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THE INHERITANCE OF CHARACTERS IN RAGI

Eleusine coracana GAERTN *

BY G. N. RANGASWAMI AYYANGAR, B.A., I.A.S.

Millet Specialist, Coimbatore

Agriculture is predominantly a question of Crop Industry. Crops have in recent years begun to be studied with increasing intensity. Specialization in them is the order of the day, though it has been recognized by the highest authorities that a wider outlook is imparted by not confining the specialization to a single crop only. Being familiar with rice, I find millets, the group of cereals which I am studying at present, affording a convenient opportunity for a study of comparative cereal genetics and the bearing of this study on the subject of crop genetics in general. I am, therefore, proposing to address you on the results of seven years of work on one of the millets, viz., Ragi (*Eleusine coracana* Gaertn) named after Eleusine, the Greek goddess of cereals. In choosing this millet, I have the feeling of appropriateness of dealing here at Bangalore, on the premier cereal of this state of Mysore. From the general Indian point of view, the reputation of this cereal for its keeping qualities gives it a predominant place as a famine reserve. I am intending to avail of this crop and the studies thereon as a thread with which to string some of my general observations on genetics in relation to the improvement of cereals.

* Presidential address delivered before the Agricultural section of the nineteenth Indian Science Congress, Bangalore, 1932.

Eleusine coracana Gaertn, Ragi—is a small-grained cereal belonging to the group of cultivated plants called millets. A medium sized annual, it grows to a height of 3 to 4 feet with a capacity to tiller and branch freely. An individual plant tends to look in general outline and configuration a chandelier. The stems are somewhat compressed, elliptic, tough and smooth and much ensheathed, exposing very little of the internodes. The leaf blade has a prominent midrib, and in spite of this many of the well-grown leaves show a tendency to snap and hang down about their upper middle. The inflorescence which is characteristic of this cereal, is borne on a long peduncle, from the end of which 4 to 6 spikes radiate in a whorl. The spikes are called fingers, and the odd one a little lower down, often found attached to one edge of the flattened peduncle, is called the thumb. The spikes are either straight or curved inwards. In each finger there are a number of spikelets (60 to 80) which are arranged in two rows and alternately attached to one side of a flattened rachis. The spikelets are sessile and contain 5 to 8 glumes each, of which the two lowermost are barren and the rest are paleate enclosing a complete flower, consisting of an ovary with two feathery stigmas and three anthers, set between two lodicules. The anther sacks during dehiscence, slit longitudinally and with their inverted margins present the appearance of two boats back to back. The ovule develops into a seed which is globular and encased in a membraneous pericarp.

The inflorescence of ragi consists, as already described, of a terminal whorl of 4 to 6 spikes. In each finger there are about 70 spikelets, each spikelet having 5 to 7 complete flowers. In the spikelet the flowering proceeds from bottom to top and in a finger the order of flowering is from the top spikelet downward. An earhead contains 1,500 to 3,000 flowers and the flowering period varies from 8 to 10 days, the maximum number opening on the third day. The flowering activity is past midnight, from 1 to 5 a.m. Varieties with open earheads start flowering between 1 and 2 a.m., and those with curved earheads between 2 and 3 a.m. *E. aegyptiaca*, a wild ally of ragi, flowers between 12 midnight and 2 a.m. It is interesting to observe the closer floral affinity between the open ragis and *E. aegyptiaca*, indicative of a sliding down of the period of anthesis towards the earlier hours of the morning in the case of the more compact and incurved varieties. As soon as the glume and palea begin to gape, the stigma and anther emerge almost concurrently and soon after, the anthers dehisce and pollinate their own stigmas. Self-fertilization is thus assured, though occasional cross fertilization in nature by wind and insects is not excluded. The glumes close between 7 and 8 a.m.

Anthesis studies are a necessary preliminary to the other studies including heredity. The mechanism of pollination is of very great importance, as its study throws considerable light on fertility and the problems connected with sterility. This delicate process is very susceptible to modification within limits. In *Pennisetum typhoideum* flowering has been noticed to proceed throughout the day, both day and night, with the main concentration at about 9 p.m., a secondary spurt at about 9 a.m., and a definite dullening round about 3 p.m. The protogynous nature of this millet, the pencillate anthers and the absence of lodicules throw some light on this peculiar floral conduct. But the fact that certain of its wild allies like *P. cenchroides* which opens its flowers from 2 to 11 a.m., of *P. ruppelii* from 10 p.m.

to 11 a.m., and of *P. purpureum* from 7 a.m. to 12 noon, raises the possibility of this all-day flowering, being a concomitant of the packed cultivated condition of the earhead of *P. typhoideum*. In *Setaria italica* the march of flowering kept pace positively with increase in humidity and negatively with increase in temperature. In sorghum the maximum of flowering is at 2 a.m. There is thus a tendency for these cereals of the dry tracts to flower at dead of night. An analysis of the rain hours in rainy days as far as available, communicated by the Meteorological Department, shows the chief maximum of rainfall to be just after midnight. It is a tragic situation in which these millets, in their attempts to escape the Scylla of heat, run into the Charybdis of midnight rain. Their only chance is a non-recurrence of the coincidence of their optimum flowering with a rainy day, and with the rainiest part of it being midnight. These observations are made in detail to give an idea of the vicissitudes which the efforts of a breeder of millets pass through. Apart from the isolated instance of Goldsmith, no systematic attempts have been made at assaying the factors responsible for the opening of flowers. It is high time, concentrated work is done from a physiological point of view to determine the various factors contributing to the opening of flowers and find out how far a survey of such floral habits could afford opportunities for the perpetuation of favourable variants.

Millets are small grains in general and the flowers of Eleusine are very tiny. The want of individuality to each floral unit and the seriateness and consequent overlapping of the spikelets, give this millet a special disability in the ease with which artificial hybridization could be effected, for the study of the heredity of characters. In the earlier years of work, before the inheritance of certain patent characters involving purple pigmentation was known, much time, trouble and patience were expended to evolve a technique of artificial hybridization with only very limited results. The delicacy of manipulation and the quickness of the anthesis militated against encouraging success. But with the advance in the elementary knowledge of the dominance of certain well-marked characters it has been possible to clip off all except a single finger or part thereof, in certain mother varieties and pollinate them by contact with the desired male earhead,—a sort of natural pollination through the agency of man, with the usual precautions for keeping off pollen not desired. Seeds from the mother finger are then sown with the certainty of spotting the first generation crosses right in the seedling stage. By the help of this method a number of artificial crosses have been raised successfully at the Millet Breeding Station, Coimbatore. This short cut while it lacks the element of romance which usually kindles the admiration of the layman over the mysteries of the breeder's art, nevertheless, provides, at an advanced stage of the breeder's experience, a ready weapon for a quick pursuit of the inheritance of many characters. Much experience is necessary in designing such crosses and a note of caution is here given against the use of this method by inexperienced hands.

Without the existence of colour other than green, nature would be one vast monotonous desert of emerald. The only diversity will be that introduced by variation in form. The revelry of colour in wild nature and an accentuation of it in her reproductive moods, leave no doubt as to the vital functions of colour in nature. Vegetative adaptations of a colour type must have a physiological bearing and be intimately linked to vital metabolic processes. When crops are grown and compulsory monotony introduced

the function of colour is baffling. If selective influences had voted in favour of colour, as reasonably they might, then crops would have been one mass of purple. The fact that both pigmented and unpigmented varieties figure prominently as types of cultivated plants, surviving and perpetuated as economic varieties, is proof positive to the fact that colour as seen is not the only determinant in the survival of a crop variety. The absence of colour has not meant the dethroning of unpigmented varieties. It is therefore arguable that colour as seen and colour potential should both be the determinants in the success of a cultivated variety. To a plant breeder this question of colour evokes the first curiosity necessary for a later sober pursuit of other less theatrical manifestations of heredity in crops.

In ragi as in most other cereals there are a number of colour types and one broad group characterized by the absence of colour. Each colour group is a variant from the one of a lower degree with a single factor difference. The manifestation of colour varies both in intensity and in distribution, different factors being involved in the process. Genetically basic colour is produced by a factor P. and its effect is accentuated in depth and distribution by two intensification factors I_1 and I_2. There is the broad separation between colour seen and colour potential. The Green-throughouts, though for a look are all alike, are separate genetic entities with different potentialities for developing colour. These can only be distinguished by breeding tests. They are waiting for the introduction of the purple factor to unfold their potentialities and bring them up to their full expression. They are like undeveloped but exposed photographic plates, all alike, only waiting to show their individuality in the presence of the universal developer anthocyan. What it is that determines where colour shall manifest, and in what depth, is a broad basic problem in bio-chemistry and plant-physiology that has, so far, not had a decent solution. To me, therefore, it appears that the time is ripe to cast away the well-known classics about purple dominance and come down to the basic concept of the where, whither, and wherefore of the very production and distribution of purple pigmentation in the crop world.

Next to colour the earhead shapes of ragi provide a marked character for sub-grouping in the varieties. In ragi there are two broad groups of panicle shape—those in which the digitate spikes of the inflorescence curve in and those in which they are open.

A factor for density designated Q, manifesting in a close packing of spikelets on the rachis is present in the curveds and absent in the opens.

The curveds are separable into in-curveds and top-curveds. In the in-curveds the spikes curve in. The top-curveds are longer than the in-curveds and in them, only the tops of the spikes curve. A second factor E elongates the rachis and separates the top-curveds from the in-curveds. The collateral effects of the E factor begin to show out in the plant even before the emergence of the earhead. Its presence elongates the length of the flag, the length of the peduncle and the height of the plant. The E factor is present in the opens also and makes two groups of them, the long-opens and short-opens. Their separation is difficult, but their existence and individuality could easily be demonstrated from segregates of crosses with top-curveds and in-curveds respectively.

The ranges of the finger lengths of short-opens and long-opens generally run into one another, the former ranging from 7 to 12 cm. and the latter from 10 to 19 cm. To prove the genetic individuality of the two groups, selections were made from them at the overlapping zones of finger length and breadth. The progeny were true to their parental ranges irrespective of the particular lengths at which they were chosen.

Earhead shape is a form-complex with its length, breadth and thickness and as such within limits liable to fluctuation owing to environment. In dealing with the hereditary aspects of this form-complex, we run into a realm where measurements are possible and where the results of such measurements cannot be read aright without the perception that behind this arithmetic there are distinctive qualities of a genetic type, which the accuracy of measurement merely clothes in the latest style. In biology behind every quantitative manner of presentation is a quality, a character, not easily spotted but delimitable by measurements. A mass of mathematical data has often connoted very little for the simple reason that it lacked the soul of quality. A series of measurements of earhead lengths in a variety of open ragi gives a curve but the constituent parts of this curve do not become apparent without the help of breeding with sister families in which, measurements apart, distinct qualitative sub-groups could be located. I take this opportunity of observing that in the application of mere formulas accounting for the significance or otherwise of statistical data in crop biology, there should be no forgetting, that we are dealing with life drilled and mobilized by man and that the opportunity which the crop breeder has of multiplying his seed material in numbers and through generations, gives him a far surer and more tangible natural gauge with which to measure the significance of his experiences.

From the earhead we pass to the grain. Unlike other cereals there is not any wealth of grain colour in ragi. It is one dull drab. The ragi grain has a characteristic brown colour, which I have designated ' ragi brown.' The pigment is confined to the outer layer of the seed coat. This ragi brown is produced by two factors B_1 and B_2 either alone or together. This brown colour of the grain is in intimate genetic relationship with plant purple pigmentation. Purple pigmentation on the plant is produced by a factor S working in association with either or both of the B factors. This accounts for the absence of white-grained ragi in purple pigmented plants. Some races of white grains carry the factor S. Crosses have been made between white-grained plants containing the S factor, and brown grained green-throughouts, and the resulting F_1 plants were purple pigmented and brown grained. These crosses behaved as expected in later generations.

In all cereals there is a natural predilection for man towards a white grain. But in ragi the predominant colour continues to be brown. People using this grain get reconciled to the brown tint of the cooked gruel. The more agreeable white ragi is comparatively less vigorous and poor yielding and is consequently rare in cultivation. Nevertheless a white-grained ragi with the S factor was required to figure in a cross in order to resolve both the plant purple and the grain brown of the ragi into their genetic compositions. This fact is of considerable significance in the evolution and survival value of the existing varieties of cultivated ragi. This phenomenon opens up a piquant problem in the bio-chemistry of plant pigments.

Certain races are met with in which the ragi colour of the grain takes on a darker shade. Given fair weather and normal ripening the separation between the ordinary ragi brown and the dark ragi brown is definite. Over-ripeness or a downpour of rain at ripening period tends to make the normal colour dark, and the dark colour reddish black, with the result that the separation of the two becomes rather difficult. These difficulties notwithstanding, the dark ragi brown has been found to be brought about by a definite factor D which acting on the ragi brown makes it dark brown. This factor behaves as a simple dominant, and is independent of the factors concerned in the production of plant purple pigmentation and is not in selective association with either of the B factors.

Young growing grains of ragi have generally a green pericarp. This green colour shows itself while the grain is still young and enclosed within the glumes, and through the transparent tissues between the glumal veins it gives the earhead the characteristic green look in the early stages of flowering. The green of the pericarp continues to be present even after the growing grain passes the milky stage, when about a week after, it dries off into a thin, loose, greyish translucent and fairly persistent membrane enclosing the mature grain.

A variant of this type has been met with. This has a distinct light green pericarp, which in the early stages gives a lighter tint of green even to the earhead. The green pericarp is associated with a dry anther mass of pale orange yellow and the light green pericarp, with ivory yellow.

The green pericarp is brought about by the presence of a factor designated C_x and is a simple dominant to the light green pericarp. This factor C_x is independent of the factors for purple pigmentation and grain colours.

This affinity between anther colour and the colour of the pericarp is noticeable in naked grains. In sorghum there is a very close association between the colour of the anther, fresh and dry, and the colour of the grain. These affinities throw considerable light on the structural and other relationships existing between parts of the plants and open up a wide and fruitful line of investigation.

