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Plant Introduction and Improvement of Grasses and Legumes (Contd.)

By

C. RAJASEKHARA MUDALIAR, M. A.
Systematic Botanist & Professor of Botany,
Agricultural College & Research Institute, Coimbatore

PART III

Improvement of Grasses and Legumes: Improvement of grasses and fodder legumes by plant introduction has been achieved in advanced countries like U. S. A., United Kingdom and Australia.

History of Grasses and Legume improvement in America: In U. S. A., when the colonists first settled they found only two local grasses namely, wild rye (*Elymus* spp.) and broom straw (*Sorghum vulgare*). These were the mainstay for the cattle during summer; even coarse reeds and sedges of the fresh and salt water marshes had to be collected to feed the cattle. Edward (1948) records that sometimes cattle were slaughtered to keep them from starvation. The grasses from England were gradually introduced and these spread rapidly and in a few generations came to be regarded as indigenous. In 1665, English grass, a term which regularly included blue grass (*Poa* spp.) and white clover were reported from many places. For a very long time the pastures were not controlled and grass improvement was rather slow. By 1840 the westward movement of colonists was confronted with the prairies and the uncertainties of rainfall added to the problem of settlement. The grasses of the Great Plains still further west were short and they were grama (*Bouteloa* spp.), galleta (*Hilaria* sp.), buffalo (*Buchloe* sp.) and other grasses. The vastness of the prairies baffled the first settlers at first; similar problems arose on the pampas of Argentina, the grassy steppes of Siberia, and even on the grass lands of North Manchuria when the Chinese migrated there. The vegetation of the Great Plains was strikingly different from that of the United States to the eastward. The characteristic natural vegetation was grass and desert shrub; in the low plains like the prairies to the eastward the grass was tall and luxuriant. The grass of these vast plains was the main reliance for the grazing of stock; the grazing was so indiscriminate that with in a short period the indigenous forage plants were gnawed to the roots. The ultimate solution of the problem of pasture improvement was provided by the Grazing Act of 1934 which stopped injury to the public grazing lands by preventing overgrazing and soil deterioration. By this Act, 142,000,000 acres of the public lands were to be organised into grazing districts. Total land used for hay and pasture was 1,126 million acres, about 59% of the whole colony in 1945. In course of time grasses for soil conservation, grasses for pastures and grasses that are tolerant for salt concentrations were introduced.

A notable result of study has been the combining of the grass with legumes in soil conservation rotation. Sweet clover (*Melilotus* spp.) and grass, and alfalfa (*Medicago sativa*) and grass mixtures were developed for many grass areas. The worth of clovers has been realised and clovers from different parts of the world have been introduced. Among other pasture legumes introduced *Lespedeza* is one. *Medicago hispidia* is another pasture legume under trial. Rough pea (*Lathyrus* spp.) has been used in some places. Of the perennial legumes grown kudzu (*Pueraria thunbergiana*) and birdsfoot trefoil (*Lotus corniculatus*) are most important. Velvet bean (*Stizolobium* spp.) and *Crotalaria* spp. are other introductions in the pastures. Among the *Crotalaria*s, *Crotalaria intermedia*, *C. mucronata* and *C. lanceolata* are grown for pasturage. The following are some of the important grass introductions:—

Agropyron cristatum (Crested wheat grass): Introduced from Russian Turkestan (1898). This is one of the forage grasses that has well established.

Axonopus ciminis (Carpet grass): A native of Central America, and West Indies; introduced in U. S. A. before 1832. It now grows in the tropics of both hemispheres.

Bromus catharticus: A native of Argentina, was introduced about 100 years ago. A short lived perennial.

Bromus inermis: Native of Europe, Siberia and China, introduced into the U.S.A. in 1844; it is adopted especially for a grass-legume mixture.

Rhodes grass (*Chloris gayana*): Introduced in 1902 from South Africa. First cultivated for pasture. Withstands trampling and recovers quickly. Also yields leafy hay.

Dactylis glomerata: A native of Europe, it is now grown in many parts of U. S. A. Forms a good mixture with *Lespedeza*.

Eragrostis curvula: Introduced from South Africa. Well adapted to southern plains.

Tall Fescue (*Festuca elatior* var *arundinacea*): Was introduced from Europe. It is drought resistant.

Napier (*Pennisetum purpureum*): Introduced from Africa; grown in many parts.

Forage Sorghums: Sudan grass (*Sorghum vulgare* var. *sudanense*) Introduced into U. S. A. in 1909 from Africa.

