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Samai—The Little Millet—*Panicum miliare*, Lamk.*

By G. N. RANGASWAMI AYYANGAR, F. N. I., I. A. S.,
Millets Specialist and Geneticist, and Principal, Agricultural College,
AND
U. ACHYUTHA WARIAR, B. Sc. (Ag.),
Assistant, Millets Breeding Station,
Agricultural Research Institute, Coimbatore.

Origin. Very little literature is available regarding the place of origin of *Samai*. De Candolle (1884) does not make any reference to this crop in his "Origin of Cultivated Plants". According to Blatter and McCann (1935) "the crop is cultivated or naturalised throughout India and Ceylon; cultivated in the Tropics". Chevalier (1922) mentions that this species is cultivated only in British India and Ceylon, and perhaps also in Central China.

The fact that it has a name in almost all languages of India, and that its wild ancestor *P. psilopodium* is found abundantly in India, Burma and the Malay Peninsula, indicates that *Samai* was first brought into cultivation in India.

Distribution. *Samai* is grown to a limited extent in almost all the provinces of India. Its cultivation extends upto an elevation of 7,000 feet or more. It is found wild (probably escaped from cultivation) in the Punjab, Burma and South-Eastern Asia. It has very little importance outside India except probably in Ceylon where it is cultivated to a small extent. It has been tried, though not with much success, in the Straits Settlements and the Federated States of Malaya. The crop has also been tried on an experimental basis in many parts of Africa by the European settlers; but its cultivation there is unimportant (Sampson, 1936).

Botanical description. The description of *Samai* has been given by Hooker (1875), Gamble (1934), and Blatter and McCann (1935). Brief descriptions are also found in many books dealing with grasses. A comprehensive description based on the above authors is given below.

Panicum miliare, Lamk., belongs to the tribe *Paniceae* under Gramineae. Its specific name, *miliare*, is derived from the old latin *milium* meaning millet. An annual grass, with culms 30—90 cm. high, rather slender, erect or base geniculate, simple or branched; *leaves* linear 15 to 50 cm. or more in length, 12 to 25 mm. broad, gradually tapering from a broad base, glabrous or finely hairy; *Sheath*—rarely hairy with tubercled—based hairs; *Ligule*—a narrow row of hairs; *Node*—glabrous; *Panicle*—very compound, contracted or thyrsiform, often nodding, 15 to 45 cm. long; *Spikelet*—glabrous, rather flattened, suddenly cuspidate, 3–4·5 mm. long, mostly paired on unequal pedicels, but often solitary at the end of the branchlets, lanceolate in flower, elliptic or broadly elliptic in fruit. *Glume I.* Very broadly ovate, subtruncate, then suddenly acute, or scarcely acute, about

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1/3 the spikelet, white, membranous, 3—5 nerved, nerves arching and anastomosing. *Glume II.* Herbaceous ovate lanceolate, 11—13 nerved, almost as long as the spikelet. *Glume III.* Herbaceous, broadly ovate, 9 nerved, slightly shorter than *Glume II*, palea as long as the Glume (3—4 mm.), flower neuter or rarely with 3 stamens. *Glume IV.* Narrow elliptic, or elliptic-oblong to broadly ovate, acute, shining white or pale brown or dark brown, often 3—5 streaked dorsally; *Fruit* Caryopsis enclosed tightly within the fourth glume and its palea (2·5 to 3·5 mm.).

Note. Some of the samples of *Samai* collected from the Agency tracts of Ganjam and Vizagapatam are much taller (100—150 cm.) and later (120—140 days) than the types from other parts of the Presidency. These do not tiller so profusely as the short duration varieties, there being only 3—5 tillers, with each tiller bearing a good-sized head. The culm is stout, about 10—15 mm. in diameter and the leaves are proportionately large. The varieties maturing in 70—90 days are shorter in height, (30—70 cm.), tillering profusely, (upto 25 tillers), especially under irrigation. Secondary branching is quite common in these varieties. The main axis of the panicle is nodding especially after the grain has set.