This chlorophyll factor for depth of green leads to an examination of the factors responsible for the production of chlorophyll. In the usual cultivated varieties lethal conditions would have led to a natural death. But in a breeding station, where seeds of different varieties from the length and breadth of the country are mobilized and have a chance of free mating with each other, there will occur some defective forms of which albinism is one. All workers on crops would thus have experienced some aspect or other of this albino condition. Albinism is the total absence of colour. Partial absences are also met with. Some of these are lethal while others act as a drag on life without extinguishing it. Even in healthy crops gradations in the depth of green are met with. An analysis of the factors responsible for the production of chlorophyll reveal the presence of a number of factors in maize, the crop in which this aspect has been worked out in great detail. Albinism has been experienced in *Setaria italica*, *Pennisetum typhoideum*, and in *Paspalum scrobiculatum*. In sorghum five types of chlorophyll deficiency

have been met with. In ragi two factors designated C_1 and C_2 either alone or conjointly seem to be responsible for the production of chlorophyll, so far as present work on it goes. It has been possible to isolate the two factors and produce albinos by crossing them.

This raises the general question of chlorophyll deficiency, as it is graphically seen in the albino, serving to give a clue to the all-vital question of chlorophyll efficiency. Under non-lethal conditions a placid contentment dismisses higher possibilities of building up this efficiency. It is a matter for examination whether the vigour usually associated with hybrids may not be a form of this efficiency. It is common experience that crops vary in the depth of green which they present *en masse*. This is undoubtedly a varietal character. It has recently been demonstrated in sorghum that there is a linkage between the factors for purple pigmentation and albinism. This again raises the ring of affinities that should exist in the purple bedecked condition of a crop variety, its simple green ally and its gradations of paler cousins down to bleached infants born to die. The whole scheme opens itself to a systematic examination and awaits the expert handling of a master bio-chemist.

Chronic sterility, short of complete sterility, is occasionally met with in ragi. It manifests itself in an almost complete failure to set seed and gives the earheads a blighted look. Sterile plants grow vigorously, flower late and put forth numerous heads. The anthers lack the free and quick protrusion which gives the healthy earheads that fulness characteristic of the blooming period. The stigmas are healthy and receptive.

The cause of this sterility is two-fold: (1) non-dehiscence of anthers, and (2) agglutination of pollen. In the first type of sterility the anthers are of the same shape and size as healthy ones. They are full of viable pollen grains, but the anther sacs do not dehisce and liberate their contents. In the second type of sterility a disintegrated mass of agglutinated pollen devoid of contents is produced. In both the types, however, a few stray grains develop and help to keep the race going. Normal dehiscence occurs with the presence of factor X. Free pollen is produced by factor Y. Both the factors X and Y behave as simple dominants to their absence which results in sterility. The X and Y factors are independent of the factors responsible for Plant Purple Pigmentation.

This experience is very interesting in that definite genetic factors have been traced to account for so vital a character as fertility. As in the case of albinism this raises possibilities of attacking and resolving the elusive problem of yield to genetic factors that help to grade up fertility.

There are 18 pairs of chromosomes in ragi. Thirteen independent factors, namely B_1, B_2, C_1, C_2, C_x, D, E, I_1, I_2, Q, S, X, and Y, have so far been accounted. The rest have to be worked out; and later probable linkage groups. It is remarkable that so far no linkages have been met with.

In all crop studies it is very necessary to aim at having a chromosomal chart of the crop to enable characters to be pursued with clarity and crosses designed with effect. In this direction lies a vast field for young botanists in the coming years.

Concurrently with this equipment of the characters of ragi as an individual, its habit as a community has begun to be studied. Ragi has the reputation of being a cosmopolitan cereal. Its capacity to adapt itself to various types of soil is well-known. Experiments designed to throw light on its adaptability to varied sowings within a year reveal the fact that this cereal has a second favourable season for its growth in addition to the usual main season. The vicissitudes in yield are less sharply marked in a year, than is the case with rice, which ragi replaces under conditions of scarcity of water. With a late variety the response to favourableness or unfavourableness is more pronounced than with an early variety. In the case of the late variety its adaptability to the second summer season is more pronounced than is the case with a short one. Yield increasing with duration generally, these experiments indicate the necessity of evolving a medium duration strain that would ensure a fairly steady yield through the years and yet stand a certain amount of unfavourableness or neglect within a year.

The intense crop breeding activities of the past quarter of a century give rise to certain reflections of fundamental importance. To a breeder of millets accustomed to an erratic monsoon the question arises whether it is not time to deviate from the orthodox conception of a pure strain and adapt his methods to the more practical end of creating a mixed population of good strains so that their varying adaptabilities may ensure an evenness of performance through years. An agricultural variety has the common characteristic of a fair amount of evenness in size of grain, height of plant and duration of existence. Other minor morphological differences are of little consequence. From the composition of many of the existing varieties that have successfully survived the rigorous demands of time, it strikes me whether an abstract quest after genetic purity should not give place, in the breeding of millets, to the unorthodox method of creating a population with possibilities of crossing with each other in non-essential characters and thus increasing their hybrid vigour with no serious detriment to the fundamental attributes that characterize a variety. It is a proposition worth considering whether the breeder's art may not be utilized to spot and weed out the unfit individuals and leave the crop community with the *elite* of the population. The matter is otherwise with more opulent crops.

The existing varieties of cultivated plants have been evolved through and are the product of centuries of selective influences adding to the survival value of the varieties. Selection is no simple process. To a rare few it is an intuitive gift. To the many, it is a perennial game of hide and seek, played with nature. Intensive studies in pure lines of any crop may give a number of interesting co-relations. Yield is such an elusive factor that it is very difficult to make it fall in line easily with these co-relations. There are certain conditions in the life of a crop when it becomes more or less static. Selection then is of no avail. Hybridization begins where selection is bankrupt. Wise and judicious selection again follows hybridization. To one in the business, hybridization is a simple process made easy with practice. This convenient tool and the easy qualitative deductions in simple mendelian experience that have characterized the mass of output of genetic literature in recent years, coupled with the linking up of such experience to economic departments like Agriculture with their demands for improved strains, create a situation that leads to the quick output of new strains not chastened by time. There is posterity and the time spirit

to judge the soundness of an effort. Theatrical predictions and premature usherings of revolutionary varieties may keep the bubble attractive and spectacular, but sooner or later the unsoundness of the adumbration will dawn in a decade in which the author of the strain would have retired into oblivion. It is true that all effort is limited to the span of one's opportunity and active service. The time spirit ought not to deter effort, but rather should it tune up the sense of the ideal in the plant breeder that will develop in him the coolness and the vision which enables him to build and build soundly on sure foundations, with a fervour that checks every gamble with an opportunity. It is obvious, therefore, that apart from the initial verdict occasionally elating and often depressing, there is sure to be the saner verdict of time, over an effort soundly designed and sincerely executed.

SORGHUM [1] IN THE WESTERN TALUKS OF BELLARY [2]

By R. NAGAN GOUDA, Ph. D., HOSPET.

Soils.—Except small patches of black cotton soil here and there the major part of these taluks is red soil. The surface soil usually is only a few inches deep. In valleys it is deeper and richer. The subsurface and subsoils are usually gravelly soils.

Rains.—*Mungari* rains commence in May and end in September. We have some showers in October and November from the North-east monsoon. Average annual rainfall is about 23 inches of which about 20 inches falls in the growing season.

Crops.—*Jonna, korra* [3] and *sajja* [4] are our chief dry grain crops. Pulses and oil seeds are sometimes grown between the rows. Rarely have we *Hingari* crops.

Varieties.—Red and yellow sorghum are mostly grown. In the black cotton soils it is white sorghum.

Seed bed preparation.—The land is ploughed in autumn immediately after harvest and left rough through winter. During late winter and early spring the soil is stirred by harrowing.

Manure.—Fields near the villages are better manured than those farther away. Ten to twelve cartloads per acre is common. Sometimes more is applied.

Sowing.—Immediately after the first good rain in May the seed is drilled in. 6 to 8 lb. of seed is used.

Cultivation.—Two, three and even four-row cultivators are commonly used. Usually twice and oftener if needed, the field is cultivated to remove weeds and produce a mulch to conserve moisture. Weeds between the plants in the row are removed by hand.

[1] *Sorghum Vulgara* Pers. Eng. Sorghum ; Tam. *Cholam* ; Tel. *Jonna* ; Kan. *Jola* ; Hind. *Juar*.

[2] A paper read at the Twenty-first College Day and Conference of the Madras Agricultural Students' Union, Coimbatore—December 1931.

[3] *Setaria italica*.

[4] *Penniselum typhoideum*.

Harvesting.—Done by hand. The stocks with earheads are stacked and left for a week or ten days. Then the earheads are cut and threshed by dragging stone rollers over them. In some parts this operation is postponed for a month or more till the work of autumn ploughing is over. However usually both are done simultaneously.

Yield.—The average yield is 600 to 800 lb. per acre. Fields that have been receiving 4 to 6 tons of manure every year regularly are yielding 1,500 to 2,000 lb. per acre. A tank bed near Hospet is known to yield as much as 2,000 lb. per acre. There are no experimental farms in this area but the yield for the Hagari experimental farm is as follows for the year 1929–30 :

Bulk area under Jonna—26·50 acres—Yield per acre 523 lb. of grain.

In Field No. 2 A. S. where cattle manure storage and residual effects experiments were conducted the maximum yield per acre was 739 lb. of grain.

Cost of production.—For cultural operations including harvesting the expenses range from Rs. 12-12-0 to 15-4-0. The cost of manuring of course varies with the application. A cartload of manure costs a rupee by the time it reaches the field.

A man with a 12–acre farm applying 14 cartloads of manure per acre incurred a total expenditure of Rs. 26-12-0 per acre. His land cost him Rs. 300 per acre. Interest on this at 6 per cent amounted to Rs. 18. He paid an assessment of Rs. 1-8-0 to Government. In all, his expenses totalled Rs. 46-4-0. The yield was 1,632 lb. of grain which he sold for Rs. 37-14-0. The straw fetched him Rs. 12 thus bringing the total gross returns to Rs. 49-14-0. The net result per acre therefore was a gain of Rs. 3-10-0.

A second man with an 8 acre field to which he had applied 100 cartloads of manure spent at the rate of Rs. 25-12-0 per acre. He had purchased his land also at Rs. 300 per acre. Together with interest at 6 per cent on investment and the Government kist the total expenditure per acre was Rs. 44-4-0. The yield from this field was 2,040 lb. per acre. This netted him Rs. 42-8-0. The straw was sold for Rs. 8. Thus the total gross income was Rs. 50-8-0 and the net income Rs. 6-4-0.

The third farmer has 6 acres of tankbed land which is reputed to be very fertile. He spent on an average about Rs. 15-4-0 per acre for his cultivation expenses. He does not apply any manure. This land was purchased at Rs. 500 an acre. At 6 per cent interest on this comes to Rs. 30. Thus together with the land revenue the total expenses come to Rs. 47-4-0. The field yielded him 1,360 lb. of grain per acre which was sold for Rs. 28-5-4. The stalks and the straw together was sold for Rs. 20. The total gross income per acre was Rs. 48-5-4. In this case there was a gain of Rs. 1-1-4 per acre.

In all the three cases cited above there was a small profit and yet the three farmers—owner cultivators who have been in possession of the fields for a long time—are not well off now. Indeed the last two farmers had to sell their farms a few months ago. The other is also fast approaching a similar condition. These are known to be hardworking and able farmers.

There are two main reasons for this state of affairs: one is the net return per acre is very small. To get enough at this rate the farmer has to multiply his holding many times which is a difficult task firstly because large areas of land in one block are not available and secondly by increasing the size of farm the return per acre is likely to go down further since big farms cannot be so economically managed as small ones with the simple farm implements now in use. There is another good reason why these farmers went broke. I have shown above that the investment on these farms is charged at 6 per cent while as a matter of fact it is charged at 12 per cent. Both the first two farmers purchased their farms over 8 years ago and have been paying interest on it at 12 per cent.

Remedies.—Co-operative societies bring no relief since the investment has to be realized and the loan paid back in 3 to 4 years failing which penal interest would be levied which would bring the level of interest to the usual market rate. This aspect of the problem does not lie in our sphere and hence it is not considered further. But what lies in our sphere is the question of increasing the yield per acre. The yields reported here are very good. It will be noticed the yields from the Hagari Farm range from 523 to 740 lb. per acre. Even these high yields are not high enough to pay a decent return to the farmer.

Selection and breeding work should be carried on more extensively to produce high yielding strains. New varieties may also be imported and tried. Dwarf milo has been reported to yield as high as 4,760 lb. per acre giving an average of 1,900 lb. for 6 years at Amarilo, Texas. California reports an average yield of 3,575 lb. per acre for 4 years by the same variety.

Our cultural methods also seem capable of improvement. Of course they have stood the test of time but that does not mean that they are incapable of improving. The American experimental farms for the last two decades have been carrying on extensive work on this. Similar work with due alterations to suit our conditions can be carried out with advantage. There is thus need for greatly amplifying the work that is now being done at Hagari.

SORGHUM IMPROVEMENT IN THE MADRAS PRESIDENCY[1]

By K. GOPALAKRISHNA RAJU, L.AG.,
District Agricultural Officer in charge, Bellary.

Introduction.—Of the total area of about 33½ millions of acres grown with different crops in the Madras Presidency, millets occupy very nearly 15 million acres of which Sorghum or the great millet alone occupies nearly 5 million acres. Of the total area of about 5 million acres under sorghum, the Ceded Districts, contribute nearly 2 million acres. Barring about half a million acres grown under irrigation, the bulk of the sorghums are cultivated under rainfed conditions. Dry crops such as sorghums are amongst the typical crops grown in most unirrigated districts, and the problems of cultivation in such tracts in which crops are entirely dependent upon rainfall, deserve our foremost attention.

[1] A paper read at the Twenty-first College Day and Conference of the Madras Agricultural Students' Union, Coimbatore—December, 1931. The paper was illustrated by charts.

The sorghums of the Madras Presidency are very numerous. Varieties which thrive well in one tract do not give an economic crop in another. Seasonal factors play a great part in the occurrence of the varieties. For example, the *Patcha jonna* of the black soil tract to the east of the Erramalas does not produce any appreciable crop in similar soils of the same district to the west of the hills, where a different type known as *Tella jonna* is the predominant variety. In Bellary district, where a *mungari* crop of sorghum is grown, it is a yellow variety, whether it be on the red or the black cotton soil. The early south-west monsoon crop of *Konda jonna* in the Circars is a white sorghum of the *Talai-virichan* type, but the variety grown in the same locality in the main season is *Patcha jonna*. Rainfall has also considerable influence on the panicle types found in different tracts. When the rainfall is low and confined to a few days in the growing period, as in the black soil tracts to the south of the Tungabadra and west of the Erramalais, we meet with *Tella jonna* with the *Muddakanki*, a hard round golf ball-like earhead, while the tract to the north of the river has what is known as the *Yeti avatala jonna* with a loose panicle. Again, the *Patcha jonna* grown in the Kurnool district in the valley between the Erramalais and the Nallamalais is of the compact type, but, as we go towards the south, where the rainfall is greater, sorghum of a less compact type alone thrives well.