Jhonson grass (*Sorghum halepense*): Introduced from Turkey in about 1830.

The following are among the most important legumes of U.S.A.:—

Lespedeza: Only two species are annuals and these are natives of Asia, and these have revolutionised agriculture; over some 20 million acres of lime-deficient sandy land are under this crop.

of the grass with *Melilotus* spp.) and others were developed and realised and clovers used. Among other *hispidia* is another spp.) has been used and kudzu (*Pueraria* *culatus*) are most *alaria* spp. are other *talarias*, *Crotalaria* own for pasturage. ctions:—

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The trefoils (Lotus spp.): Lotus corniculatus and Lotus uliginosus. These have been introduced from the Old World within the past 20 years. They are good for pastures, mixtures and give good hay.

Medicago sativa: (alfalfa): A native of Mediterranean. One of the most important forage crops of the United States. It is now grown in 15 million acres in U. S. A.

Kudzu (Pueraria thunbergiana): A native of Japan introduced in U. S. A. in 1876. Now about 300,000 acres are under this plant. Used for hay, pasturage and control of soil erosion.

Velvet bean (Stizolobium spp.): Vigorous, summer annual. A native of India, introduced in Florida a century ago. For soil improvement, especially sandy soils, velvet bean has been found to be one of the best crops.

True clovers (Trifolium spp.): More than 80 species are indigenous to U. S. A., but the native species proved to be of no Agricultural value. The origin of true clovers is believed to be South Western Asia Minor and South East Europe.

Grass and Legume Improvement work in Australia: A number of temperate and tropical legumes were introduced in Australia for the possibility of using them for the following purposes:—

- (1) Pasture, (2) Grass land renovation, (3) Soil conservation, (4) Green manuring.

Pasture forms one of the mainstay of Australian agriculture. Schofield (1941) records that Queensland alone gave a return of £ 30,000,000 out of a total of £ 44,000,000.

From the trials it was concluded that temperate legumes are useless under coastal conditions. Among the numerous types of lucerns, trifoliums and Lespedezas under trial not one of them established.

Among the tropical legumes introduced the following deserve mention:—

(1) *Stylosanthes guianensis*, SW: A native of Brazil, found valuable for pasture or hay.

(2) *Centrosema pubescens*, *Pueraria phaseoloides* and *Calopogonium mucunoides* have established as good cover crops; these have also been found very useful for grassland renovation, and soil conservation.

Among the grasses introduced, the following were found to be outstanding:

Phalaris stenoptera, *Dactylis glomerata* and *Phalaris tuberosa*. Those of average performance were *Bromus inermis* and *Festuca elatior*.

The following grasses were found suitable for mixture with subterranean clover.

Festuca mairei, *Phalaris tuberosa*, and *Bromus inermis*.

The grasses that were outstandingly productive despite dry season were:—

Bromus arduennensis, *Dactylis glomerata* and *Bromus inermis* etc. Pasture improvement along four main lines are suggested for Australia by McTaggart (1940).

(1) Use of superphosphate and subterranean clover to raise the carrying capacity.

(2) The sowing of pasture species mainly confined to the areas of liberal rainfall.

(3) Improvement in methods of pasture management.

(4) The recognition and selection of improved strains of pasture species.

India: The improvement of grasses and legumes in India has been sporadic as already pointed out. This work was taken up in Delhi from about 1946 onwards, and several grasses and legumes have been under trial. From Delhi, seeds were distributed to different centres. Apart from this there has not been any concerted action for improvement of grasses and legumes. But by individual efforts very important grasses and legumes have been introduced in India for the past seven or eight decades. Outstanding among those introductions are:— *Napier grass* (Elephant grass): (*Pennisetum purpureum*): This is a native of Southern Rhodesia and the sets of this grass are said to have been imported in Bombay in 1915 as reported by Mann (1926). In Madras State, however, the slips and seeds of this grass were obtained direct from South Africa and tried at the Central Farm, Coimbatore (1917). In Bengal this was introduced only in 1927 from a third source, namely, Peredeniya, Ceylon. This is at present one of the important heavy-yielding fodder grasses all over India.

