

Plant Introduction and Improvement of Grasses and Legumes. *

By

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

PART — I

General: Improvements of crops in general and food crops in particular are engaging the attention of research workers in India and all the world over. But in many States of India we are faced with deficit in the matter of the production of food crops. Several attempts are being made to make up this deficit by evolving high yielding strains, and conducting manurial and cultural investigations to find out the best method of improving the yield. Plant Introduction as a means of crop improvement is only a recent approach in India. Improvement of cereal food crops received first attention and in the early stages of crop improvement the search for new types was confined to places within our country and the desirable types were isolated and grown. With the introduction of new plants, one has to guard against the introduction of dangerous pests and diseases also. To this end plant quarantine measures are being adopted in all advanced countries.

America: America is the first country to start Plant Introduction work; and the history of Plant Introduction and the different phases of this work is interesting. Bailey (1922), records that in 1838, United State Congress made its first allotment in aid of Agriculture in the form of a grant of one town-ship of land in South Florida to Dr. Henry Perrine for the purpose of encouraging the introduction and cultivation of Tropical plants in the U. S. A. In 1839, Mr. Ellsworth, Commissioner of Patents, appealed to the diplomatic crops of United States residing abroad and also to the officers of the Navy to collect valuable plants and seeds for trial in U. S. A. The diplomatic Crops and officers of the Navy took up this work with patriotism and cheerfulness. In 1840, the work of plant introduction, coupled with that of gathering statistics in Agriculture, received a sum of 452 dollars from the State; in 65 years this sum reached a figure of 6,000,000 dollars. The pioneers in Plant Introduction work were not men trained in the Agricultural needs of the Country, with the result that no proper records were kept, and even the introductions sometimes did not suit the purpose. For example, as early as 1870, the Government introduced useful scions of Russian apples; besides this the

* "Maharajah of Travancore Curzon Endowment Lectures in Agriculture"
— 1953 — Madras University.

Officer of the Government, private nurserymen and seedsmen have long been in the habit of introducing interesting plants from other Countries, but for want of popular enthusiasm, these introductions have disappeared.

It was not until 1897 that the work of Seed and Plant Introduction was put on a Scientific basis. The Bureau of Plant Industry was then formed which included the Divisions of Plant Introduction, and Division of Forage crops and Diseases. Ever since the Bureau of Plant Industry was organised, it has done systematic work on economic plants including grasses and other forage plants.

The Council of American Genetic Association awarded the Mayor medal, periodically for distinguished services in Plant Introduction. One of the recipients of the medal was Mr. H. N. Riddy, who was responsible for the introduction of para rubber into East Indies. Another recipient, Dorselt, was responsible for the introduction of Soyabeans into U. S. A., he explored China and made more than 2000 collections. He also made expeditions in Brazil and introduced many varieties of Citrus and ornamental plants.

Some of the interesting plants that formed the first arrivals in the work of plant introduction in America will be of interest. The largest collection of date varieties were grown in the gardens of Arizona and California. A very large collection of tropical mangoes which were first raised in green houses have been distributed to Florida, Porto Rico and Hawaii. Thousands of Japanese rush plants (reeds) used in matting industry, of which the Country was importing several million dollars worth every year, have been successfully introduced in South Carolina. Berseem (*Trifolium alexandrinum*) one of the best winter forage crops has been introduced from the Nile valley into the irrigated tracts of South West of U. S. A. Likewise, the Kaffir Corn from the uplands of Abyssinia the East Coast of Africa and India were first tested in Kansas and naturalised. A newly found Oat from Northern Finland was found to be superior to those in Alaska.

One of the most far reaching in its possibilities of all the introductions is the drought resistant durum wheat, which yielded Crops, where all-ordinary wheats have failed for want of water; this was unknown in the American markets in 1898, but since then has been grown in such large quantities that the U. S. exports several million bushels to other Countries.

Another important introduction was the Japanese Kiushu rice, which was partly responsible for the extensive rice areas of Texas and Louisiana.

