Chips: (Sundried). After peeling off the skin, the tapioca tubers are cut into slices half an inch long and sun-dried for two days. This is used for curry or mixed in cooking along with meat and put to several other culinary uses. Fifty maunds of tubers give sixteen maunds of sun-dried chips or nearly one-third of it. The chips keep unspoiled for four or five months, provided it is sun-dried once a month.

Flour: Well-dried or dehydrat d chips are ground into fine flour and used as a substitute for rice flour, for almost all the preparations where rice flour happens to be the main constituent. Sixteen maunds of chips give about 13½ maunds of flour. The flour keeps on unspoiled, up to six months with occasional sun drying. The war-time price of flour used to be Rs. 45/- per cwt. The present price is about Rs. 22/- per cwt.

There is a great future for the growers of these subsidiary crops; with proper propaganda on the nutritive value of tapioca and sweet potatoes, many low-yielding sandy loams can be brought under these root crops with little expense and great profit. At present, the following factors are hampering maximum production. More than 50% of tapioca crops come to harvest after inadequate irrigation, due to want of water in the wells. A concerted drive to sink boreholes with the Government supplying the necessary equipment, even on a hire basis, will go a long way towards remedying the dearth of irrigation water. By starting processing factories for manufacture of sago and removing the export restrictions, and by conducting intensive propaganda for making greater use of the products of tapioca by the common man, the consumption and production of this crop can be stepped up to a considerable extent. Allotting manure purchase loans without interest at the time of sowing and collecting the same after harvest will also help the grower to increase the area under this useful food crop.

Natural crossing in Cumbu Pennisetum typhoides Stapf. and Hub.

By

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Cumbu or *Bajra* is the second important millet of Madras coming next to sorghum. It occupies an area of 2·6 million acres in the Presidency and produces an outturn of 6,85,5000 tons of food grains annually. The natural crossing in cumbu was studied with a view to evolve high yielding hybrid strains in the crop, as a first step in it.

The ear of cumbu is a compound cylindrical spike whose length varies from 8" to 15" with a thickness of about one inch to 1½ inch according to the varieties. The spikelets are commonly in clusters of two. In each spikelet there are two flowers. The third lemma bears a male flower and the fourth lemma bears a hermaphrodite flower. The most peculiar feature of the floral mechanism in cumbu is its protogyny. In the progress of flowering, the emergence of the stigma proceeds from apex to the base. This process is completed within three days. On the fourth day the anthers of the hermaphrodite flowers (whose stigmas had already emerged) start protruding and shedding their pollen. This wave also starts from the apex of the head and proceeds similar to the stigmatic wave and is completed in about three days. Finally the anthers of the male flowers of the third lemma start a secondary wave of a pollen supply and complete the work of pollination in three days.

The inflorescence of cumbu, in the stigmatic stage, whose period is about 3 days, courts cross pollination, the extent of which depends upon the availability of foreign pollen. After the three days period, the anthers of the same flower start shedding their pollen and the chances of cross pollination are then reduced to the minimum. With a view to take advantage of this floral mechanism which favours cross pollination, in the evolution of hybrid strains of cumbu, the intensity of natural crossing in this crop was studied at the Millet Breeding Station, Coimbatore, together with the methods by which crossing in nature could be intensified. In the monsoon season of 1948 (September to December) an experiment was laid out with the following variations to estimate the extent of cross pollination that takes place in this crop, under each treatment. The two selected parents were sown under the following conditions (the progeny of the plant selected to serve as pollen parent is designated as the "male line", while the stigma parent as the "female line"):—

1. *Interval of time:* The two parents were sown in adjacent lines (two links apart between the lines) on (a) the same day, (b) with an interval of three days between the sowing of parents, (c) 5 days interval and (d) 7 days interval. The object of this treatment is that the earlier sowing of the pollen parent may facilitate the synchronisation of the emergence of the anthers of the male with that of the stigmas of the female and help in obtaining greater amount of crossing.

2. *Interval of time and space:* (a) Parent lines one link apart sown on the same day, at 3 and 5 days interval and (b) lines 4 inches apart sown on same day, at 3 and 5 days interval.

3. *Shaking the male lines:* The plants in the male lines were shaken several times in the day to facilitate the shedding and free dispersal of pollen. This was tried in sowings done on the same day, 3 and 5 days interval between parents.