(2) *Guinea grass* (*Panicum maximum*): This is also a native of Africa. It appears to have been cultivated in West Indies, Jamaica long before its introduction in India. In Jamaica it is said to have been introduced about 1774, from the Coast of Guinea under interesting circumstances. It is stated that one John Ellis got some birds from Guinea and took them to Jamaica, and with the birds, some seeds also for feeding. The birds died soon after they reached Jamaica, and the seeds were thrown out as useless. From these seeds a luxuriant growth of grass was noticed by Ellis, which was later cultivated in his garden, from where it spread throughout Jamaica. It is not exactly known as to when and by whom Guinea grass was introduced in India, but it is reported to have been successfully grown by J. Bell, Secretary to the Agri-Horticultural Society in Madras in 1831. This grass was cultivated on a field scale in Saidapet Farm (1837). This is now one of the widely grown irrigated fodder grasses; this has been observed to thrive remarkably well under sewage conditions in Coimbatore, Madurai, Bangalore

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and other places. Under purely rainfed conditions its performance was observed to be satisfactory in Pattambi (Malabar) and Hosur.

(3) *Buffalo Grass (Brachiaria mutica)*: This is a native of West Indies. It was introduced by Charles Campbell in 1804 into the Calcutta Botanical Gardens. It was said to be introduced in Poona in 1896. In Madras State, it was first noted in Quilon, where it was cultivated in an intensive scale. It is believed that this grass must have been introduced into Quilon from Ceylon by some private persons.

(4) *Thin Napier (Pennisetum polystachyon)*: This has spread in India from Tropical Africa and is found to be one of the best grasses under rainfed conditions for heavy rainfall tracts of the West Coast; this has now spread rapidly by self-sown seeds; in Wynaad and Taliparamba it is spreading vigorously and has occupied all available waste places and hill slopes suppressing other grasses and weeds.

(5) *Lucerne (Medicago sativa)*: Although lucerne is considered a native of Western Asia according to De Candolle and hence thought to be largely used in India from time immemorial, there is no evidence of its having been grown in India more than 130 years ago; but it appears to be certain that it entered India from North West. This is also one of the widely cultivated leguminous fodders under irrigated conditions.

(6) *Berseem (Trifolium alexandrinum)*: This is a well known fodder legume of Egypt and known by the popular name Egyptian clover. It was first introduced in Sind in 1904; it was conclusively proved by trials that berseem is one of the very valuable introductions for Sind. It has proved to be one of the best leguminous fodders. It grows in soils which are slightly saline and hence used in the reclamation of saline soils.

Research of grasses and legumes: Concentrated action to improve the grasses and forage legumes was taken by the Indian Council of Agricultural Research in formulating a model scheme in 1951. The participating States were required to prepare a scheme based on the model scheme. A scheme was prepared by the Madras State and submitted for approval by the Indian Council of Agricultural Research, and this awaits sanction. According to this scheme indigenous and exotic pasture grasses and legumes are to be obtained from the Indian Council of Agricultural Research for testing and pure line selection. Hybrid material of F_2 stage is to be supplied from Delhi for breeding and selection of plants, the following desirable characters have to be watched: wide adaptability, good seeding habit, low water requirements, resistance to disease, drought and frost and response to manuring. The experiments have been programmed to be taken up at three different centres, namely, Coimbatore, Hosur and Siruguppa.

Agronomic investigations include, application of organic and mineral manures, grass legume mixture, controlled versus indiscriminate grazing etc.

Madras: In Madras State grass improvement work was preceded by a preliminary survey of the Grass flora; Jacob (1939, 1942, and 1944) has surveyed parts of Travancore and Madras State and recorded the indigenous grasses. He has also drawn a grass map of Madras State showing principal annuals and perennials Chandrasekhara Ayyar, et al, (1949) have surveyed the grasses and legumes of Coimbatore district and enumerated the list of fodder grasses and legumes. The first intensive study of the grasses was made in the Botany Section of the Agricultural Department by raising some of the important perennial grasses of the State and multiplying the mass selected bulks. This work was gradually expanded when new introductions were received either from other parts of India or from outside. From out of the 150 grasses and 60 fodder legumes received in this Section, America contributed 40 grasses and 4 legumes, Ceylon 24 legumes and United Kingdom 6 grasses. Besides these a few species were received from Armenia, Singapore, Peru and other parts. The total number of plants tried including exotic and those received from other parts of India is 480. The performance of the following among the introductions deserve mention:

Grasses: *Eragrostis curvula*: An introduction from America, was tried at Ootacamund and Nanjanad, and very vigorous growth was recorded in spite of frost.

Bromus inermis: Introduced from America and tried in Ootacamund and Nanjanad. Growth was very vigorous at Ootacamund and promising.

Dactylis glomerata, *Eragrostis lehmaniana* and *Eragrostis chloromelas*: All introductions from America, were tried at Nanjanad and found to be good.