The author (Bailey, loc. cit.) concluded that the plant introduction of a Country must be in the hands of Government to guard against the

danger of introducing noxious weeds, insect pests and fungal parasites. In some countries like Italy, Greece, prohibitive quarantines have been placed against the introduction of foreign plants. Possibilities of organised plant introduction are almost unlimited. Interchange of plants between countries must be taken up on a large scale; the author is of opinion that the building up of new plant industries in a country will one day rank with greatest of national duties.

Technique of Plant Introduction adopted in America: Morrison (1943) records the technique of plant introduction in U.S. A. Plant introduction involves the preparation of plants for shipment and special care to restore them to full growth and vigour in a new environment. The stage of the plant which will bear transport without much damage, is its dormant condition, namely, the seed, bulb or the dormant shoot etc.

Thousands of plant introductions received in Washington in the form of seeds, cuttings, plants etc., are unpacked and immediately given an identification number in the specially equipped Plant Introduction-laboratory; these are examined by competent inspectors of the sanitary branch of the service, to prove and record their freedom from disease and insect pests. The Officers of the Bureau of Crops, act in collaboration with the Plant Pathologists and Entomologists. The staff entrusted with the duty of field exploration in any part of the World consists of Botanists and Horticulturists who collect whatever material that may be needed to diversity or improve Agriculture. This also includes a unit in Washington, whose function is to plan the work and maintain the historical records of each enterprise. Another important activity of the Division is to develop the service of exchange of Plant Introduction.

If a new introduction is found free from insects and diseases it is given a clean bill of health which permits it to be forwarded to the Specialist of the Department for whom its was specially secured, or to the Plant Introduction gardens, for propagation, cultivation, preliminary tests, and finally if found suitable to be grown for distribution. If an introduction is found to be affected with insect or other pests, it is ordered to be kept into quarantine and the necessary treatment prescribed.

It is at these plant introduction field stations, that the experts determine which of the new plants show promise of being of economic importance.

To mention an example of Plant Introduction service let us take the case of *Cinchona ledgeriana*. As soon as it is received from the ship, it is examined by the Bureau of Entomologists and Plant Pathologists, is given a serial number and delivered to the Botany Division; the correct nomenclature is given by the Botanists; a sample is reserved of the seed against any future verification and the seed sent to Plant Introduction

garden; here it is grown under best conditions; if the seeds are fresh, within three weeks there must be good germination; the seedlings are watched with care. If carefully transplanted, normally in six months time the seedlings are sufficiently grown up for transport to any other place of trial. Before transporting to other centres, special fumigation is given, the necessary sanitary certificates are issued. The recipient of these plants from the Introduction gardens must be well trained to prepare them for nursery growth and latter for field planting. He must have known all about the plant in its native habitat; this is more or less the story of each plant that arrives the Plant Introduction Garden and leaves it.

Sufficient care must be bestowed in selecting a Plant Introduction Garden, it must have good soil, desirable slope and drainage facilities. Special green houses are erected which fall under three categories:— (1) Those intended for Plant Quarantine, (2) those that serve as propagation house, and (3) those used for continued growth. David Fairchild (1917) records that every one who is keenly interested in introducing new plants should correspond with the Officers in charge of Plant Introduction Gardens and get small samples of successful new introductions.

Benefit derived from Plant Introduction in America: Plant Introduction has given to the United States practically all of its commercial crops. The Plant Introduction Field Station of the Department of Agriculture situated in Miami is most advantageous for the preliminary testing of a wide range of new Plant Introductions from tropical and sub-tropical countries, this Station is almost free from frost, and is a very near approach to the tropical countries. The Department of Agriculture has six such Introduction Gardens situated all over the U. S. A. The following are a few selected examples which give an idea of range of new Plant Introductions:—

(1) The jujube (*Zizyphus jujuba*), from china is as promising a crop commercially for California and the semi arid regions, as any of the other crops or ornamental plants.