Agricultural varieties. Names of agricultural varieties are usually descriptive of duration, grain and plant pigmentation, and panicle shape. It is of common knowledge that the wealth of varieties and varietal names show the antiquity and the importance of a crop in the locality. Basu (1890) mentions five varieties cultivated in Bengal (1) The Black or *Kariya*, most commonly cultivated (2) The white or *Charka* (3) The ant-headed *Dia-muri* of a motley colour (4) The *Burhi*, a late variety and (5) the *Bere*, a variety always grown mixed with ragi. In the Madras Presidency most of the samples collected have no special names except the general term *Samai*. However, a few had varietal names which are listed below with the characteristics of the samples.

Name and place of collection.	Duration in days.	Pigmentation.	Panicle.	Grain colour
Ajjamu, Kamakarai, Kollegal.	133	Mixture of P. and medium P.	Loose	Olive Brown (O Br.)
Aruppu Samai, Ramnad.	88	Mixture of P. and medium P.	Loose	Light olive brown (L O Br.)
Bele Samai, Mundigundum, Kollegal.	133	Medium P.	Branched and normal heads, half open panicles	Mixture of very light olive brown (VLOBr) and LOBr.
*Chittan Samai, Reddiyur, Javadi Hills.	87	Mixture of P. and medium P.	Loose	LOBr.
Jupy Suwa, Monliguda, Jeypore.	108	Mixture of P. and G. T.	One-sided	Mixture of VLOBr. and LOBr.
Karboka Samai, Ambrampalayam, Pollachi.	81	Mixture of P. and medium P.	Compact	Mixture of LOBr. and OBr.

Kar Samai, Okkilipalayam, Pollachi.	83	Mixture of P. and medium P.	Compact	Mixture of LOBr. and OBr.
Kollu Samai, Kumblankolam, Palur.	102	Medium P.	Loose	Mixture of VLOBr. LOBr. and OBr.
Malligai Samai, Manapparai.	132	Medium P.	Loose	LOBr.
Pedda Samalu, Parvathipuram, Vizagapatam.	132	Mixture of P. and medium P. and G. T.	Mixture of dropping and erect panicles	Mixture of VLOBr. and LOBr.
Perum samai, Ramnad.	135	Medium P.	One-sided	LOBr.
Perum Samai, Kumblankolam, Palur.	106	Medium P.	One-sided	Mixture of VLOBr., LOBr. and OBr.
Porukku Samai, Ramnad.	135	Medium P.	One-sided	LOBr.
Punam Samai, Taliparamba.	127	Mixture of P. and G. T.	Arched	Mixture of VLOBr. & LOBr.
Sada Samai, Manapparai.	132	Medium P.	Branch and half open	LOBr.
Vellai Samai, Punganur.	87	Mixture of P. and Medium P.	Loose	LOBr.

Extent of cropping. Figures are not available to know the exact acreage of this crop in India. In the Madras Presidency the normal area under this crop is 589,940 acres. About 21% of this area is in Salem, 18% in Anantapur, 13% in each of Coimbatore and Madura, 8% in Tinnevelly and 6% in North Arcot. The districts of Trichinopoly, Vizagapatam, Chittoor, Bellary, Ramnad and Malabar grow this crop to a certain extent, but the area is below 5%. The crop is unimportant in the other districts.

The Role of Samai in the system of cropping. The importance of *Samai* as a crop is neither in the total area cultivated nor in the money return it gives to the cultivator, but that it gives something in the shape of food-grain to the ryot, from a soil which may otherwise yield little or nothing. It is a hardy crop which can withstand drought better than most of the other cereal crops and also water-logging to a certain degree. If the crop fails, the cultivator stands to lose very little, for the cost of production is very small and the assessment of the land very low.