Panicum antidotale: An introduction from Australia in 1932 has been found to possess drought resistant qualities. It has been found successful in some parts of Madras State. As its seeds freely and the seeds give a high percentage of germination, its propagation has been made very easy.

Chloris gayana (Rhodes grass): An African introduction has performed very well at Coimbatore. This has been independently introduced in Banaglore and is one of the best grasses raised under sewage conditions. In Hosur it is cultivated as a pasture grass.

Cynodon plectostachyum, Pilger — (Giant star grass): This is an African introduction introduced in 1940. It was found to be very good

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for soil binding. It is being tried for soil conservation purposes along earthen embankments of tanks, irrigation channels etc.

Cenchrus ciliaris: (Bangalore variety): This was obtained from the Indian Diary Institute, Bangalore, where also it is stated to be an exotic grass. Its performance at Coimbatore under dry rainfed conditions was very good. This has been distributed to different parts of the State and is well reported upon.

Among the leguminous forage crops introduced, the following deserve mention:—

Indigofera endecaphylla: Though indigenous to India, seeds were obtained from Delhi and Ceylon. Its performance was observed to be best in higher altitudes with heavy rainfall such as Anamallais, Arakuvalley etc. In Anamallais, this has been observed to form a good mixture with the local buffalo graas, called *Paspalum platycaule*. As a soil conserving plant it was found to be excellent; along with the local grasses it was found to give best mulch and cover for the soil. Efforts are being taken for its large scale multiplication.

Trifoliums: (clovers): *Trifoliums* spp. have been recently introduced from Africa and distributed to the Research Stations in the Nilgiris for trial. It has been observed that in the Nilgiris, *Trifolium* spp. particularly *Trifolium repens* and *Trifolium subterraneum* have already become naturalised at elevations of about five to six thousand feet; but it is not known as to when it was introduced in the Nilgiris. They have also been found to form good mixtures with *Pennisetum clandestinum* and *Paspalum platycaule* and other grasses.

Calopogonium mucunoides, Desv.: A native of Tropical America, is said to have been introduced in Burma in 1920. This is grown extensively in rubber estates; this adapts itself to any soil but thrives best in heavy rainfall tracts, within six months of its sowing it covers the soil completely. This has been introduced in the West Coast rubber estates long ago, and is regularly being grown as a cover crop. This was introduced in Wynaad and Ambalavayil Farms and has established very well in all waste places; the fodder is also relished by cattle. Large quantities of seeds have been distributed all over the State to be raised as cover crops. In the east coast it has been successfully raised in Arakuvalley and Narasapatnam.

Pueraria phaseoloides: (Tropical Kudzu): This is a popular cover crop in rubber plantations in India, Ceylon, Indo-China, and Malaya. The trials in Madras State revealed that it is best suited to heavy rainfall tracts such as Mangalore, Burliar, Nileshwar, Wynaad and other places. Seeds have been distributed to these tracts for extension in all hill slopes.

Centrosema pubescens: This a tropical American plant growing wild in Trinidad and introduced successfully in Malaya, Ceylon and South Africa. It has been observed to grow vigorously and spread over a large space in a short time. In the trials at Coimbatore this has been observed to withstand dry weather and form a good cover. This is now under trial in heavy rainfall tracts such as Nilgiris, Malabar, South Kanara and Arakuvalley. From the reports received so far, its performance was not so good as kudzu or *Calopogonium*. All these three cover crops, namely, *Centrosema pubescens*, *Pueraria phaseoloides* and *Calopogonium mucunoides* have been used as fodder and found suitable in Australia.

Glycine javanica: This is used as fodder legume in Southern Rhodesia as recorded by Sampson (1932); this was collected in one of the surveys near Coimbatore on a rocky hill slope. The seeds were collected and tried at Coimbatore; it formed a good cover and at the same time found to be a good fodder.

Conclusion and suggestion for improvement and development: From a survey of the Plant Introduction work, it is clear that in countries like U. S. A. and Australia to start with, there was a great dearth of economic plants, and by strenuous and carefully planned work by means of a 'Plant Introduction Bureau', phenomenal success has been achieved in the matter of food self-sufficiency. Raw plant materials for vast industrial development have been produced by developing excellent pastures grown with nutritive grasses and legumes, milk and dairy products were produced in such large quantities as not only to meet their home requirements, but also to export to other countries. An efficient 'Soil Conservation Service' has been organised and steps were taken to control erosion on steep slopes, in severely eroded areas, in waterways, on high banks, and in the treatment of gullies, by introducing suitable over crops like 'kudzu' from Japan.