Besides the climatic conditions above referred to, certain economic factors also determine the type of sorghum found in different tracts. Where the rainfall is precarious, and the cultivator has to make the best of adverse conditions, he grows a type of sorghum which will give him good fodder as well. But, in a tract, bordering the hills with an assured supply of rain, and having facilities for grazing cattle, we find types of sorghum such as the *Talai-virichan cholam* of Coimbatore or the *Konda jonna* of the Circars, which give high yield of grain, but straw of inferior quality. In the southern districts, as *sajja*[1] (*cumbu*) is the main staple food crop of the dry land farmer and also because *sajja* fodder is inferior in quality to that of sorghum, we meet with the *Irungu cholam* of the south which is eminently a fodder variety yielding very good fodder but very little grain of low quality.

It will thus be seen that sorghum is one of the most important field crops in the Madras Presidency. To the agricultural population sorghum is more important than even rice and wheat. It provides the cultivator as well as his cattle with their daily food. Any improvement on the crop, therefore, though it may not make a boom in the industrial market, vitally affects the needs of many, especially in a country like ours, where more than 70 per cent of the population are dependent on agriculture for their livelihood. As the time at my disposal is short, I shall confine myself to some broad agricultural aspects relating to the improvement of the crop. I shall also incidentally review the results of recent experimentations at the several centres in the Presidency, but my chief object shall be to indicate how best the knowledge so gained can be extended to meet the real needs of the cultivator. As an agriculturist I should like to lay stress more on the economic aspect of the problem

Varietal Improvement.—The most obvious channel of improvement on the crop, though not necessarily the widest, is the evolution of varieties

[1] *Pennisetum typhoideum.*

and strains. In sorghum the number of cultivated varieties and sub-varieties is enormous as has already been pointed out. For purposes of this paper mention need only be made of those varieties which have got extensive application in the several areas. In this connection the results of trials made at the agricultural stations of Hagari, Nandyal, Koilpatti and Coimbatore go to show that for each tract there is generally one particular variety that is most suitable. Taking dry lands into consideration, the varieties that have been found best in the several tracts are *Periamanjal* for the Coimbatore tract, *Irungu* for the Koilpatti tract, *Tella jonna* for the Hagari tract, and *Patcha jonna* for the Nandyal tract. This concentration of suitable types for the several tracts may have an ultimate influence in the work of crop improvement in that more and more tracts and sometimes sub-tracts, will have to be investigated during the process of selection.

Pure Strains.—The most suitable variety for a locality once having been fixed, the next step in improvement consists in the evolution of the best pure types from them. Work in this connection was started in Nandyal and Hagari much earlier than in other centres. A general consensus of opinion exist among ryots that a compact variety is better suited to give higher yields than a spreading one, but experimental evidence is wanting on the point. An examination of the plants in *Tella jonna* and *Cherukupatcha jonna* in the Hagari and Nandyal tracts respectively pointed to two classes of plants regarding their fodder value. These were (1) plants with a dull coloured mid-rib with sweet and succulent fodder, and (2) those with white mid-rib with pithy and tasteless stalks. This differentiation led to a very easy channel for purposes of selection in that sweet stalked varieties were chosen. As the result of a number of trials, two strains were evolved in the year 1915 by the then Deputy Director of Agriculture, Mr. Hilson. One of these called Type 1, a *Tella jonna* variety with compact earheads, and sweet fodder, is still commanding the field at Hagari against a host of strains from all parts of the presidency. This gave an average yield of 310 lb. of grain for the past five years in the strip tests. The strain chosen at Nandyal was Type 6, a *Patcha jonna* variety with large yellow grain and sweet stalk, and has given on an average 360 lb. of grain at that station for the past 6 years. A new strain recently evolved by the Millet Specialist, known as N. 23/10, has given higher yields on the station than Type 6, and is put this year under comparative trial in ryots' land.

Before concluding on this part of the subject, I should like to emphasise the need for quality in both grain and fodder while selecting suitable material. Mere yield with coarse grain will ultimately defeat itself in the long run. The size of grain and earhead, earliness, uniform maturation and such other characters of economic importance should as far as possible be combined in a singe type. Owing to differences in soil conditions, the yields obtained at our agricultural stations cannot always be taken as the standard. For example, at Uyyalawada in Koilkuntla taluk and Polur near Nandyal, as much as 1,000 pounds of grain and more per acre are said to be the yields obtained from unirrigated sorghum crops. Again, in some tracts the people prefer to consume *jonna* in the form of *shankati* (gruel) and others as unleavened bread. The white mid-rib type, whose stalks are pithy and tasteless, are found to carry better sized earheads than the dull mid-rib type with sweet and succulent fodder. It may be possible to combine the desirable characters found in both these types. Improvement in quality of

fodder is as important as that of the grain. If the good quality of a dull mid-rib consistent with sweet stalk and succulent fodder could be imparted to the *Irungu cholam* of the south, it would be an achievement of no small measure. The shedding qualities of the straw must also be taken into account in selection work, as the ryots generally allow the crop to remain in the field for some time after reaping the ears.

Manuring.—Selection work is but the beginning of improvement on the crop. It has to be supplemented by other activities to make it more complete. In the sorghum crop, for example, manuring also plays an important role. I shall broadly review in this connection the result of the experimental work done in this direction. The earlier work was done on cattle manure and sometimes on sheep penning as these had almost equal value. I shall take up cattle manure first as the data on it are more complete.

In Nandyal and Hagari the application of cattle manure every year to sorghum and cotton, and every alternate year to sorghum only gave the following results :—

YIELD IN POUNDS PER ACRE

—	Nandyal			Hagari		
	Every year	Alternate year	No Manure	Every year	Alternate year	No Manure
Sorghum ...	1,036	910	427	532	466	400
Increase % over 'No manure' ...	140%	110%	...	33%	17%	...
Cotton ..	254	234	146	270	219	204
Increase % over 'No manure' ...	74%	60%	...	33%	7%	...

It will be seen that the response to manure is much higher in the case of the sorghum than in cotton and much greater at Nandyal than at Hagari. If the figures are examined year by year it is seen that the effect of manuring is uniformly beneficial at Nandyal whereas at Hagari the increases are apparent in good years only. As a matter of fact, in poor years the 'No manure' plots appear better. This difference is due to the rainfall of about 19" annually at Hagari as opposed to 28" at Nandyal. Again taking the cost of the manure into consideration, it can be shown that manuring of sorghum in alternate years is alone profitable in both the tracts.

I shall next take up the results at Koilpatti from the classical experiments started by Mr. Benson. In these trials a comparison of the loose box and other systems of preserving cattle manure has been made with neem cake, artificials (consisting of super and saltpetre) and local compost. The manure was applied for two full rotations of cotton and cereal, and the residual effects noted for five years.

A remarkable feature of these experiments is the large residual value of the box manure which extends beyond even the fifth year of application. This is in addition to the direct effects. As in Nandyal, the effect is more seen in sorghum and cumbu than in cotton. This residual value of the 'box-manure' is evident even in the experiments in other tracts as in Nandyal and Hagari. From the Koilpatti results, it is seen that the effect of heap manure is soon exhausted while in the case of artificials and cakes the deterioration becomes faster, and there are also indications of adverse effects. In Nandyal also cattle manure is better and cheaper than cake, while its residual effects last a number of years. In Hagari the residual effect although equally lasting, is felt only in good years.

Artificial Manures.—The foregoing results show that it is profitable to apply cattle manure best to the sorghum crop and that its application to cotton is not correspondingly beneficial. Unfortunately in our country due to the poor condition of cattle and the many practices by which manure is being burnt or wasted, the supply of cattle manure is not adequate. For instance, the Ceded Districts ryot finds it difficult to manure his dry lands even once in every 6 or 7 years. It, therefore, goes without saying that the extension of the area under manuring will go a long way towards solving the ryots' problems. The present supply of cattle manure is variously estimated as ranging from 1/20 to 1/10 of the requirements of cultivation. This deficiency requires making up. Our next step shall be to exploit all avenues in utilizing our store of organic waste and organic matter to increase this supply. Before dealing with that I shall indicate how far artificials will supply this long-felt dearth of cattle manure.

Recent work in this province has been conducted to find out the manurial effects of ammonium sulphate or groundnut cake, in combination with super-phosphate on our cereals and cotton crops. At Koilpatti the responses ranged from 35 per cent with cotton to 60 per cent on cereals. At Hagari the sorghum crop benefited more than 100 per cent. On a cost basis the manure was profitable on *Irungu* fodder at Koilpatti, but not on cotton. Results at Nandyal show that cattle manure is cheaper than groundnut cake. The general conclusion from all of the considerations seems to be that unless the price of sorghum rises high, manuring with artificials cannot be a paying proposition. This is especially true of such a cheap cereal as sorghum. Although in recent years the prices of artificial manures are falling, they have not fallen adequately enough to make their application to dry land fruitful of results. Sorghum is especially suited for dry areas. On the other hand, the less the rainfall the more harmful artificials can be. Also a certain amount of care is necessary in their application. The natural conclusion seems to be that except in a period of rising prices or in tracts with a sufficiency of rainfall or irrigation facilities, manuring the sorghum crop with artificials may not be resorted to. Even under such circumstances, it is always best to use basal dose of bulky organic manures on which they can act.

This leads us again to the inevitable problem of increasing our natural resources in respect of organic matter. In some tracts the sorghum crop is harvested leaving long stubbles. In Hospet and Cumbum taluks as much as three to four feet of stubble are left on the ground. In most cases the stubbles are collected at leisure and used as fuel. The utilization of stubbles of crops, waste straw, organic refuse, green leaves, etc., to produce manure

will go a long way to solve the problem. The real point is that more land could be manured than at present with not much extra labour. This is the fundamental problem at issue.

Poudrette.—There is still another source of manure and this is in poudrette. Experiments at Nandyal show that this is a very good manure for sorghum and groundnut but not for cotton, the average increase in sorghum for over four years being 90 per cent (390 lbs. per acre). From the station reports it will be seen that poudrette has, in addition to the increased yield, actually added to the fertility of the land. This conserving value appears even better than with cattle manure. Except for the sentimental objection attaching to its application, there are large economic possibilities in the use of poudrette.

Economics of Sorghum Manuring.—I have so far laid much large stress on the manuring of sorghum because for this crop on account of its poor price, the finding of a cheap and suitable manure is an imminent necessity. Also the problem of dry land manuring is essentially the problem of sorghum manuring, for it is only by application to sorghum that the manuring is rendered economical. I might in this connection reiterate that cattle manure and sheep penning form the best manures for the crop and that the use of artificials and cakes can be delegated to the more paying crops, and can be used, if necessary, to supplement cattle manure, whenever indications are given. Also our attention should be directed towards increasing our store of cattle manure. If all this is done, the return from the sorghum crop shall be much better than it is.

Cultural Improvements.—I shall now refer briefly to certain cultural experiments done in our presidency. Due to the large number of years they take to give conclusive results, the experimental evidence in this connection is not as adequate as is desirable. The results of the soil moisture experiments at Hagari for the past three years, go to show that deep ploughing to the sorghum crop is beneficial, but it is not necessary to do this more frequently than once in five years. The ryot usually deep-ploughs once in three or four years before his cotton crop in these tracts. The evidence from Hagari experiments have not pointed to any particular advantage derived from deep-ploughing to this crop. In Koilpatti, however, the advantages of deep ploughing are indicated, and even here once in 5 years seems adequate for all needs. The advantage in this tract is that deep-ploughing removes *harialí* (*Cynadon dactylon*), a pernicious weed in the eradication of which the ryot spends a large amount of money by crow-barring.

Bunded plots in the soil moisture experimental plots at Hagari have given increased yields especially of sorghum. There are indications to show that dry farming methods, when practised systematically, will result in satisfactory yields and minimise crop failures in tracts of precarious rainfall such as the Ceded Districts. I may herein mention that a scheme for intensive research work on dry farming methods is under consideration at the Hagari Agricultural Research Station.

The advantages, if any, of line cultivation and consequent working with *guntakas* were tried in the Koilpatti Farm during the past two years. No differences were found between drilling and broadcasting the *Irungu* crop, while ploughing gave practically the same yields as harrowing with *guntaka*. As line cultivation has the advantage of labour saving, it deserves more

extended trials. This condition is not however applicable to irrigated sorghums where the practice of sowing in lines although useful in the saving of irrigation water, was not a successful operation. In cotton, however, the results are different. Water logging kills sorghum, hence ridging is advisable. In dry climates this operation is unnecessary but intercultivation is essential.

Spacing Experiments.—I shall now refer to the results of spacing experiments at Nandyal and Hagari. These show that broad spacing (24") between plants has been useful at Hagari, but, at Nandyal, the results are not conclusive. It might be mentioned that there are certain villages in the Kurnool district where a spacing of 2½ ft., as opposed to the general spacing of 10½ inches, is uniformly adopted, and very high yields are got. It can also be taken as a general indication that wide spacing is more suited to tracts with less rainfall, and this probably applies to dry seasons as well. Whenever the rainfall is precarious, wider spacing can be adopted with advantage.

Rotation of Crops.—The commonest practice among ryots all over is to sow sorghum mixed with other crops which vary according to the nature of soil, the seasonal and local conditions. In the Ceded Districts, green gram and other pulses, gingelly and gogu are mixed in small and irregular quantities with sorghum seed, while red gram, lablab, cow gram and castor are sown in lines amongst the crop. In a sense, this is a form of rotation, but there is room for considerable improvement in the cropping of sorghum as at present followed by ryots.