Cultivation of Samai. Season. With the receipt of the sowing rains, the *ryot* attends first to the more valuable crops and then only to *Samai*. Naturally he reserves his best lands to his more profitable crops and

sows *Samai* in the poorer ones. Often it forms one of the mixtures and as such its sowing coincides with other dry land crops. It may be said that the sowing season of *Samai* is determined according to the advent of the South-West monsoon rains, i. e., June—July or August in the districts of Malabar, Coimbatore, Salem and Anantapur, the Agency tracts and in parts of Madura, Ramnad and Trichinopoly districts. In parts of Coimbatore and Tinnevelly districts it may also be sown in August—September. Rarely it is grown in April with the hot weather rains.

Rotations. The scope for rotations is very limited because of the nature of the soil on which it is sown. In single-crop dry lands of an inferior type as in the central division of Anantapur district, *Samai* follows horsegram in a two-year rotation. In parts of Salem, which are favoured by both the monsoons, *Samai* is sown in the South-West monsoon season and is followed by horsegram in the North-East monsoon. In parts of Tinnevelly near the Western Ghats, it is grown as a second crop in October—November after a cholam crop. In the uplands of Malabar and in Bengal, *Samai* follows dry land paddy or blackgram. In Bombay it follows *ragi* in dry lands. What is lacking by way of rotations is made up by mixed cropping. The usual crops grown as mixtures are *Samai, cumbu,* and *varagu,* among the cereals, lablab, horsegram and blackgram as pulses and occasionally mustard, gingelly and castor also.

Cultivation. *Samai* is cultivated only as a rainfed crop. It is seldom raised on garden lands, chiefly because better crops are selected for such lands and the increase in the outturn of *Samai* would very seldom pay for the cost of irrigation. With the advent of rains, the land is broken up with an ordinary plough. Two or three ploughings are usually given. Very little manure is applied, the available manure being used up for more paying crops. The seed is sown broadcast at the rate of about 10 lb. per acre, (when sown pure) and covered by ploughing once or twice. The field is sometimes levelled with a brush harrow or a levelling board. One weeding is usually given and nothing more is done until harvest time. This method of cultivation is common in almost all parts of India, the only exception being that the crop is sometimes transplanted in parts of Bombay. A special kind of cultivation of this millet, "the shifting cultivation" is prevalent in many hilly parts of India especially in Madras, Bombay, Bengal and Central India.

Harvest. The crop is cut close to the ground, tied up into sheaves and allowed to dry. When fully dry, it is threshed out by cattle if there is a sufficient quantity, or simply trodden down by foot. When cultivated on the hills, the crop is cut half-way leaving a stubble of $1\frac{1}{2}$ to 2 ft. in length, which is subsequently burnt to form manure for the next crop.

Duration. *Samai* takes usually $3\frac{1}{2}$ to 4 months to mature. There are varieties which mature in $2\frac{1}{2}$ to 3 months. Some of the hill varieties from the Agency tracts take about five months to mature.

Yield. The yield varies from 200 to 500 lb. of grain and 800 to 900 lb. of straw (semi dry).

Grain. The grain is husked before cooking. The husk forms about a third of the grain. The husked grain is cooked like rice and eaten. In parts of Tinnevelly and Malabar the grain is boiled before husking, similar to the parboiling of paddy. The rice is sometimes ground into flour and cakes are made out of it. As a food, *Samai* rice is not very tasty and is seldom preferred to any other grain if available. According to Church (1886) the analysis of *Samai* grain is as shown below :—

Water	10·2
Albuminoid	9·1
Starch	69·1
Oil	3·6
Fibre	4·6
Ash	3·5

The nutritive ratio is 1: 8·4 and the nutrient value of 85.

Straw. The cattle are fond of the straw, but in South India as a fodder it is considered inferior to that of paddy and *ragi* straw. In Northern and Central India, the straw has little value as fodder. It is cut and put into the manure heap or simply burnt down to form ash for the next crop.

Anthesis and Pollination. The only record available is that published by Youngman and Roy (1923). They have stated that the time between the opening and closing of the flower is 15 to 20 minutes only. At Nagpur, the flowers open between 9-30 and 10-30 A. M. With the commencement of the opening of the glumes, the styles and the filaments spring out at once, with explosive suddenness. Self-pollination is the rule in this crop.