(2) *Aleuritis fordii* was introduced sucessfully in N. California, N. Florida and other parts. The oil obtained from the seeds of this plant is one of the drying oils and can be used for the paint industry. The United States has been importing several million dollars worth of paint oil.

(3) The Chinese variety of Persimmon (*Diaspyros kaki*) can be sucessfully grown in California and the south. It may be of interest that Persimmon is one of the sucessful fruit trees grown in the Nilgiris now.

(4) The Chinese Chestnut (*Castanea mollissima*) is a very interesting introduction; in the Plant Introduction Gardens this plant

was observed to be resistant to Chestnut bark disease so common in American Chestnuts. After trials in these field testing centres, the seeds were distributed to disease infested areas.

Most of the major agricultural crops, namely, Maize, Tobacco, Squash, Pumpkins etc. had been introduced by the migrating Indians from more Tropical regions of America. More than 95% of the cultivated crop plants of the United States are of exotic origin and more than three fourths of them are natives of the Old World. The wild relatives of these Old World crop plants have been used in breeding crop plants resistant to disease etc. No fewer than 17 genera and 23 species have been introduced and grown successfully in America, but there still remain no fewer than 9 genera and 164 species not growing in the New World. Thus introduction of plants had been a fundamental factor in the Agricultural Improvement of United States, and will continue to be so to meet with the new situations and problems that may arise. To determine which of the World regions are most likely to supply new material, requires an intimate knowledge of the climates and soils of the World in relation to those of the U. S. A. Materials needed for specific needs in the U. S. A. should be obtained from as nearly similar climates as possible, in order that the plants may grow as naturally as possible. Usually, most plants tolerate varying growing conditions, otherwise many plant immigrants will succumb. Generally too severe summers or winters, wide range of variations in humidity, drought and other factors have a tendency to stunt the growth of plants. Sometimes the plant may grow well but fail to set viable seed. The experiences we meet with in the common 'Kikyu' grass (*Pennisetum clandestinum*) growing luxuriantly in the Nilgiris, is an example. This grass is a native of Kenya, it is probable that in its new environment it has not got the requirements of light, heat, humidity, etc. which it has in its native home. Some plants may require lime in the soil, while others may do well in acid soils. Some plants may tolerate alkali or salinity, but majority of them do not. As instances of grasses and legumes, and other plants tolerating salinity mention may be made of a few plants recorded by Chandrasekhara Ayyar, et al (1949) the authors have recorded that *Crotalaria verrucosa*, *Crotalaria striata* and *Rothia trifoliata* among the legumes have been observed to withstand salinity to a remarkable degree. One must have at least a general knowledge if the introduction is to receive a fair trial.

Russia: The study of plant geography is now receiving more and more attention by those who want to intensify the work of Plant Introduction. Vavilov and his co-workers made intensive explorations into the foot-hills of the mountains of Asia and have located several primary centres of origin of cultivated plants as for instance the Hindukush mountains, the Caucasus, the Himalayas etc. which were found to possess wild ancestors of several fruit trees, Wheat, Rye etc.