The introduction of a pure legume in the rotation of sorghum and cotton was tried in the early experiments of our department. In Coimbatore the legume had no effect on the succeeding crop. In Nandyal, however, the legume appears to be beneficial. With groundnut, the rotation seems still more justified. As a matter of fact, the cultivation of groundnut has increased in the Kurnool district at the expense of cotton in the past few years. The reasons are however probably economic. Groundnut pays in the rotation and to that extent it can be recommended. With this end in view, rotation experiments have been started this year in Nandyal and Hagari Agricultural Research stations with various legumes such as horsegram, Bengalgram, blackgram and groundnut.

Experience at all farms shows that it is possible to raise very good fodder crops from sorghum. Even in the dry lands at Nandyal, it has been possible this season to get such high returns as 20,000 lbs. per acre. This offers a ready source of raising fodder and providing against famine years. I mentioned under cultural improvements that broad-spaced sorghum gave higher yields at the Hagari Agricultural Research Station. Will it not be then more advantageous for the ryot to reduce his total area under sorghum and grow separately a grain crop of broad-spaced sorghum in an area just enough for his needs, and crop the rest of the sorghum area for fodder only ? Such a system would enable the ryot to increase the area under more paying crops such as groundnut and at the same time adopt a better system of cropping by the introduction of a legume in the rotation. And what is more important is, that the increased outturn of grain and fodder which will be obtained on account of manuring and the raising of grain and fodder crops separately, will provide against famine so frequent in the Ceded Districts,

and also result in an increased production of cattle manure by setting free a plentiful supply of litter and dung. The increased production of cattle manure would in its turn result in an increased return from all crops. These are just possibilities, and investigations on these lines have been commenced this year at Hagari and Nandyal Agricultural Research stations.

Conclusion.—In concluding, I should like to say that the improvement of the sorghum crop is intimately associated with the varying requirements of the needs of individual tracts, and sometimes sub-tracts. With the choice of the suitable varieties, the choice of pure lines follows as a next step for improvement. Attention in this connection should be directed to the value of fodder as well as grain in addition to yields.

The sorghum crop also responds profoundly to manuring. Cattle manuring and sheep penning are best for the purpose. Cattle manure especially has got residual effects extending to a number of years. Artificials are also effective, but they do not always cover the cost of manure. As a consequence, resort should be had to all sources of organic matter in making manures and increasing the supply. Poudrette also offers great possibilities in this direction.

There are possibilities of very good fodder crops of sorghum being raised even in dry lands. The trial of ensilage methods at Hagari and Nandyal has been very successful, and can be safely recommended in tracts where failure years are common and where it is necessary to guard against a dearth of fodder. There is scope for improvement in the method of cropping by adopting a well-balanced rotation of crops including a pure legume such as groundnut. With the adoption of such methods and with a little more enterprise in his methods of manuring there are great avenues for the ryot for improving the sorghum crop. The improvement shall not only benefit himself but also his cattle on whom he is dependent for his daily agriculture.

SORGHUM—THE GREAT MILLET[1]

By G. N. RANGASWAMI AYYANGAR, B.A., I.A.S.,
Millet Specialist, Agricultural Research Institute, Coimbatore.

Sorghum (*Sorghum vulgare* Pers.) Tamil *Cholam*, and Telugu *Jonna*, *Jowar* of Northern India, is one of the millets, a group of cereals with small grains. Round the origin of the word 'sorghum' has entered a lot of speculative discussion out of which the likeliest explanation seems to be that it originated from the Italian word *Surgo* (to rise), indicative of its rising head and shoulders over every other cereal. Many of the Chinese and Japanese names have a similar import. According to Pliny's statement, this Italian origin is possibly after its introduction into Italy in the first century A.D. in the time of Nero. It is called the 'Great Millet' for the reason that it is the biggest and the most important of the millets.

Origin.—The Asiatic or African origin of sorghum is a disputed and unsettled point. Its habitat seems to be primarily Asia. From affinities to many of the local wild species of sorghum, it is obvious that for many cultivated varieties, India was the original home.

[1] A paper read at the Twenty-first College Day and Conference of the Madras Agricultural Students' Union, Coimbatore—December, 1931.

Distribution in India.—Next to rice, this is the most important cereal in India, wheat being a close next. It covers an area of about 31 million acres. This area is concentrated in the central and peninsular portions. Hyderabad, Bombay, Madras and the Central Provinces and Berar monopolize it. Madras with five and a half million acres is the third in importance, Hyderabad and Bombay being first and second.

Importance.—This crop is of great importance to the bulk of the population, being the food crop of the poor. Its area relatively to rice is no standard with which to measure its role as a feeder of the population. Rice has a commercial backing that gives its acreage. Sorghum is pure and simple a food crop grown for the people and their cattle. Its adaptability to adverse conditions and its adjustment to varying types of soils, coupled with its enormous production of forage, give it a paramount place in the agriculture of this country.

In rice the amount of straw produced is almost equal to or a little more than the amount of grain. The average production of paddy in the presidency is about 1,750 lbs. of grain and about 2,000 lbs. of straw, a total of about 3,750 lbs. Coming to irrigated sorghum the average is 1,450 lbs. of grain and about 6,750 lbs. of straw, a total of 8,200 lbs. An examination of the grain yields of irrigated sorghum in the various parts of the presidency shows a range of yield from 1,200 lbs. to 1,500 lbs. round a difference of 300 lbs. The same difference of 300 lbs. obtains for dry crop yields which range from 400 to 700 lbs. From this it will be evident that in dealing with yields from dry lands the various tracts will have to be handled separately. At Nandyal the yield is about 400 lbs. of grain and about 1,350 lbs. of straw, a total of 1,750 lbs. At Coimbatore, a radically different tract, yields of dry *Peria manjal* are 600 lbs. of grain and over 3,400 lbs. of straw, a total of 4,000 lbs. It may be noted that the average rainfall of the Kurnool and Coimbatore areas is about the same. A review of these figures leads to the general conclusion that potential material producing capacity of sorghum is far higher than that of rice, that relatively to grain the vegetative bulk is correspondingly very high and that given optimum conditions like irrigation or very favourable rainfall, sorghum is capable of increasing its grain, though in no case decreasing its straw below three times its weight of grain, but still keeping to a higher nett production of both grain and straw than rice. A certain vegetative build is therefore taken for granted in the evolution or betterment of this crop, a fact of paramount importance to face in any attempt at improving this crop mainly through efficiency in the transpiration part of its build. It is given to this cereal to be the most abundant producer of nett plant material of all rainfed annual crops.

In food value sorghum is considerably superior to rice though only second to wheat. It is, according to Colonel McCarrison, richer than rice in protein content, richer than wheat and infinitely richer than rice in fat content.

Trade.—There is hardly any sorghum imported into India. The pre-war average of exports was about 28 thousand tons, and this has dwindled to an average of about 14 thousand tons to the value of Rs. 22 lakhs in the last five years. Most of it is exported from Bombay and finds its way to Africa, Arabia and Persia. Madras figures very little in this export trade.

A feature of the internal trade may be said to be that the great producing areas export to tracts of country inhabited by simple agricultural folk or to regions where modern civilization with its luxury has not permeated to any extent.

It can, therefore, be taken that our interest in this cereal in Madras is purely as a food of the poor and not a rent-paying article of export. This aspect while it has the advantage of sentiment and sympathy behind it, lacks the momentum which trade and finance give to the improvement of a crop both in acreage and in quality.

Previous work in Madras.—The Royal Commission on Agriculture prominently points out the paucity of effort towards dry crops in general and dry cereals in particular. A review of previous work on sorghum in our presidency provides no exception to this statement. The interest in sorghum was as early as 1870 at the Saidapet farm. Like almost all early attempts the basic motive behind this interest was novelty and an importation. Fodder and a short cut to sugar stimulated activity with the almost inevitable disappointments over sweetness unrealized, and mere fodder without a backing of good grain, proving an uneconomic proposition. The Saidapet experiments discursive as they are, suffered under the added disability of the Coromandel Coast with its 50 inches of rainfall.

Similar experiences leave the Koilpatti and Central Farm attempts nebulous. The only tangible economic results of work in the immediate past are the *Patcha jonna* strain type No. 6 of Nandyal and *Tella jonna* strain type No. 1 of Hagari, both associated with Mr. G. R. Hilson, recently Director of Agriculture, Madras. Similarly the only attempt at understanding the plant as such has crystallized round the Munagala Prize Essay of Mr. V. Ramanathan.

Current work.—The first serious attempt at handling this crop was the addition of a Millet specialist to the number of crop breeders already at work at Coimbatore. Cotton, paddy, and sugarcane, each of these single crops commanded the undivided attention of a whole-time officer, with the requisite staff. Sorghum with its acreage about half that of rice could not be the exclusive domain of one man and as such shared with other millets the attention of one specialist. The Millet Specialist was the first deviation from single crop attention, and in taking stock of the work of the Millets section with reference to sorghum, the fact that in succession millets like *Ragi*, *Korra* and *Cumbu* came in for a share of attention, should not be forgotten. This conjoint attention notwithstanding, the predominant attention given by the section was to sorghum.

Land for the Millets Breeding Station was acquired at the end of 1923 and the first crop on it raised in 1924. During these seven years the crop has been under intensive study both from an economic as well as from a genetic point of view. The extent to which it is being handled will be realized from the fact that in each of these seven years an average of a thousand units of selections have been under examination. In this period, two years had a rainfall below average, and two much above average, leaving three years normal. Abnormalities in rainfall vitiate judgment both of qualitative as well as quantitative characters and reflect seriously on yield, so that the goodness of any particular strain grown under rainfed

conditions becomes pronounced only after its performance gets evened up through at least a decade.

Economic work—Coimbatore.—Strains of the local variety, *Peria manjal* cholam have been under trial and, out of the original two hundred, have come down to a picked six, one from which it is difficult to choose. They are under a final trial this year and the likeliest will be multiplied on a bulk scale and distributed. In this connection a study of the differential vicissitudes through which each of these strains passed through the years makes me observe whether it is not time, in dealing with dry millets, to give up the orthodox conception of a single pure strain and adapt selection work in a direction which weeds off undesirables from a local population, leaving the *elite* as a healthy mixture. This method has the additional advantage of increasing inter-crossing and keeping up hybrid vigour in a crop whose floral structure and habits fit it for cross pollination in nature.

The case of irrigated sorghums is otherwise. With an assured water supply the potential capacities of this sturdy millet show out. A strain of white sorghum—A.S. 1543 which has had its first outing, has been well reported about; and another A.S. 1575 has this year proved better than A.S. 1543, on the station. With another year's trial this should easily spread round about Coimbatore and the neighbouring taluqs of Salem and Trichinopoly districts. In *Chinna manjal*, the irrigated counterpart of *Peria manjal*, strain A.S. 809 has proved consistently good in three years of comparative trials and is ready to go out.

While at this question of irrigation, the all-important subject of fodder, raised as fodder, crops up. In this direction sorghum is paramount, *Peria manjal* particularly so. To test the palatability of this fodder, other fodder varieties have been tried side by side with *Peria manjal* and of these Bellary *Tella jonna* has proved easily the best. This variety suffers from the disability of free setting of seed under Coimbatore conditions, and crosses have been made between this variety and the local *Peria manjal*, to tone up the latter from a fodder point of view.

Economic work—Bellary.—Hagari is the centre of the *Tella jonna* area. The area under this variety is confined to the black soil plateau with an elevation of about 1,400 feet, mostly black soil, and is a continuation of the big tract embracing southern Bombay, Hyderabad and part of the Central Provinces. The earhead of this variety is the acme of perfection in sorghum. The plants are short and stubby, very leafy, and the stem sweet. Good as it is, it is so very sensitive to optimum conditions, and the vast mass of headless plants and plants with eggy heads that one sees in abundance in a crop under a wave of adversity, shows what depredations are possible, through want of timely rains.

Hagari, the research centre of this tract, is in a particularly restricted zone of very low rainfall, and as such suffers from extra disabilities. Selections in *Tella jonna* have been made and averaged 150 these few years, but so far, except one year, the average performance of the selections through the series of bad years was very disappointing. From the current seed material the best strains have figured in the first comparative trial on the station.

Economic work—Kurnool.—Nandyal with its more favourable rainfall is about the centre of a very vast yellow sorghum area, running into the adjacent districts of Guntur, Nellore, Cuddapah and Anantapur. Right from the start of the sorghum work on this station the progress was very encouraging, so much so, that as early as 1924 comparative trials with strains commenced. These trials have been in progress till last year, when *Patcha jonna* strain No. N 23/10, which proved good through a series of years, was considered fit and has gone out for trial in the lands of the cultivators. This strain is remarkable for its adaptability to varying seasons, and I feel that in it we have a first reliable strain that will, apart from a very good or a poor yield in odd years, be capable of a decent dependable average.

Economic work—Future Development.—All economic work for particular tracts have to be done in centres within those tracts. Luckily Coimbatore, the headquarters of the Millet Specialist, is in the heart of an all-round millet area. Even so not all varieties do well here. It is remarkable that between the neighbouring districts of Bellary and Kurnool varietal incompatibility is chronic. *Tella jonna* of Bellary tried at Nandyal was mere leaf and no head. Outstations to the primary station are thus indicated as a necessity. In the case of paddy, a well-ordered development was possible and executed through sub-stations for the simple reason that the crop to receive intense attention was only paddy. Hagari, Nandyal and Koilpatti have from a very long time been stations primarily for the improvement of cotton. With the starting of intensive work on millets, the 'all-round conception of the problems of the tract assumed importance with the result that it was impossible to think of a separate cotton station, a separate millet station, and a third groundnut station, in each of the main tracts. This change in the angle of vision is the primary determinant in the future of sorghum work. Sorghum is certainly important. It gives food for man and fodder for beast. But side by side with it cotton is wanted for clothing and capital, and groundnut for cake and cash. An all-round agronomic attack is the broad campaign in which millet improvement is only one of the fronts. This concept leads to its logical conclusion, that the local authority, familiar with local conditions and intensely aware of local needs, is the best agency for outstation work. A recognition of this fact led to the posting of one assistant trained in the technique of millet breeding, to each of the Agricultural research stations, Hagari and Nandyal. The seed material evolved by the Millet Specialist has been transferred to the Deputy Director of Agriculture of the Circle. Other assistants similarly trained are programmed to be posted, one to Guntur and another to Koilpatti.