Detailed studies were made at the Millets Breeding Station, Coimbatore on the anthesis and pollination in *Samai* in the year 1936.

Emergence of the Panicle. As in the case of *ragi*, (Ayyangar and Wariar 1934) the flag, the leaf subtending the panicle, cannot be differentiated from other leaves and hence the emergence of the panicle which is contained in the sheath of the flag has to be closely watched. From the emergence of the tip of the flag from the last leaf-sheath, it takes four to five days for the appearance of the inflorescence. In many cases the inflorescence does not emerge completely from the sheath of the flag; the lowermost branches remaining inside.

Order of anthesis. The opening of the flowers commences on the second or third day after the appearance of the panicle. The flowering progresses from the top to the bottom of the panicle. The maximum number of flowers opens on the 6th or 7th day. It takes about a fortnight to complete the flowering in a panicle. Observations were also made on the period of opening of flowers. It shows that in fair weather, the flowers begin to open by 9 or 9-30 A. M. The flowering progresses rapidly upto 10-30 or 11 A. M. after which it begins to decrease gradually and stops by 11-30 A. M. If the weather is cloudy the flowers may continue to open

upto 12 noon, but not afterwards. Differences in the season of sowing or methods of cultivation do not affect the order of anthesis, or the period of opening of flowers in a day.

Detailed observations were made on a number of individual flowers. The following table gives the average time required for each stage of the anthesis.

Details of anthesis.

	Average time taken	
	On a clear day.	On a cloudy day.
	min.	*min.*
Glume begins to gape	0	0
Stigma and anther visible (begin to emerge)	1	19
Anthers emerge (out of glume)	1½	19
Beginning of dehiscence	2	20
Completion of dehiscence	2	21
Stigma separate and become divergent	2	21
Glumes begin to close	3½	21
Glumes close completely	5½	22
Stigma begins to wither	6½	22
Stigma withers completely	19	28

The first sign of the opening of the flower is seen when the third glume slightly separates from the fourth glume. The palea then begins to separate itself gradually from the fourth glume. The opening of the flower is brought about partly by a swelling of the lodicules and partly by pushing from inside by the growing anthers. In fair weather, the opening of the flower is a quick process and is accomplished in one to three minutes. If the weather is cloudy the opening may take up to 20 minutes, the rest of the process being similar.

Within a minute of the gaping of the glume, the filament of the anthers elongate and by the time the glume is completely open, the three anthers as a column reach the mouth of the gaping glume with the stigmatic branches protruding from its periphery. The dehiscence of the anther takes place at the mouth of the glume or just before the anther reaches that position. The free pollen gets dusted on to the stigma. The filament then elongates and the anthers become pendant. As a result of this elongation of the filaments and spreading out of the anthers, the stylar arms that were caught up within these filaments are able to diverge and take up a position on either edge of the glume, exposing the two stigmas. The whole process of anthesis is fairly rapid and is completed in two or three minutes. Immediately after the anthers assume their pendant form, the glume begins to close. This closing is completed in about two minutes leaving the anthers and the stigma outside. A glume once closed never reopens. From the foregoing account it would be clear that self-pollination is the rule in this millet. The percentage of natural crosses occurring in *Somoi* is very low (about 0·05).

Artificial Hybridisation. The artificial emasculation and pollination of this millet is rather a difficult process. However, the glumes can be opened and anthers removed with a fine-pointed forceps. The desired pollen can then be dusted on to the stigma. Such operated flowers are enclosed in a glass tube in order to exclude foreign pollen. The percentage of success depends mainly on the dexterity of the operator. An easier method of hybridisation is "the contact method" of crossing which is described in detail in connection with the anthesis and pollination in *ragi* (Ayyangar, and Wariar, 1. c). The percentage of F_1s obtained by this method ranges up to 5.

Inheritance of Characters. Anthocyanin Pigmentation. Two broad groups may be distinguished in *Samai*, one with purple pigmentation and the other without it, the "Green-throughouts". Among the purple-pigmented plants, two types are distinguishable and are designated, Purple and Medium purple. The characteristics of three types of pigmentation are given below.