4. *Seeds of both the parents mixed and sown in the same line:* The seeds of both the parents were mixed in the proportions of female to male 1 : 1, 1 : 2 and 1 : 3.

5. *Artificially pollinated:* This was done by bagging the heads in female lines and hand pollinating them with pollen from the plant from the male line morning and evening for 3 days till the anthers of the female began to emerge. No emasculation was attempted. This treatment was used for comparison.

The pollen parents that were used in the experiment had the dominant purple colour in the vegetative parts. The female lines were harvested and the seeds from them were sown in beds. Counts of purple plants that appeared were taken and the percentage of out-crossing which took place was estimated as presented below:

Extent of Natural Crossing in 1948 (Rainfed crop)

Treatment		Percentage of amount of natural crossing obtained (Average of 2 replications)
1. Interval of time (parents sown in alternate lines)	Sown same day	77·8
	„ 3 days interval	64·7
	„ 5 days „	41·4
	„ 7 days „	38·9
2. Interval of time and space (Parents sown in alternate lines)	(a) 1 link apart	
	Same day	69·9
	3 days „	54·2
	5 days „	32·4
	(b) 4 inches apart	
	Same day	27·7
	3 days „	27·3
	5 days „	38·0
3. Shaking plants in male lines to shed pollen (Parents sown in alternate lines)	Same day	55·1
	3 days „	42·1
	5 days „	52·6
4. Seeds of both the parents mixed and sown (in same lines (proportion of female to male)	1 : 1	59·6
	1 : 2	45·4
	1 : 3	75·7
5. Artificially crossed by hand pollinating the stigmas, without emasculation.		88·3

The season was normal for the cumbu crop throughout its growth. In group (i) where interval of time was introduced, the sowing of the parents on the same day gave the highest amount of natural crossing.

being 77·8%. The female parents sown in alternate lines, 2 links apart with intervals of 3 days, 5 days or 7 days in the plot after the male lines were sown, were crowded out by the male lines and they made very poor growth. Moreover, as there were several tillers which were later than the main tillers, there did not appear much point in adjusting the sowing so as to synchronise the emergence of anthers and stigma in the two parents in the group of treatments (2) where intervals of time and space were introduced the closer spacing of 4 inches between lines did not show any advantage. The closer spacing gave poorer plants. In this group also sowing them on the same day was better. In treatment 3, the shaking of plants in the male lines did not improve matters. The cumbu plants shake with every little wind and shed the pollen easily. It did not require artificial shaking to accentuate it. In treatment 4, the 1 to 3 mixture, gave 75·7% cross pollination and the equal mixture gave 59·6%. From the practical point of view, plants intended as be adopted only when it is possible to recognise the plants intended as male parents and eliminate them in the harvest. In treatment 5, artificial pollination, a crossing of 88·3% was obtained. This is the ideal that could ever be possibly reached in this crop.

The data presented above are from the main season of 1948. The experiment will be repeated in the coming season. In the evolution of hybrid strains in cumbu the extent of natural crossing plays an important part, because the percentage of hybrid seed in the "hybrid strain" evolved depends on it. The hybridisation between the chosen parents will be left to nature. This method of work is somewhat different from the hybrid maize work where cent percent crossing could be obtained owing to the monoecious nature of maize, while in cumbu the hermaphrodite nature of flower makes it impossible to eliminate self pollen, and the only help that could be obtained is the protogynous nature of the cumbu flowers.

Summary: The extent of natural crossing in cumbu (*Pennisetum typhoides*) was determined at the Millet Breeding Station, Coimbatore, in the monsoon season of 1948 under different lay-outs of sowing of the parents. The amount of crossing varied from 27% to 8 ·% according to the treatments. The higher amounts of crossing were obtained by sowing the parents in adjacent lines 2 links apart on the same day (77·8%) and also by mixing the seeds of the parents in the proportion of one female to 3 male (75·7%). This study was undertaken with a view to produce hybrid strains of cumbu in which natural crossing will be the factor in hybridisation. The work will be different from that on hybrid maize owing to the differences in the floral structure of the two plants, as maize is monoecious while cumbu is hermaphrodite. The only help is the protogynous nature of cumbu flowers.