Studies—Classification.—Concurrent with selection for yield, studies of sorghum as a plant have been in progress. The classification of the sorghums has not been done in any thoroughness so far. This work has begun and is in progress at Kew. Madras has sent in its quota of varieties. Kew has determined the four main botanical varieties of this presidency as follows :—

1.	*Peria manjal* cholam and other allied compact-headed grain sorghums, dry or irrigated ...	*Sorghum Durra*, Stapf.
2.	*Tella jonna* of Bellary ...	*Sorghum cernuum*, Stapf.
3.	*Talaivirichan* cholam and its allies ...	*Sorghum Roxburghii* var. *hians*, Stapf.
4.	*Irungu* cholam and its allies	*Sorghum Nervosum*, Bess.

This varietal classification of Kew is the basis of preliminary observations on all work involving varietal distinction, though with the progress of our work it is possible, nay, probable that Kew may have to revise the basis of its classification. Anyway, a survey of the sorghum varieties of the presidency began last year, and it is hoped that in a few years a systematic account of the sorghums of this presidency will be available, based after Kew, and as modified by our intense varietal studies. The order of attack on a crop is to make first a reconnaissance, gather varieties, make a preliminary study, and armed with this knowledge begin a systematic survey so that the greater knowledge of the individual may help to evaluate its status as a community.

Chromosomes.—There are ten pairs of chromosomes in sorghum. Its characters will have to be charted out among these.

Depth of Sowing.—Right from the start of its life the sorghum seedling shows differential adaptability. Experiments made to study the effect of sowing at different depths, show that with increasing depth there is a progressive decline in germination, a progressive increase in the length of mesocotyl (primary root), and coleoptile (primary shoot), and progressive decline in the number of secondary roots. With deeper sowings there is a tendency for having a longer underground portion of the primary shoot. Deeper sowings develop a larger number of rootlets on the primary root—all tending to bank on deeper layers of moisture. Shallow sowings tend to give bigger, heavier and more leafy seedlings than deeper-sown ones; and this vigour can only be kept up with a continuance of favourable conditions. There is an appreciable variation in the different varieties in their response to deeper sowing with regard to percentage of germination and combined primary root and shoot lengths. The percentage of germination has a vital relationship with this combined length. These observations throw light on the current agricultural practice of sowing *Peria manjal* cholam behind a country plough in seasons of deficient rainfall. If this deeper sowing is implemented by an inherent capacity of the primary root and shoot to correspondingly respond to this depth of sowing, then optimum results in germination will be obtained with the resultant better stand in the crop. This aspect will have to be borne in mind in the evolution of a strain for drought evasion.

Pollination.—Studies in the pollination of sorghum have been made over a series of years. The earhead takes eight days to finish flowering. Flowering proceeds from top to bottom in the earhead, and in each branch of the earhead, from tip to base. The maximum number of flowers open between the third and the sixth day. The time of opening is between midnight and 10 a.m. The flowers keep open for 45 minutes. When they start opening, the anthers emerge in a column enclosing the two feathery stigmas. The dehiscence of the anthers is simultaneous with the opening of the glumes. When the flowers close, they leave the pollinated stigmas outside clipped between the glumes. Side by side with grain-bearing flowers there are abortive flowers, the ones at the periphery being males, in compact headed varieties. These later on start opening and provide a second dose of pollen. They seem to be in the nature of an emergency reserve.

This night flowering habit of sorghum is shared by *Korra* and *Cumbu*. They can flower in the cool hours of the night. But an analysis by the

Meteorological Department of the rain hours in a rainy day shows that they are heaviest at just past midnight in that part of the year coinciding with the flowering period. Thus the advantages of night pollination run the risk of a set-back through a possible heavy downpour of rain. These observations are made in detail to give a peep into the vicissitudes which the efforts of a breeder of millets pass through.

Natural Crossing.—The floral habits detailed above while they favour self-pollination, provide a considerable amount of cross-pollination in nature. The amount of natural crossing occurring in sorghum has been variously estimated by different workers. C. R. Ball (1911) reported from Washington, that in the case of adjacent rows of different varieties flowering at the same time, as high as 50 per cent of the seed produced by the leeward row has been found to be cross-fertilized. Graham (1915) working at Nagpur estimated the proportion of natural cross-fertilization in a loose panicled type as 6 per cent and in a type with compact panicle as 0·6 per cent. In one of his varieties as much as 20 per cent occurred. Karper and Conner (1919) working in Texas, U.S.A., got an average of 6 per cent where plants of one variety are entirely surrounded by another variety. Sieglinger (1921) observed that under Oklahoma conditions the amount of cross-pollination between adjoining rows of the same height and duration ranged from 2·61 to 8·56 per cent in the direction of the prevailing wind. Kottur and Kulkarni (1922) working at Dharwar experienced a range of crossing from 0·3 to 12 per cent with the largest frequency between 1 and 2 per cent, for side by side plots. Patel (1926) under Surat conditions observed natural crossing occurring to the extent of 25 per cent on the average when plants are 3 feet apart and even at a distance of 6 feet not a single plant examined escaped contamination. At Coimbatore where there is a very large collection from various sources the amount of natural crossing has varied with proximity, the build of the head, and the special receptivity of the variety to adjacent pollen. To quote a chronic case, crossing up to 90 per cent was experienced. In summer Cholam, on a bulk scale between neighbouring strips the amount of crossing was determined at about 7 per cent. The broad fact remains that this crop is very liable to taint from foreign pollen and in any attempt at improving it an efficient organization for seed supply is a condition precedent. In the breeding technique this natural crossing offers very many practical difficulties which impose extra caution in the hybridization of this crop.

Characters.—Considerable knowledge has been gained in the inheritance of characters in sorghum. The results of this knowledge are being published in two series of articles in the *Indian Journal of Agricultural Science*, one on the inheritance of characters and the other on general studies in sorghum.

Purple Pigment.—The best aid in the initial stages of the pursuit of characters in any crop is the presence of purple pigmentation in some of the varieties of the crop under study. In rice and in the Italian Millet it is a common experience to be able from the seedling and vegetative stages, to separate lot from lot. The outstanding difficulty in the case of handling sorghum is the failure of this helpful guide that serves as an easy index to other characters. Pigmentation only helps in the very seedling stage to make two definite groups, the 'Pigmented' and the 'All-green'. In the early vegetative stages the mass of varieties under study show very little colour differentiation, the only guide to separation being two or three main habit

characters. Direct colour effects are lacking but give place to innate potentialities with an occasional puncture due to insect or fungoid attack or mechanical injury. These are, in their nature, erratic and as such serve as no standard guide. It is very remarkable that wealth of colour in sorghum is made manifest only when ripe earheads are marshalled. It is a common experience that purple pigmentation is a potential symbol of distress and it is a matter for investigation why in sorghum so liable to distress it is so very latent instead of being patent.

Naked Grain.—Unlike most cereals the developing grain of sorghum lacks protection both in the early and in the late stages of its development. It is virtually a naked grain. Unlike *Ragi* which is also a naked grain, it has not got the protection of a well defined papery pericarp. Unlike *Cumbu* it lacks the sheltering protection of a mass of dry anthers in the early stages. It is thus a grain extremely sensitive to climatic influences and most susceptible to attack through birds and insects. To a breeder this aspect of the crop offers extra obstacles in the way of classification and choice of material with so shifty a standard in the selection.

Chlorophyll efficiency.—Chlorophyll deficiency of a total type resulting in white seedlings that germinate and die, has drawn pointed attention to the existence of other grades of deficiency in the chlorophyll, ' lethal ', ' lingering lethal ', and ' surviving ', pales. A single factor difference seems to mark off each grade from the other. These chlorophyll degradations which have been graphically brought home owing to the lethal ends to most of them, have raised the very vital question of chlorophyll efficiency and the factors that grade up towards this. It is a common experience that varieties differ from each other in their mass effects of emerald, and the question arises whether a systematic survey of their chlorophyll estimations is not called for to assess their relative efficiency. This is a line of attack proposed to be pursued in the near future.

Interrelated Characters.—It has been found that in sorghum there is a relationship between the colour of the leaf sheath and that of the glume, between the colour of the anther and that of the grain, between the colour of midrib of leaf and sweetness of stem, between colour at node and certain tints of grain, pairs of relationships that open up further possibilities of pursuing such relationships and relating them to vital factors like drought resistance and the all-important end, namely, yield. Most of the factors responsible for grain colour have been analysed and the relationship between the factors responsible for the translucent and chalky grains fixed up. The seed coat of the sorghum grain varies in its structure with different varieties with the consequent varying adaptations to the absorption of moisture, and a microscopic study of this seed-coat has commenced. An analysis of the panicle, its shape and inheritance, is in progress.

Correlation.—In handling a crop the object of the study of any character, be it a quality describable or a quantity measurable is to relate it to the all-important end of yield. In sorghum, within a variety selections can be made for yield, with the help of the following summary of the experience in correlation work, so far gained on this crop. In comparing one individual selected with another preference may be given to the one with the longer height, with the bigger thickness of stem, greater leafiness, and longer and broader earhead. There appears to be a close relation between the

laxity of the head and the amount of rainfall in the tract where any type is grown.

Mate of Sugarcane.—The sex-starved sugarcane has found in this great millet a fitting partner and the abiding results of this union will be watched with interest.

Malt.—Though primarily a food grain, the industrial possibilities of sorghum are by no means little. Its value for malt has been demonstrated. Varietal excellence for this purpose seems to differ and sorghum varieties have been supplied to the Agricultural Chemist for this purpose.

Broom Corn for Cottage Industry.—This sorghum is a variety similar to the local *Talaivirichan* cholam, and has figured as an exotic introduction from the year 1882 when it was first tried at Saidapet. As a broom, I fear it has no future when plenty of uncultivated land and cultivable waste are rich in material for broom making of all types. Extremely pithy, very coarse growing and with grain with much of husk and little of palatability, its encroachment into cultivated area is neither desirable nor practicable. Of late years it has found an enthusiastic supporter in Dr. S. S. Nehru, B.SC., M.A., PH.D., of the Indian Civil Service, whose contagious enthusiasm in matters agricultural is unique. According to him it could be an asset to develop cottage industries productive of not only brooms, but of brushes, chicks, baskets and ropes, and how far there are other superior competitors in the field, is a matter for detailed consideration in any scheme of developing this for cottage industries. The experience of growing broom-corn at Coimbatore has shown how liable it is to disease and to natural crossing and the consequences of its introduction on a large scale into a grain sorghum area will have to be preceded by a careful weighing of the *pros* and *cons* of such an introduction.

Physiology.—In dealing with a cereal so vulnerable and susceptible to weather conditions it is essential that any attempt at improving the general condition of the crop should have two ends to it. The first is the soil end, the medium in which the plant is rooted. The physics of this soil and the water relationships that exist in that soil are of great importance as also its aeration and temperature. Equally important, if not more, is a study of the physiology of the plant and the role that water plays in the efficient discharge of the various metabolic processes contributing to the efficiency of the physico-chemical properties of the protoplasm in the plant. The sorghum plant by restricting the amount of growth by the efficient and economical use of the water, delays the ultimate exhaustion of the limited supply of soil moisture and thereby evades early desiccation. Thus the wilting coefficient of the plant, the osmotic pressure of its cells, its sap content and colloidal properties, the density of venation, the length of the stomata, and such other pertinent details in its equipment have to be gone into. Rational explanations of many a popular verdict as to the favourableness or otherwise of environmental factors including wind and weather, can be given only after a thorough study of the physiology of the crop and its water balance. Basic ideas of plant physiology are the common property of all botanists but after the advent of intensive research work on crops in agricultural departments and of specializations in the universities, the subject of Plant Physiology has along with Cytology assumed an individualistic importance of great magnitude. In cotton, a crop worked practically threadbare, it

required two decades before it was effectively realized that in its improvement there were vital factors which needed the help of a plant physiologist. Provision for one such was made last year, and one of the best young men that our Agricultural College has produced was sent to get equipped in this branch of botany, at Cambridge. That being so, it is needless to stress that in the more herbaceous, but coarser growing sorghum, with no tap root, with its waxy cuticle and ashy bloom, its dreaded hydrocyanic acid and notorious after effects on the succeeding crop, the all vital question of drought resistance and evasion can efficientiy be tackled only by intensive research in the general physiological equipment of the plant. Even in the west, intensive studies in this line have been recent and confined to Russia and America. In India the attempts to study the physiology of the cotton plant in the Benares Hindu University, and the physiology of the rice plant at the Royal Institute of Science, Bombay, are but the beginnings in this line. A plant physiologist is indicated as a vital addition to the equipment to cope with this cereal.

[We are compelled for want of space, to hold over three remaining papers on the symposium on sorghum, and a report of the discussion that followed, for the next issue.—*Ed., M.A.J.*]

THE TWENTY-FIRST COLLEGE DAY AND CONFERENCE

The twenty-first College Day and Conference came off this year between the 19th and 21st December. The College Day was purposely postponed from July to December as it was at that time expected that the conference of the Gazetted officers of the Department would also be held in December and as such, we could have them present for the College Day and Conference. Unfortunately, however, on account of financial reasons, Government could not permit the holding of the Gazetted officers' conference and as a consequence we had to miss once again this year very many familiar faces. The several functions went off successfully and the Union offers its grateful thanks to all those ladies and gentlemen who had contributed towards the success of the celebrations.

Athletic Sports.—The College Sports came off in very bright weather on Saturday the 20th December. On account of a counter attraction, the District Police sports in the Town, the gathering on our maidan was not as large as it used to be. The events however were hotly contested and following the procedure set up last year, run on strictly olympic lines. It is gratifying to note that records were broken in Quarter Mile, and equalled in Hundred Yards and High Jump, Bennet of Class I, who happens to be the champion of the year, having to his credit two of these achievements. At the end of the Sports Mrs. Wrench of the Forest College very kindly gave away the prizes. The following is a full list of prize winners of the various items.

Cross-country Race.—1. K. Bushanam, 2. N. Srirama Reddy, 3. G. Ayyadurai.

Hundred Yards Dash.—1. P. M. Bennet, 2. K. Radhakrishna Rao, 3. F. L. Daniel.

Long Jump.—1. P. M. Bennet, 2. U. Patnaick, 3. K. M. Narayanan.

16 lbs. Shot Put. –1. P. M. Bennet, 2. T. S. Dakshinamurti, 3. Md. Obeidullah Shah.

High Jump.—1. K. M. Narayanan, 2. P. M. Bennet, 3. K. G. Kallapiran.