Purple (*P*). In this type the pigmentation is manifested on the leaf, the leaf-sheath, the exposed internodes, the glumes and the stigma. The anthers are orange in colour. It is interesting to note that the node and the junction of the leaf are not coloured in any of the pigmented types.

Medium Purple *(Med. P.)* This type has the leaf, the leaf-sheath, the exposed internodes and the stigma coloured purple. The glumes are green and the anthers orange.

Green Throughout *(G. T.)* The plant is free from purple pigmentation on any of its parts. The anther is orange and the stigma colourless.

Crosses were made for elucidating the inter-relationship of these types of pigmentation. A cross between P. M. 21 (G. T.) and P. M. 31 (P.), gave the F_1 as Purple. In the F_2 it segregated into 53 P. and 18 G. T. indicating a 3:1 ratio. Another cross between P. M. 33, (G. T.) and P. M. 27, (Medium P.), gave a Medium Purple F_1 and segregated for 56 Med. P. and 16 G. T. in the F_2 indicating a 3:1. A third cross between P. M. 27, (Med. P.) and P. M. 30 (P.), gave a Purple F_1 and segregated into 103 P. and 34 Med. P., showing a 3:1 ratio. Crosses were made between P. M. 33, (G. T.) and P. M. 31, (P.) which gave Purple in the F_1 and 64 Purple, 23 Med. P., and 27 G. T. in the F_2. Its behaviour is given below:—

Generation No.	Family No.	Behaviour		
		P.	Med. P.	G. T.
	Parents	P. M. 31		P. M. 33
F_1	Cross P. M. XII and XIII	F_1		
F_2	P. M. 133 and 134	64	23	27
	X^2 = ·33 P between 8 and ·9.			
F_3	1 family	89		
(From P.M. 133)	2 families	141	44	
	3 families	90		31
	5 families	142	45	58
	3 families		176	
	3 families		111	38
	2 families			72

A Factor P is responsible for the production of Purple pigmentation on the body of the plant and stigma of the flower, thus giving a Medium purple plant. P is a simple dominant to p the Green-throughouts. A factor H colours the glume purple thus producing a Purple plant. H is a simple dominant to h. The effect of H is noticeable only in the presence of P. The interplay of these two factors P and H thus results in a 9 : 3 : 4 ratio of P. (PP HH) : Med. P. (PP hh) : G. T. (pp HH or pphh). The behaviour is parallel to the one observed in *Eleusine coracana* (Ayyangar *et al*, 1933).

Grain Colour. Grain colour in *Samai* can be grouped into three types viz., very light olive-brown or the white grain ; Light olive-brown and olive-brown, popularly known as *Karum Samai* or *Nalla Samalu* in Madras and as *Kariya* in Bengal. The inter-relationship of these three types has been worked out and is presented below.

A natural cross, P. M. 167, having a very light olive-brown grain was spotted in P. M. 21, a Light olive-brown grained type. In the F_2, it segregated into 98 Very light olive-brown and 29 Light olive-brown grains, indicating a monogenic segregation. Another family, P. M. 60 (Light olive-brown grain) segregated for 103 Light olive-brown and 41 Olive-brown grains showing a 3 : 1 ratio. Having observed these monogenic differences between successive groups, crosses were made between P. M. 33, Very light olive-brown and P. M. 20, Olive-brown type. The F_1 had Very light olive-brown grain. In the F_2 there were 22 Very light olive-brown, 18 Light olive-brown and 2 Olive-brown grained plants, a ratio suggesting a 9 : 6 : 1. The F_3 behaviour given in the accompanying table confirms the ratio obtained in the F_2.