Vavilov quoted by Julian Huxley (1940) records that "cultivated species, as well as their closely allied wild relatives, in their evolution, during the course of their distribution from the primary centres of species-formation, have been differentiated into definite ecological and geographical groups". Conducting expeditions to various primary regions of the origin of cultivated plants, Vavilov says that an enormous diversity of species and varieties formerly unknown were recorded. For Wheat alone 800 botanical varieties were recorded by the Soviet Expeditions, while the previous workers have recorded only 191 varieties; similarly in the case of potato (*Solanum tuberosum*) only one species was recorded, but the Soviet Expeditions have discovered 18 new species of cultivated potatoes, some of them comprising many varieties. By a comparative study, under various environmental conditions, of the Agro-ecological groups of the most important annual crop plants of the Old World by the Russian works, Vavilov (loc. cit.) says that definite agro-ecological and geographical groups can be formed of these plants; he records 19 such groups with reference to cereals such as wheat, barley, rye, oats and grain Leguminosae such as peas, lentils, chick-peas, etc. and flax, both seed and fibre forms. From a study of these groups one is struck by the diversity of forms brought about by the ecological factors. It varies from the small seeded, arrow leaved, early, xerophytic types of the *American Xerophytic Mountain group* to the giant forms of wheat, rye, barley, peas etc., of the *Caucasian Mesophytic High-Mountain group*. The former group occupies the region of the arid, mountainous steppes of Soviet and Turkish Armenia, while the latter comprises the large territory formed by the high plateaux in mountainous Daghestan and Georgia. Between these two extremes of diversity we meet with various types, each representative of a definite ecological group. Vavilov (loc. cit.) says that *Indian group* on the whole is comparatively uniform, notwithstanding the diversity of conditions; in general, all spring varieties of cereals, as well as flax and grain Leguminosae, are distinguished by non-bushy habit, small narrow leaves, thin stiff stems, resistance to drought, rapid filling out of seeds and small seeds. In the *Chinese-Japanese group* Vavilov (loc. cit.) records that the entire group is characterised by low or medium height, extremely small seeds and rapid filling out of the grain and that many varieties of wheat have been proved to be resistant to brown and yellow rust. One noteworthy feature of the *Mediterranean group* has been observed to be the presence of a great many varieties resistant to *fungus diseases*, such as leaf-rust, smut and many other parastic diseases.

By a detailed study of these geographical groups, the Russian workers have discovered the Xerophytic, non-shattering forms of *Triticum vavilovianum*, Jacubz. in Soviet and Turkish Armenia. *Triticum persicum*, var, a 28-chromosome species and *Secale montanum*, Guss, a Xerophytic wild mountain rye in the neighbourhood of the Caucasian

mountains. Likewise, several useful cultivated and wild forms of Cereals, grain Leguminosae etc. were discovered.

A knowledge of these agro-ecological and geographical groups, opens out to the Scientists a wide range of plants of diverse characters to choose and introduce in suitable areas. Vavilov (loc. cit.) says that for many important cultivated plants of the Old World, the Caucasus, South-eastern and South-western Asia is the place where one must look to for diversity of forms; similarly for the New World, Southern Mexico, Central America, and the South American Andes must be the place to search for new forms of cultivated plants. In these regions of the Old World one can come across all intermediate forms between wild and cultivated types in the case of such crops as almonds, figs, pistachios, walnuts, grapes, wheat, rye, oats etc. In the unexplored regions of the New World enumerated above, one can come across similar forms in the case of cottons, potatoes etc. Vavilov finally concludes that "there are vast areas in South America, Central America, and Southern Asia with enormously rich floras, which have not yet been studied even superficially, thousands and thousands of new species have yet to be discovered; the lack of even such superficial knowledge is a great hindrance to our general knowledge (understanding) of the flora of the World. The basic biological work which must embrace a knowledge of the entire flora is not yet finished, even in its first approach, namely, in the Linnean understanding of the species". In the words of Vavilov "The most remarkable regions of the World, the cradles of primitive civilizations—the mountainous regions of Southern Asia, Central and South America—are still in need of investigation even as to their resources of cultivated plants".

Australia: Australia being a comparatively new country, and isolated from the more advanced Agricultural countries of the World, has no Agricultural crops of importance indigenous to the country. All the chief cultivated plants, fruits, vegetable, crops etc., grown in Australia to-day had originally to be introduced from some other part of the World. It was recognized that the best chance of success in plant introduction, lay in turning more to those countries which had similar climatic conditions to those of Australia. Wenholz (1929) records that maize from Africa was of much greater success than wheat from England, in the coastal districts of New South Wales. In Australia, for many years it was purely a question of crop introduction without any great regard for the variety or kind of crop. It was only after the State Departments of Agriculture took a hand in economic plant introduction that there was much discrimination as to the variety or kind of crop introduced; and much more rapid headway was made after the more expert handling of the work.