Quarter Mile.—1. P. M. Bennet, 2. U. Patnaik, 3. T. Ramanujulu.

Cricket Ball Throw.—1. U. Patnaik, 2. P. C. Sahadevan, 3. G. Ayyadurai.

Half Mile Race.—1. F. L. Daniel, 2. K. M. Narayanan, 3. D. T. Dhanapandyan.

Half Mile (Invitation).—1. Forest College, Moinuddin Khan, 2. Municipal High School, 3. P. S. G. & Sons Industrial School.

Sack Melee.—1. K. C. G. Paniker, 2. Nagarajan, 3. S. Krishnamurti Rao.

120 Yards Hurdles.—1. Md. Obeidullah Shah, 2. P. M. Bennet, 3. K. M. Narayanan.

Old Boys Race.—1. Kurup, 2. Hanumantha Rao, 3. Varadachari.

One Mile Race.—1. K. Bhushanam, 2. T. Ramanujulu, 3. U. Ananda.

Obstacles Race.—1. D. T. Dhanapandyan, 2. Srirama Reddi, 3. K. Tejappa Shetty.

Inter-tutorial Relay Race.—Mr. V. Muthuswami Ayyar's Wards.

Inter-tutorial Tug-of-war.—Mr. S. Sundararama Ayyar's Wards.

Champion of the Year.—P. M. Bennet.

The record of 60⅘" for Quarter Mile established in 1924 by M. Ratnavelu was broken by P. M. Bennet who finished the course in 59⅘". The records of 10⅘" in 100 Yards Dash established by K. Hanumantha Rao in 1927 and 5' 1" in High Jump established in 1923 by A. Jeevaratnam were equalled by P. M. Bennet and K. M. Narayanan respectively.

Entertainments.—On the night of 20th, the students staged *Mathuseva* ('Worship of Drink') a social play in Telugu, and *Anandapalan* a drama in Tamil specially written for the occasion featuring current ideas in an ancient setting. All the actors acquitted themselves very creditably. One noteworthy feature was the yeoman service rendered by the Boys Scouts of the Estate, under their Instructors P. R. Venkataraman and B. Krishna Rao who helped in fitting up the stage, enclosing the main hall, and arranging seats, the whole work being a practical application of scout-craft.

The General Body meeting.—The General Body meeting of the Union was held on Sunday the 20th at 9 a.m. under the Chairmanship of the President, Mr. C. Tadulingam Mudaliar. During the discussion that ensued after the annual report and accounts were read, Mr. C. Narasimhachari enquired why a rebate was taken from the Ramasastrulu-Munagala fund. The Secretary explained how in some years the prize was awarded from the Union funds and as such the original endowment had increased beyond what it should have by mere interest alone. This was discovered only now and at the suggestion of the auditors and with the sanction of the managing committee, a proportionate rebate was taken to the union accounts this year, and hereafter, a separate account will be kept for this endowment. With reference to a statement made in the auditors' report that a certain fixed deposit mentioned in last year's budget did not at all exist and that it was a clerical mistake, it was resolved after discussion, that the next committee go into the question and publish a statement in a later issue of the journal. After these, the Annual report and accounts were adopted, as also the budget for 1932 after slight modifications.

The next subject was amendment of rules, notice of which had been given earlier. That annual topic, the deletion of the word 'Students' in the name of the Union, elicited warm discussion and as last year, the no-changers carried the day by a decisive majority. Other amendments were chiefly about raising subscriptions for some classes of members but these were all thrown out, only one—of deleting in rule 4-b, 'over Rs. 250' and inserting 'Rs. 250 and above'—being passed. Amendments regarding increasing the number of members in the managing committee and about the Union ceasing to conduct the College Day Sports and entertainments in future were after discussion, withdrawn by the various movers. With reference to an amendment that 'every member shall on joining, pay an entrance fee of Rs. 2 and an annual subscription of 0-8-0, etc.,' it was resolved that this be gone into by the next managing committee and after that, the decision arrived at by an emergent general body meeting of the resident members of the Union be mandatory. Rule 10, para 6 was amended as follows:—'All meetings of the Managing Committee shall be presided by the Vice-President and in his absence by one of the members.' In regard to consideration of a change of the Annual Conference from July to December, it was felt and expressed that despite the fact crops could be seen to better advantage during December than during July, there were many inconveniences chiefly for the students, by having the celebrations in December and therefore it was resolved that there was no need to change the date.

The question of sending an appeal to the Government for subsidy to the Journal was then taken up. The Secretary explained how Government regretted inability to grant any subsidy this year but had asked the Union to renew the request as soon as the finances of the Province improved. It was resolved that an appeal be made to Government and to the Imperial Council of Agricultural Research for a subsidy. The election of office-bearers was then proceeded with:

M. R. Ry. T. V. Rajagopalachariar Avergal was elected Resident Vice-President, Dr. T. V. Ramakrishna Ayyar, Editor, and M. R. Ry. M. R. Balakrishnan Avergal, Secretary.

The following is a full list of office-bearers for the coming year :—

COUNCIL (15)

1. C. Tadulingam Mudaliar, *President.*
2. T. V. Rajagopalachariar, *Resident Vice-President.*
3. Rao Bahadur D. Ananda Rao, *Mofussil Vice-President.*
4. Rao Bahadur M. R. Ramaswami Sivan, *Mofussil Vice-President.*
5. K. Gopalakrishna Raju, *Mofussil Vice President.*
6. M. R. Balakrishnan, *Secretary.*
7. Dr. T. V. Ramakrishna Ayyar, *Editor.*
8. M. Mangesha Rao.
9. C. Jogi Raju.
10. M. S. Madhava Rao.
11. K. Krishnamurthi Rao.
12. C. S. Krishnaswami.
13. Rao Bahadur B. Visvanath.
14. G. N. Rangaswami Ayyengar.
15. Thirumal Rao (Student).

MANAGING COMMITTEE (9)

1. President.
2. Resident Vice-President.
3. Secretary.
4. Editor.
5. M. A. Sankara Ayyar, Manager.
6. M. Rajagopala Iyer, Treasurer.
7. V. Gomathinayakam Pillai.
8. S. R. Srinivasa Iyengar.
9. Bhavani Sankar Rao (Student).

EDITORIAL BOARD (7)

1. Editor.
2. Secretary.
3. Manager.
4. K. Ramiah.
5. K. M. Thomas.
6. C. Narasimhachari.
7. B. C. Hanumantha Rao (Student).

The Conference.—Punctually at 9-30 a.m. on Monday the 21st December the Conference assembled in the main hall of the Research Institute, under the distinguished Presidentship of the Hon'ble Mr. P. T. Rajan, Minister for Public Works. Many messages of good wishes were read, prominent among which were from Dr. G. J. Fowler, Mr. C. M. Ranga Reddy, Mr. Lodd Govindas, Dr. C. A. Barber, Mr. Alan Curruth, Rao Sahib Y. Ramachandra Rao, Mr. H. C. Sampson, His Highness Kerala Varma the first Prince of Cochin, the Raja of Kangundy, Mr. R. D. Anstead, Rao Bahadur M. R. Ramaswami Sivan, Mr. R. C. Wood, Mr. G. R. Hilson, S. V. Ramamurti and T. F. Mayne. After the President declared the Conference open, Mr. C. Tadulinga Mudaliar, the President of the Union in a neat little speech, welcomed the Minister and the guests to the twenty-first College Day and Conference. Mr. K. M. Thomas, Secretary, then read the annual report which recorded all-round progress of the Union and which is published elsewhere. After this the following medals and prizes were distributed to the various prize winners by the Minister.

The Robertson Prize	K. Virabhadra Rao.
The Clogstoun Prize	D. V. Krishna Rao.
The Kees Prize	S. Rajaratnam Chetty.
Dewan Bahadur A. Raghunatha Rao Prize	S. Rajarathnam Chetty.
The D'Silva Memorial Prize	N. Sobhanadri.
The Anstead Medal	T. S. Balasubramanyam.
The Goschen Prize	S. Krishnamurthi Rao.
The certificate Course Cup	R. Suryanarayana.
Rao Bahadur K. S. Venkatarama Ayyar Medal...	Y. V. Narayana.

The President then delivered his address which was listened to with rapt attention. The following six papers contributing to a Symposium on Sorghum were then read.

1. Sorghum in the Western taluks of Bellary by R. Nagann Gowda, Ph. D., Hospet.

2. Sorghum improvement in the Madras Presidency by K. Gopalakrishna Raju, Dt. Agrl. Officer in charge, III circle.

3. Sorghum the Great Millet by G. N. Rangaswami Iyengar, B.A., Millet Specialist.

4. Chemistry in the production and utilization of Sorghum by Rao Bahadur B. Visvanath, F.I.C., Government Agricultural Chemist.

5. The Entomology of the Sorghum Plant by Dr. T. V. Ramakrishna Ayyar, B.A., Ph. D., F.Z.S., Government Entomologist.

6. Sorghum Diseases by Mr. S. Sundararama Ayyar, M.A., Government Mycologist.

The reading of papers was followed by a discussion; three of the papers, and the Presidential address are printed separately in this issue.

The President in his concluding remarks said :—

I have listened with great pleasure to the addresses of the several experts who are engaged in improving the sorghum crop. They were very encouraging and interesting and so also was the discussion that followed. As it invariably happens, experts very seldom agree. They disagree and differ. But this conference gives an opportunity for persons working at different angles to exchange views and clarify opinions. That itself would justify the holding of this conference. I realize how very unfortunate it is that the Deputy Directors and the District Agricultural Officers are not taking part to-day. I hope that the disability of finance will disappear very soon and that all officers will be enabled in future to take part in these conferences.

About sorghum, Mr. B. V. Nath in his very interesting report assured us that sorghum is ready for industrial purposes for the manufacture of Malt and Starch. I shall tell both the Director of Agriculture and the Director of Industries to give effect to a practical scheme of manufacturing these, as soon as the financial conditions improve.

I am glad to see that the demonstrator coming in contact with the experts here, goes back to the ryot with clarified and definite ideas. Whatever may be the result of experiments, the ryot is chiefly concerned with whether the Madras Agricultural Department is going to increase the yield maintaining the cost of labour. I myself am a ryot, and as a ryot, and as a man in the street, I am very glad by my participation in to-day's conference to note the excellent work done by the Agricultural Demonstrators. During the coming Legislative Council discussions I shall be able to give tangible proof to the critics about the work turned out by the demonstrators.

I finally thank you Mr. Principal and you Mr. Director for giving me an opportunity to preside over your deliberations to-day. My only regret is that my stay with you is very short and I hope that sometime later, I shall be able to spend some more days with you.

Votes of thanks.—Mr. C. Tadulinga Mudaliar, President of the Union, proposed votes of thanks to all the Committees that had worked whole-heartedly for the celebrations this year. Rao Bahadur D. Ananda Rao proposing a vote of thanks to the Chairman, regretted how it was not possible to get the gazetted officers for this year's conference and on behalf of the Union and on behalf of himself, offered warmest thanks to the Minister for so readily responding to our invitation. With three hearty cheers to the Minister proposed by Mr. C. Tadulinga Mudaliar and lustily responded to, the function came to a successful close.

PRINCIPAL'S WELCOME SPEECH

HON'BLE MR. RAJAN, LADIES AND GENTLEMEN,

The pleasant duty of welcoming you all to this, the twenty-first College Day and Conference, has devolved on me as the President of the Madras Agricultural Students' Union once again. Since I had the privilege of last discharging that duty in July 1929, changes have occurred in the Ministry and in the personnel of the Head of the Agricultural Department. The Hon'ble Mr. P. T. Rajan, who has kindly consented to guide our deliberations and who is with us to-day has become our Minister and to you Sir, I offer my respectful congratulations and extend a very hearty welcome on behalf of the Union and on my own behalf on this occasion and feel sure that under your helpful guidance the Conference will be brought to a successful conclusion. Director Mr. Anstead has retired and Mr. G. R. Hilson has left. Once again after the lapse of about ten years, a Member of the Indian Civil Service is appointed Director and to Mr. S. V. Ramamurthi who is shortly taking over, we tender our congratulations.

The world depression and the financial stringency that has followed, tend to paralyse the activities of this department also. I feel however that the members of the department will rise equal to the occasion and in spite of cuts and retrenchment will, with unabated zeal, continue their efforts towards the advancement of Agriculture. On account of financial stringency it is unfortunate that several District Officers who could be here are not present to help us and we hope this is merely a passing phase and during the next College Day, conditions will become normal.

Ladies and Gentlemen, I thank you for kindly responding to our invitation to be present here at great personal inconvenience and sacrifice and hope you will kindly excuse us for any shortcomings in our arrangements. I welcome you all once again.

MESSAGES

[*We publish below a few select messages received on the occasion of the College Day.* —*Ed., M.A.J.*]

Dr. C. A. Barber, formerly Sugarcane Expert, Coimbatore :—Thank you for reminding me of a College Day and asking me to send a message to my old student friends and acquaintances at Coimbatore. It is true enough that I often think of my spell at the College. . . . I watched with interest the progress made by my successors and enormous spread of the cultivation of Coimbatore seedling canes in India. The M. A. S. Union is a very different thing from what it was when I left the country a dozen years ago and especially congratulate it on the position its journal is taking up among the Agricultural journals of India. Hearty wishes for a very successful meeting on College Day.

Mr. Alan Carruth, formerly Deputy Director of Agriculture, Live stock :—My recollections of the College Day and Conferences are still vivid although ten years have now passed since I last attended one of these functions. . . . I note with interest month by month as the journal comes to hand the progress the Agricultural Department is making in Southern India. It is encouraging to read many interesting papers in the journal by men who were students while I was at the College. . . . I shall always regard it as great privilege to have been associated with the Madras Agricultural Department and the M. A. S. Union. While I would have preferred to have been present to meet many past friends and acquaintances and also to make many more and probably see my old walking stick in the Museum, I must content myself with sending my best wishes for the success of the College Day.