Generation No.	Family No.	Behaviour		
		Very light olive-brown	Light olive-brown	Olive-brown
	Parents	P. M. 20		P. M. 33
F_1	Cross P. M. XIX	F_1		
F_2	P. M. 136	22	18	2
	X^2 = ·55 P between ·7 and ·8			
F_3	2 families	190		
	6 families	277	89	
	4 families	166	108	17
	5 families		484	147
	3 families		353	
	2 families			187

Two additive factors I_1 and I_2 act as inhibitors on the olive-brown grain (X), the colour base. When any one of these factors is present, the colour of the grain is Light Olive-brown and when both are present, the grain becomes Very light olive-brown or white, thus giving a factorial composition of i_1i_2X for Olive Brown, i_1I_2X or I_1i_2X for Light olive-brown and I_1I_2X for Very light olive-brown grain. These factors have no relation with the plant purple pigmentation groups.

Albinism. One family P. M. 217, when sown was found to segregate for green and albino seedlings. Counts taken from P. M. 217 gave 1044 green seedlings and 72 albino seedlings showing a 15:1 ratio of green to albino. From the surviving greens fortyfive single plants were carried to the F_3 generation. Of these nineteen were pure for green seedlings fourteen segregated for green and albino as 3:1, while twelve gave 15:1 ratio of green to albino.

Generation No.	Family No.	Behaviour		
		Green	Albino	
F_2	P. M. 217	1044	72	$X^2 = 06$
F_3	19 Families (pure)	1637		$P > 8$
P. M. 217	14 Families (3 : 1)	1315	421	
(1—45)	12 Families (15 : 1)	1590	109	

As in the case of *Eleusine coracana* (Ayyangar and Krishna Rao, 1931) two factors C_1 and C_2 are responsible either alone or together for the production of chlorophyll in *Samai* also. In the absence of both of these factors, the plant is an albino and dies off in about ten days.

Pests and Diseases. There is no record to show that this crop is subject to the attack of any serious insect pest. *Samai* (Butler 1918) is subjected to the attack of a fungus known as *Uromyces lineoris*, B. and Br. The fungus is known only in India, Ceylon and the Phillippine islands and no information is available as to the extent of the damage which it causes. It is a rust affecting the leaves of the plant.

Summary. This paper presents a brief account of a minor millet, *Samai—Panicum miliare*, Lamk.

Studies on anthesis and pollination have shown that the flowers open between 9 A. M. and 12 noon under Coimbatore conditions and that self-pollination is the rule. Emasculation and artificial pollination can be done with a fair amount of success. Very good results can also be obtained by "contact crosses".

Two types of purple pigmented plants, Purple (PH) and Medium purple (Ph) are met with, while with p, the plant is green-throughout. A segregation where these three groups occur has given a 9:3:4 ratio of P, Med. P and G. T.

Three types of grain colour viz., Very light olive-Brown, Light olive-brown and Olive-brown occur in *Samai* by the interaction of two additive factors I_1 and I_2, inhibitory in effect on Olive-brown grain.

Albinism was noted in the seedlings of *Samai*. Duplicate factors C_1 and C_2 are responsible for the production of chlorophyll either alone or together.

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The "Nendran" or Malabar Plantain.

By P. NARAYANAN NAYAR, B. Sc(Ag.),

Agricultural Research Station, Taliparamba.

The Nendran is a type of plantain chiefly grown on the West Coast of the Presidency and abundantly in Malabar. Although sporadic efforts have been made to grow this crop in other parts of the Province, it has not been successful outside Malabar and parts of South Kanara. Probably the partiality of this crop for the porous well drained laterite soil and the heavy rainfall of the Coast is responsible for its coming up well only in these tracts.

Uses. The fruits both raw and ripe are available in important towns of Malabar all the year round. It is much bigger than the ordinary plantain fruit, and is a favourite among the people of the West Coast. It forms a part of the New Year present on "Vishu" from the tenant to the landlord or on festive occasions like 'Onam', etc. Both ripe and raw fruits are used in all households in various ways. The raw fruit is used for culinary purposes either by itself or mixed with other vegetables. After peeling the skin and slicing, the well matured fruits are fried in oil and preserved either salted or sweetened in jaggery syrup. The ripe fruits are consumed either in their natural state or by cooking in steam or baking in hot cinders. They are best eaten when the rind becomes flecked. The fruits are largely used in the preparation of 'prathaman', 'halva', fruit salad and many other sweets