Many valuable introductions have been made; the late William Farrier was one of the first in Australia to recognise the all important

value of wheat introduction from India, Canada and other countries; for, without which he could not have evolved "Federation Wheat" into the breeding of which Indian and Canadian wheat entered. A careful and systematic study of certain areas of South Wales and their climatic counter parts in the United States led to the introduction of important maize varieties such as Funk's Yellow Dent and Golden Glow, Saccaline, Collier, and White African Sorghums are introductions far superior to the old "Planters' Friends" which was the best yielding forage variety for many years in New South Wales. 'White Burley Tobacco' from America has been used by the tobacco expert when crosses were made with local tobacco varieties; from these crosses 'Dinbai', a superior variety for 'flu' curing was evolved. Most of the valuable introductions are the result of ceaseless search for plants from current literature.

With the establishment of the Plant Breeding Bureau in 1927, the work of Plant Introduction was placed on a more systematic basis; this branch was specifically charged with the duty of plant introduction in consultation with Crop Specialists, as it is of considerable importance to Plant Breeders.

In the introduction of seeds and plants, Australia like U. S. A. has adopted very strict measures to prevent entry of injurious insects and diseases into the country. All quarantine regulations were meticulously followed, every parcel of seed or plant introduced was fumigated and examined by Entomologists and Plant Pathologists. After this strict examination the Crop Specialists tried them under strict quarantine conditions, where close watch was kept.

Wenholz (loc. cit.) states that plant introduction may be carried on more or less successfully between organised services, but when carried on between individuals who are mutually interested in a particular phase of work in a crop, it is lifted from a routine study to a level of greatest possible value, and this plan is being adopted by the Department of Agriculture in Australia. It is argued that the large measure of success of U. S. Department of Agriculture lies in the efficient organisation backed by the more expert advice of Crop Specialists and Plant Breeders; without such organisation and backing, plant introduction becomes costly hit and very often proves a failure.

Cereals: From a study of similar climatic conditions of the World, it has been observed that early maturing wheats from some of the warmer parts of the World such as India, Italy, North Africa, and Iraq may be of possible direct value to the direr parts of Australia. Many of these are also being used in cross breeding. Wheats resistant to rust, smut, and other diseases have been introduced from America, Africa, Germany etc. The rice industry is being served through important introductions from Louisiana, California etc.

Fodder Crops: With regard to fodder crops new sorghum varieties from America, India and Africa have been under observation; some promising lucerns have already been introduced from Spain and South America. A new field pea from U. S. A. has been observed to be one of the outstanding introductions.

Similarly with regard to fruits and vegetables, many promising plants have been introduced from U. S. A.

Gleanings

Cottonseed has multiple uses: Four types of products are derived from cottonseed: Linters, hulls, oil and meal.

The linters are the fuzzy fibers left around the seed after the cotton has been ginned. These fibres are almost pure cellulose, and are now used for stuffing mattresses and upholstery, lacquers, films, and plastics.

The hulls, which cover the seed, are excellent as a livestock feed and especially as roughage needed by dairy and beef cows. Experiments have been made in the use of the hulls for industrial products and it has been found that ground hulls filled with a resin binder can be moulded into radio cabinets, table-tops, airplane panels, and industrial gears.

The oil that is pressed from the meat of the cottonseed is valuable as a food for human beings. It is a superior oil for shortening, (vegetable cooking fat), margarine (substitute for butter), cooking oil, and salad oil.

The meal, a fine powdered substance, is valuable as a feed for livestock and as a fertiliser. It is rich in proteins — the muscle-building materials found especially in meats, eggs, cheese, and milk. As a fertiliser it is excellent for tobacco and nursery crops.

With all its many uses, today, no part of the seed from cotton is wasted. Cottonseed yields farmers in the UNITED STATES a cash income of more than £ 300,000,000

(Farmer — April 1953. Vol. IV, No. 4).