Mr. H. C. Sampson, formerly Director of Agriculture and now Economic Botanist at Kew :—The Agricultural conference was an occasion to which I always look forward, for it gave me an opportunity of meeting so many of my friends in the Agricultural service both those who are working under me as well as those who were working in other parts of the Presidency. . . . One of the most valuable results of the conference is to help to keep the farmer in touch with the research and enable the research worker to keep in touch with the farmer. . . . Since I last met the senior delegates of the conference, I have been granted the privilege of seeing the agriculture of many countries in the tropics and I may say that I have not met anywhere such a high standard of arable farming as exists in Madras. Much of the practice is empirical being based on years of experience. But this empirical knowledge is very sound and based on scientific principles which it is the duty of the Agricultural Department to discover. I do not know how many of you realize what a number of the crops and fruit trees now commonly grown by the farmers of this Presidency have been introduced into this country. The members of the Telugu Students' mess may not realize that the Chillie is a native of America and was unknown to the Old World before 1494. I am sure they cannot visualize the time when their forefathers had to be content with the ginger and pepper to give to their food that pungency which their mess always demand. When one considers the high efficiency which the cultivation of this crop has reached under such wide differing conditions as those which prevail in Guntur and Coimbatore, one feels that no research worker can neglect the study of the art of agriculture which is practised by the Madras farmer and I trust that those who attended the Conference will take the opportunity of discussing their work, whether it be research at these institutes or whether it be research in the field, with the members of the other branch of the service. . . . For this reason I wish the Conference a long and prosperous life as I feel that you now have an opportunity of exchanging information and views which may lead to research, which may prove of the greatest help to the primary producer, in enabling him to earn his living.

Mr. R. D. Anstead, formerly Director of Agriculture :—Since I was last among you I have had an opportunity of seeing the Agricultural work which is being done in Ceylon, Australia, New Zealand, and the South Sea Islands. I saw in Australia and New Zealand magnificent Agricultural Colleges teaching a practical course to future farmers and leaving the Universities to deal with their own Agricultural Courses for the training of teachers. I saw in New Zealand herds of some of the finest cattle in the World, research work on rotational grazing and the handling of pastures, and a wonderful system of raising disease resistant seed of cereals on a vast scale.

I saw many other things and though of course we have much to learn and much we might improve upon, at no time had I any reason to feel anything but proud of our Department, as regards its equipment, its standard of research, or its methods of getting the results of research translated into action by the actual peasants.

I am convinced that the foundations of our Department were well and truly laid by those who went before us and that the building which we have begun to erect on those foundations is good. I hope that this will never be forgotten and that those of you who will now have the duty of completing the superstructure will see to it that it is always worthy of the foundations.

You have asked me for a message. In these days of storm and stress, men's hearts are apt to be torn asunder, and old friendships, old loyalties, old standards, and old ideals forgotten. I plead for calmness and for kindly remembrance of old friendships and loyalties of men who gave their all to India and the Madras Agricultural Department.

I would remind you of a tale that is told. It is said that while the battle of Waterloo was being fought between the opposing armies a peasant calmly continued to plough his field. Wars had nothing to do with him, he proceeded with his task.

This should be the attitude of the Agricultural Department. Its job is to see that the blessings of knowledge and science are brought to the peasant that his crops may be increased and his standard of life improved. Nothing else concerns the Department and I should like to think of them continuing to plough the fields and continuing to raise those two blades of paddy where only one grew before, while about their heads crash the political storms and stresses un-noticed and un-heeded.

Keep your standards high and let nothing turn you from the straight path of truth and efficiency.

Rao Bahadur M. R. Ramasami Sivan, formerly Principal of the Agricultural College :—For the first time since the College Day was inaugurated at Coimbatore over twenty years ago, I am obliged to be absent at the celebration, coming off at the end of this week. Apart from the multifarious duties which I had to perform in earlier years, in my capacity as some office-bearer or other of the Union, the College days were to me a source, not only of enjoyment and pleasure, but to a certain extent, of rejuvenation. Because, coming in contact with my old friends, mostly my old students and therefore younger men, I felt myself young again, when conversing with them and exchanging reminiscences. . . . Though obliged to be absent in person, my heart is there and I beg to convey my best wishes for a successful session.

Mr. R. C. Wood, formerly Principal of the College and now Professor of Agriculture at the Tropical College of Agriculture, Trinidad :—It gives me great pleasure to congratulate the M. A. S. Union on its 21st birthday. I was present at its birth and in fact I was one of its very first officers and I do not remember that it was particularly a vigorous child. But it has gathered strength as it grew and I think its members have every right to be satisfied with the progress it has made. That however is not to say that there is plenty of work to be done. Times are changing rapidly and more than ever before will a sound tradition become of importance to all institutions of the nature of the Agricultural College. There is a tendency sometimes for progress to be too rapid and unbalanced and it is one of the functions of the Union to see that due heed is paid to the lessons and traditions of the past. A sound agricultural education in my opinion must include practical acquaintance with the various operations which have to be performed in the field or in the steading in the process of farming. Those of you who remember me in Coimbatore will remember my insistence on the value of the practical classes in the field and the way in which the classes were broken up and allotted to the performance individually as far as possible of the duties of the Dairy, the Store or the Veterinary Hospital. . . . I was lecturing yesterday to the post-graduate class on rice and made use of a number of photographs both of the farm rice lands and the Paddy breeding station, which put me in mind of old times. I am just now harvesting a very heavy crop which should average out at over 4000 lbs. to the acre. My Madras experience stands me in good stead here. I am a most successful paddy farmer! Best wishes for the success of your meeting.

Mr. G. R. Hilson, formerly Director of Agriculture :—To your Union as a body, I tender my heartiest congratulations on your reaching your twenty-first anniversary in so healthy a condition. My wish for you for the coming years is that they may find you ever stronger in body, wider in activity and reputation, and longer in purse. May you live to a ripe old age. To the individual members of the union, please convey my best wishes for the coming year.

SECRETARY'S ANNUAL REPORT

MR. PRESIDENT, LADIES AND GENTLEMEN,—

The Madras Agricultural Students' Union beg to submit a retrospect of the period of 18 months since the last College Day and Conference held in July 1930.

The period under review has been unique in the history of the Presidency. The economic depression which swept the whole world, affected agricultural countries worst and India with its 85 per cent of agricultural population was severely hit. World commodities like cotton, sugar, oil-seeds, food grains, jute, rubber and tea depreciated heavily in the world's markets and India came in for a big share of the trade slump which followed. Besides this, our Province in general and the East Coast districts in particular had the misfortune of experiencing unseasonal rains which caused droughts and floods and the consequent losses to the cultivator. While we are gathered here to-day, comes the distressing news that our less fortunate brethren in the southern districts of the Presidency are in the throes of a flood which threatens the destruction of valuable crops in several thousands of acres.

The College Day and Conference.—The twentieth College Day and Conference held under the auspices of this Union came off between the 15th and 18th of July 1930. For the first time in the history of this Conference, gazetted officers of the Department resident in the districts could not be present. The College Day functions began with College Sports which were held on the 15th July, as usual, under the auspices of the Union. The athletic events were conducted on Olympic lines and all the items on the card keenly contested. Student M. G. Ponnappa won the Championship honours. The Union offer their thanks to Mrs. Munro who kindly gave away the prizes. On the 16th and 17th, various Research sections of the Institute and Government of India Sugarcane station put up an interesting and educative exhibition explaining the nature of the problems under study and the results achieved. Besides acquainting the large concourse of visitors with the work of the Department, departmental officers were able to acquaint themselves with the latest activities of various sections and to exchange ideas. Demonstrations with ploughs and the H. M. and R. E. *guntakas* were held in the fields. On the 16th night the students of the College put on boards a Tamil and a Telugu drama, both of which were highly appreciated.

The Conference was held on the 18th July with Mr. G. R. Hilson, then Director of Agriculture, in the chair. After the President declared the Conference open, the Principal welcomed the delegates and guests. This was followed by the Secretary's Annual Report which recorded all-round progress in the several activities of the Union. Mr. Hilson delivered his presidential address on ' The Duties of the Agricultural Demonstrator '.

Prizes were then awarded to the several successful candidates in the B.Sc. (Ag.) degree examination held in April 1930.

The following papers which formed a symposium on Sugarcane were then read :—

1. ' Sugarcane ' by MR. T. V. RAJAGOPALA ACHARYA, Dip. Agri., Vice-Principal ;

2. ' Sugarcane Breeding—its chief characteristics ' by RAO BAHADUR T. S. VENKATARAMAN, B.A., Government of India Sugarcane Expert ;

3. ' The Manuring of Sugarcane ' by RAO BAHADUR B. VISWANATH, F. I. C., Government Agricultural Chemist ;

4. ' Sugarcane Insects in South India ' by RAO SAHIB Y. RAMACHANDRA RAO, M.A., Government Entomologist ; and

5. ' Sugarcane Diseases ' by Mr. S. SUNDARARAMAN, M.A., Government Mycologist.

The reading of papers was followed by a prolonged and lively discussion in which a large number of the audience took part. The Union offer their thanks to all the gentlemen who contributed to the symposium and made the Conference the success it was.

The Journal.—The most important activity of the Union was the publication of its Journal—*The Madras Agricultural Journal*. The journal is this month finishing its nineteenth year of life. Thanks to the labours of the office-bearers and to the co-operation of several members and others both within the Department and without, the journal attained a very high standard during the period. On an average 1,000 copies of the journal were in circulation and the monthly issues were published with remarkable punctuality. It is a matter for gratification that the journal has established for itself an undisputed place among the agricultural journals of the Tropics and has earned the name 'India's premier Agricultural Monthly'. Though the journal is to-day playing an important role in the agricultural education of the Province, the time has arrived to make it still more useful to the public; but lack of adequate funds preclude such a step in the immediate future. With a desire to improve the scope of the journal and still further increase its usefulness, the Union approached Government for the grant of a subsidy. Though Government regretted their inability to grant a subsidy immediately owing to the present financial stringency, they have very graciously asked us to renew the request when the finances of the Province improve. While we feel gratified that Government are appreciating our efforts, we still hope that erelong Government will find it possible to come to the aid of the Union with a substantial subsidy.

Membership.—Propaganda work was done on a large scale to enlist more members and subscribers. Over 100 people eligible for membership joined the Union, making the total membership nearly 400. Subscribers were enlisted from all parts of India, Burma and Ceylon.

Lectures and discussions.—With a view to give opportunities for members of the Union and others to discuss outstanding problems relating to agriculture, a new institution called the M. A. S. U. Parliament was inaugurated during the period. Four sessions of the parliament were held and the following subjects were debated upon:—

1. The restriction of further increase of rice area in Madras,
2. The restriction of export of indigenous manures from India,
3. The destruction of prickly-pear by the cochineal insect,

and 4. Should agricultural graduates go back to the land?

These discussions were of a very high order and were highly appreciated not only by those who attended the meetings but also by the readers of the *Madras Agricultural Journal* in which the proceedings were published in detail. Advantage was taken of opportunities to invite distinguished personages in the field of agriculture, finance, etc., to deliver popular lectures. The Union take this opportunity to express their thanks to all those who participated in the discussions and also to those who delivered special lectures.

Ramasastrulu-Munagala Prize.—In response to the invitation of the Union for papers competing for the above prize which is awarded to the best account of original research or enquiry made by any member of the Union, two papers were received. Both were declared by the Committee of judges to be of a sufficiently high order to deserve the prize. The prize was awarded to Mr. C. Jagannatha Rao, B.A., Cotton Assistant, Nandyal, for his paper 'The effect of time of planting on some economic characters of the cotton plant'. We offer our congratulations to Mr. Jagannatha Rao on his success and express our gratitude to Rao Bahadur T. S. Venkataraman, Mr. A. C. Edmonds and Dr. K. Venkata Rao Badami who acted as judges.

General.—Founded in 1909, growing progressively through over two decades and privileged to play its humble, yet meritorious share in agricultural education and extension work in the Province, the M. A. S. Union has become a power in the country commanding recognition in matters agricultural. The growth of the Union has been in a large measure due, on the one hand, to the active sympathy and encouragement of successive Directors and Principals and on the other to the willing labour of love rendered by the office-bearers and members of the Union. The Union take this opportunity to offer their thanks to Messrs. G. R. Hilson, Rao Bahadur D. Ananda Rao, C Tadulingam, R. C. Broadfoot and P. H. Rama Reddi for their abiding interest in the affairs of the Union. Our thanks are also due to the office-bearers, members of various sub-committees and to all those ladies and gentlemen who contributed to the success of the various activities of the Union.

PRESIDENTIAL ADDRESS

(Delivered by the Hon'ble Mr. P. T. Rajan, B.A. (Oxon.) Bar-at-Law, M.L.C., Minister for Public Works at the 21st College Day and Conference)

It gives me much pleasure to meet an old established association like yours which has built up traditions and annually brings together old and new students of this College.

I am fully conscious that the subject with which you are concerned is one of unique economic importance in this country. The income of our people is derived mainly from agriculture. The largest part of the revenue of the Government is also derived from the land. But such income both for the people and the Government is now stagnating. The industrial development of this country is likely to be more in the direction of cottage and small scale industries using up agricultural products available nearby than in that of large scale industries feeding on raw material from elsewhere. The only large source of revenue to the Government other than land revenue is excise and that is a diminishing source. Miscellaneous sources of revenue rise and fall with the prosperity of agriculture. Thus both for the people and the Government, agriculture occupies the central and dominant place in their economy.

If agriculture is to remain where it has been for many centuries, then there is no scope for the economic improvement of the people or for the increase in the revenue of the Government. But the hopeful fact before us is that modern civilized countries have utilized science in the last century or two to increase manifold the yield from agriculture and if we adapt such methods to this country with, on the whole, a fertile soil, a suitable climate and a population patient and willing to work, there is no reason why we too may not share in the large increase of economic prosperity which has been achieved elsewhere. I would, therefore, impress on you, wherever your lot may be cast—be it in the laboratory or out among men—to put forth every ounce of your strength to stimulate the use of science where they are known but not followed and discover new ways of using science where they are not now known. Demonstrators who go about among the people have not only to pass on to them the methods that have evolved from the laboratory but also, with a quick and sure observation, pass back to the laboratory the problems which need to be solved, if the ryot's position is to be improved. Those of you who work in research laboratories and farms will no doubt appreciate that it is given to you to do creative work which, if successful, multiplies itself millionfold in the country.

