the southern tracts of Kerala and the landlocked districts of Karnataka and eludes the possible chemical control measures. This situation as such now poses a challenge to the breeder and the possible solution is the evolving of types resistant to it.

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