In the U. S. A. the first shipment of Sorghums, Martin (1940),—from South Africa in 1857 formed the nucleus, and hundreds of other Sorghum varieties from different tropical countries, followed suit, and to-day the prairie lands of the semi-arid west are regularly cropped with drought-resistant Sorghum species. The U. S. A. now grows about 8,000,000 acres of grain sorghum and 2,000,000 acres of sweet sorghum for fodder purposes. The same story repeats itself in the case of Australia also with regard to wheat, fruits and fruit products.

All this achievement in America and Australia is undoubtedly due to the formation of an organisation for plant exploration and introduction. The formation of such an organisation in India cannot but be too much over emphasised. Pal (loc cite) has emphasised it, and Parthasarathy (loc cite) has reiterated it with equal force.

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From a study of the plant introduction work in other countries and in India it is suggested that the following improvement and development are worthy of consideration by the authorities.

(1) *Formation of an efficient Plant Introduction Bureau:* This work which now forms one wing of the Department of Botany in the Indian Agricultural Research Institute, Delhi, may be formed on the same lines as in U. S. A. or Australia. When such an organisation is formed, the useful information so far gathered by sporadic introductions, will form the basis for future work on more advanced lines. The material received by the bureau may be passed on to different states. The seed material received by the States may be passed on to the Department of Agriculture, for trial by the Section of Botany. In each State, 'Plant Introduction Gardens', have to be located in different parts so as to represent different climatic and soil types. In Madras State such a nucleus organisation was functioning already during 1947 to 1949. In the selection of sites for 'Plant Introduction Gardens' the best land in the selected locality must be earmarked, with good irrigation facilities.

(2) *Systematic survey of plant wealth:* It is admitted on all hands—Chopra (loc cite)—that the vast plant wealth of India has not yet been completely explored. It is suggested that the 'Botanical Survey of India', which was still recently functioning has to be revived. The Government of India have already taken action in this respect by the appointment of a Special Officer for the re-organisation of the 'Botanical Survey of India'. When the Botanical Survey of India is revived, it can be the central organisation co-ordinating the work of branch organisations in each of the States. Intensive survey work can be taken up in each State and district floras compiled and published. In Madras State intensive survey of local floras has already been taken up and much progress has been made.

(3) *Improvement of grass and forage legumes:* "Fodder crop as such is grown only over about 4.6 lakhs of acres in Madras State"—Krishnaswamy, et al (1948)—The same authors quote the fodder production from all sources as 33.75 million tons, dry roughage, which works out at 4.91 lb per day cow unit. The authors recommend that 'fodder will have to be grown as a pure crop to bridge the gap between demand and the supply'.

As already pointed out a Scheme for the improvement of grasses and legumes has been drawn up on the lines of the Model Scheme suggested by the Indian Council of Agricultural Research. The main object of the scheme is the establishment of a chain of grass and fodder research stations in well defined regions of the State both under rain-fed and irrigated conditions; the scheme also contemplates the study of the

nutritive value of grasses and fodder crops that give the maximum yield. The programme of work in brief includes (a) the trial of indigenous and exotic grasses; (b) breeding of hybrid material. In this connection Larin (1951) states that introduction into cultivation of wild species has been observed to be a quicker method of developing new forage plants than breeding from existing cultivated varieties. The author quotes as example the increased yield obtained in growing wild forms of *Fescue* and *Dactylis glomerata* than the cultivated local varieties. The experience of the Russian worker is well worth consideration in the breeding programmes that may be contemplated; (c) Agronomic investigations regarding grass — legume mixtures, cultural, irrigational and manurial requirements etc.; (d) investigation on controlled and indiscriminate grazing in collaboration with the Forest Department.

It is suggested that the scheme as recommended by the Indian Council of Agricultural Research merits top priority, so that the fodder supply of the State is placed on a sound basis.

Acknowledgement: My thanks are due to the University of Madras for having given me an opportunity to deliver the 'Maharaja of Travancore Curzon Endowment Lecture' for 1952 - '53 on 'Plant Introduction and Improvement of Grasses and Legumes'.

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Trade Notes:

The receipts of loose cotton at presses and spinning mills in the Madras State from 1st February 1953 to 26—6—1953 amounted to 160174 bales of 392 lb. The receipts in the corresponding period of the previous year were 163648 bales. 181853 bales mainly of pressed cotton were received at spinning mills. No bales were imported by sea during the week ending 26—6—'53 the progressive totals being 4623 bales exported and 49968 bales imported from 1—2—1953 to 26—6—1953.