I have stressed the importance of the work you are concerned with because if we are to pass out of the present economic depression and to insure as far as possible against future economic depression, the one and only method we have is the improvement of agriculture for which there is enormous scope. We need, therefore, specially to concentrate our energy on such improvement and I trust that you will fully bear your share in such a task

Notes and Comments

New Year Greetings.—Through the medium of this number we extend our cordial greetings and best wishes for a happy and prosperous New Year to our subscribers, readers, printers, contributors and advertisers and to all those who have helped us in various ways in the conduct of journal. With this month, the *Madras Agricultural Journal* enters its twentieth year of its life and we need hardly add that this steady progress of the journal through a period of well nigh two decades has been entirely due to the substantial support and hearty co-operation which it has been receiving from

our many sympathisers and well-wishers during these years of its adolescence. We all venture to believe that the journal has not failed to secure a place for itself among the important agricultural periodicals of the day. It is our fervent hope that the journal will continue to receive the same help and encouragement during the coming years.

The Economic Depression.—We cannot however refrain from referring to one important and rather disheartening picture, viz , the octopus-like effect of the present economic situation on all human activities all over the world and our journal cannot escape its grip. What with the universal financial embarrassment and what to the flat cut in the salaries of Government servants, the outlook is rather gloomy and very discouraging. But it is our earnest prayer that such a period of trial may be only a short and temporary one and that it may pass off soon. We therefore make an earnest appeal to all our subscribers and sympathisers to continue their support to the journal during this period and hope the response may be adequate.

The College Day and Conference.—The Annual College Day and Conference came off the third week of December and the Union has been very fortunate in securing the Hon'ble Mr. P. T. Rajan, M.L.C., the Minister for Public Works, to preside over the Conference. We offer our thanks to the Hon'ble the Minister for so readily responding to our invitation and giving us the benefit of his guidance during the Conference proceedings. Elsewhere in this issue will be found the valuable address which he delivered on this occasion and which we commend to all our readers.

The new Director of Agriculture.—We offer our cordial welcome and hearty New Year felicitations to S. V. Ramamurthi, Esq., M.A., I.C.S., the new Director of the Madras Agricultural Department. After a period of nearly twelve years the Department is again coming under the control of a civilian officer. We hope that the new Director would not only extend the same patronage and privileges which the Union and its Journal have been enjoying at the hands of previous directors but may also find time now and then to favour us with some encouraging messages.

New Year Honours.—We offer our congratulations to Mr. T. V. Rajagopalacharya, the Vice-President of the Union on the title of Rao Sahib conferred on him. Mr. Rajagopalacharya has seen well nigh three decades of active service in the Agricultural Department, of which about thirteen years were spent at the College in several capacities as teaching assistant, Lecturer and Vice-Principal. His exposition of Agricultural knowledge should be familiar to several generations of students of the College. We trust that the present distinction is only the forerunner of several more in store for him.

Age-limit for entry into Service.—We note with satisfaction that Government have raised the maximum age for entry into the Agricultural Department for Agricultural graduates and diplomates from 25 to 27. This is a move in the right direction as several deserving candidates were on this account debarred from entering the service.

Correspondence

Poultry Farming

MR. MUSHTAG AHMAD QUERISHI, JACOBABAD, U.S.F., writes :—

I have made up my mind to start a poultry farm which could supply eggs in market on a large scale. I am of the opinion that I shall have the hens consisting of four country hens and one English cockerel. I do not mind keeping some birds as fancy birds. Please say if it will be profitable. I shall be thankful to you if you will very kindly express your opinion if I shall start the farm with eggs, (and get these hatched), day old chicks, pullets, or grown-up birds. What is your opinion about marketing capons and if there is any sale for these? If so, please say from where to have caponising instruments and the literature on the subject. What is your opinion about hatching with the incubators? Does it suit the Indian climate, if so, please say which incubator is the most reliable.

Answer.—Your idea of leaving country hens with an English cockerel is a good one. I should advise you to have about 8 to 10 pullets to a Rhode Island Red Cockerel. By this method you will be able to supply good capons and the cross-bred pullets will be useful layers at the same time. Whether or not the concern will pay depends mainly on your efforts. Poultrying particularly needs personal attention, and it would be futile to depend on the type of servants you get in this country. You may start with egg-laying types of country pullets. By trap-nesting you will be able to evolve an Indian utility type and you will know that it will be best to keep only good layers. As it would not be easy to start with the chicks, I should advise you to have five months' old Indian pullets and a good type of Rhode Island Red Cockerel. By the time the hens begin to lay you will get to know their habits and you would be prepared to rear chicks. If you have a good market it would be worth while caponising the cockerels and fattening them off. Caponising instruments can be had either at the United Provinces Poultry Association, Lucknow, or at Messrs. Spencer & Co. Please get a veterinarian to help you to use them at the start. The incubators are quite useful but it may not be possible to use them on the plains during the hot months. The capsule should be suited to the elevation and the room should be kept fairly humid especially at the latter part of the hatching period, by sprinkling water on the floor or keeping buckets of water in the room. The Livestock Research Station, Hosur Cattle Farm, is getting satisfactory results with the Hearson's incubator Please refer to the article on poultrying in the *Madras Agricultural Journal*, vol. xix, No. 5 (1931, June).

Review

REPORT ON THE OPERATIONS OF THE DEPARTMENT OF AGRICULTURE, MADRAS PRESIDENCY, FOR THE YEAR 1930–31. Government Press, Madras : price Re. 1–2–0.

The above is a very lucidly written brief outline of the work done by the Department of Agriculture during the year. The subject-matter is discussed under various heads such as Administration, Agricultural Education, Season, Research, Demonstration, etc. During the year 38 students obtained the B.Sc. (Ag.) degree. The restrictions in the number of students admitted to the College every year to 48 is being criticised by the non-official members of the Selection Committee. The results of Middle School education have not been satisfactory and it is obvious that this course does not meet the need of either the agricultural or the non-agricultural community. This unsatisfactory conditions is proposed to be remedied by instituting short practical courses in farm management and its allied branches, the period of such courses extending from a few weeks to a year according to the nature of subjects dealt with.

Under research, the work of the several experts at the Research Institute at Coimbatore is outlined under the different heads—Botany, Chemistry, Crops, Entomology, Mycology, etc.

Researches on the live stock of the Province are carried on at three centres—Hosur, Chintaldevi and Guntur. The experiments in the Bangalore heads consisting of crosses between Ayreshire bulls and Scindhe and Saneival cows seem to show that the hybrids begin to degenerate from the second generation as indicated by their poorer yield of milk and greater susceptibility to disease. The Scindhe herd is found to thrive well in Hosur and the animals are said to be good milkers. The chief object of maintaining the herds is stated to be to supply good breeding bulls for improving the poor milking breeds like those for example on the West Coast. Good herds of Kangayam and Ongole breeds are also maintained. The chief object being to produce by careful selection animals which combine in them the qualities that go to make good draft cattle and heavy milkers. Besides cows and buffaloes studies are also being made on sheep, pigs and poultry. Under demonstration are discussed the various items of propaganda, the most tangible and fruitful item of this appears to be the distribution of large quantities of seed, of improved strains of crops. To give an idea of the extent and scope of this line of work, it may be stated that in paddy alone, 160 tons were of pure seed were distributed to the ryots in different circles. There are also several demonstrations of improved ploughs and *guntakas* on ryots' fields during the year. The report ends with a programme of research and demonstration work for the coming year.

College News and Notes

Students' Corner.—The College reopened after Christmas on the 4th. On the same day Classes III and II left on tour; the former in charge of Messrs. V. Muthuswami Ayyar and V. T. Subbiah Mudaliar, visited Udumalpet, Dindigul, Vriddhachalam and Lalgudi and returned on 13th; the latter in charge of Messrs. S. Narayanayya and M. Satyanarayana visited Mettur and Palayakottai and returned on the 10th. Rao Sahib T. V. Rajagopalacharyar joined the students at Palayakottai. At Mettur the Second Year students played matches in hockey and tennis with the Mettur Staff.

Indian Science Congress.—The following from Agricultural College and Research Institute attended the 19th Indian Science Congress held at Bangalore:—Messrs. G. N. Rangaswami Ayyangar, Rao Bahadur B. Viswanath, V. Ramanatha Ayyar, Dr. T. V. Ramakrishna Ayyar, Dr. T. R. Seshadri, C. V. Ramaswami Ayyar, N. Krishnaswami Ayyangar, R. L. N. Ayyangar, and P. Krishna Rao.

Visitors.—Lady C. V. Raman stayed for a few days on the Estate and gave a very interesting account of 'My experiences in the West', at the Ladies' Club on the 7th. Dr. Taylor, formerly Agricultural Economist with the Government of the United States of America, and now one of the Commissioners of the Laymen's Foreign Mission Enquiry, visited the College and Stations on the 12th and 13th. On the 12th, he gave an informal talk at the Madras Agricultural Students' Union on Economics and allied subjects, which was extremely valuable and interesting.

Scouts.—The Scouts of the local troop began the New Year with a rally on 1st January, when M.R.Ry. C. Tadulinga Mudaliar Avl., very kindly presented the Second Class Badges to the Scouts that have qualified for the same. On the 3rd, they had a camp fire which was attended by many Estate residents who highly appreciated the impromptu entertainments supplied by the boys.

Weather Review (DECEMBER 1931)

Rainfall data

Division	Station	Actual for month	Departure from normal	Total since January 1st	Annual Average	Division	Station	Actual for month	Departure from normal	Total since January 1st	Annual Average
Circars ...	Gopalpore ...	0	− 0·7	30·4	45	South ...	Negapatam..	33·7	+ 22·6	67·9	55
	Vizagapatam.	0·1	− 0·9	47·5	37		Madura ...	6·0	+ 4·0	35·1	34
	Cocanada ...	0	− 0·9	55·5	42		Pamban ...	22·9	+ 15·4	61·5	37
	Masulipatam	0	− 0·7	47·2	38		Palamcottah.	18·6	+ 14·6	26·3	28
Ceded Districts.	Kurnool ...	0	− 0·2	25·7	26						
	Bellary ...	0·6	0·5	12·9	21	Ceylon ...	Colombo ...	15·4	+ 10·1	103·4	84
	Cuddapah ...	0·1	− 0·8	18·8	31						
Hydera-bad.	Raichur ...	0·1	− 0·1	25·7	28	West Coast	Trivandrum.	7·2	+ 4·8	67·4	65
	Hyderabad ...	0	− 0·2	28·9	32		Cochin ...	2·7	+ 1·6	131·1	115
	Gulbarga ...	0·3	+ 0·4	26·5	31		Calicut ...	2·2	+ 0·5	132·2	117
Carnatic...	Nellore ...	4·4	+ 1·1	49·0	38		Mangalore ...	2·3	+ 1·8	150·1	126
	Madras ...	10·3	+ 4·9	58·5	51						
	Cuddalore ...	42·4	+ 34·8	76·5	53						
						Mysore	Bangalore ...	0·8	+ 0·4	25·8	31
Central ...	Vellore ...	10·4	+ 7·6	51·7	42	and	Mysore ...	1·6	+ 1·3	25·8	25
	Salem ...	5·8	+ 4·8	40·5	39	Coorg ...	Chitaldrug...	1·7	+ 1·3	23·1	25
	Coimbatore Town ...	3·8	+ 2·7	22·8	22		Mercara ...	1·0	+ 0·3	142·9	125
	Coimbatore Res. Inst. ...	3·4	+ 1·6	17·4	25	Hills ...	Kodaikanal ..	15·7	+ 10·6	70·7	62
	Trichinopoly.	13·0	+ 10·4	47·7	33		Coonoor ...	21·7	+ 14·8	70·5	66

Summary of general weather conditions :—

Weather was fine for the first week of the month at the end of which, conditions began to become unsettled in the south-west of the Bay to the south-east of Ceylon. A depression developed there by the 9th and moving in a north-westward direction lay off the extreme south of the peninsula on the 10th. The depression continued to move in the same direction and on the 12th recurved towards the West Coast and approached it near Ratnagiri and disappeared on the 15th without crossing the coast. The depression gave rise to very heavy rain in the vicinity of its track, and rainfall was very heavy south of the line joining Cuddalore and Palamcottah, occasioning much damage to crops and property. The second disturbance originated to the east of Ceylon and on the 22nd had developed into a depression which moved north-westwards and crossed the coast just to the south of Negapatam on the night of the 24th ; thereafter it weakened rapidly and disappeared. This disturbance also gave rise to heavy rainfall over the South-east of the peninsula and locally very heavy falls at Negapatam and Cuddalore on the 24th.

The month's rainfall was associated with these two depressions and was in very large excess on the South Coromandel Coast. Rainfall was absent from the Circars, and was normal or in excess elsewhere. The chief falls were : Cuddalore 16·8″ (12th), Negapatam 14·4″, Cuddalore 9·7″ (24th), Pamban 7·9″, Palamcottah 7·5″ (10th), Coonoor 6·1″, Trichinopoly 5·3″ (11th), and Coonoor 5·3″ (12th).

Temperature fell rapidly and was below normal over the greater part of the area towards the end of the month with the setting in of the fine weather associated with an invasion of a ridge of high pressure from the north-east.

Weather Report for the Research Institute Observatory :—

Absolute Maximum in shade	87°·0
Absolute Minimum in shade	57°·5
Mean Maximum in shade	82°·5
Mean Minimum in shade	68°·1
Total rainfall	3·44″
Mean rainfall for month	1·57″
Departure from normal	+ 1·87″
Heaviest fall in 24 hours	2·39″ (11th)
Number of rainy days	4
Mean daily wind velocity	1·6 m.p.h.
Mean 8 hours' wind velocity	1·9 ,,
Mean humidity at 8 hours	84·0%
Total hours of bright sunshine	167·7
Mean daily hours of bright sunshine	5·4

Summary of weather conditions :—

Rainfall occurred almost throughout the month in connection with the unsettled weather in the Bay and the two disturbances which originated to the south and east of Ceylon. The first disturbance caused cloudy weather and was attended with a heavy fall of the Barometer between the 8th and 10th and rain fell continuously for over 12 hours from mid-day of the 10th when the depression lay nearest to this observatory. The weather cleared rapidly thereafter and was fine till the 24th when the second disturbance began to affect the weather. Rainfall was again continuous on the night of the 24th though only 0·45 inch was recorded. Rainfall was in excess by 1·87 inches over the normal.

Temperature fell rapidly at the end of the month and reached the minimum for the season on the 30th, the thermometer recording a minimum temperature of 57·5 on that day. P.V.R. & B.S.N.

S. V. RAMAMURTHY, M.A., I.C.S.
Director of Agriculture