

3. Results of mango inarching on a bulk scale during different months for two consecutive years have been furnished to indicate the possibility under West Coast conditions of the scope for bulk production of grafts during the major part of a year.

4. Figures for the cost of production of grafts at the Agricultural Research Station, Taliparamba, and the average figure for a few nearby centres are also given.

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SELECTED ARTICLE

The Search for Economic Plants

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The search for plants yielding spices and the history of their cultivation and use, as well as the story of the transport of the spices, is a romance which includes accounts of geographical discovery, monopolies, economic warfare, annexations of territories, and all the vices of theft, envy, hatred and malice, and all uncharitableness enumerated by the Apostle St. Paul.

Perhaps the spice which should be put in the forefront is pepper (*Piper nigrum*), native of Malabar and of the forests of Travancore, a spice now too seldom seen or appreciated in its natural conditions as black pepper corns, which was the staple article of trade between Europe and India for many ages. Most people to-day use white pepper, which is the small berry-like fruit or peppercorn, ground after its pericarp has been removed, thus depriving it of some of its pungency and best seasoning qualities.

Pepper was well known to Theophrastus in the fourth century, B. C., and to Dioscorides and Pliny, the former stating it to be a product of India. Its export from Barake on the Malabar coast, near Calicut is recorded in A. D. 64, and black pepper is one of the spices on which the Romans levied duty at Alexandria about A. D. 176. The first particulars, we have, that it was a climbing plant "sticking close to high trees like a vine" occur in the writings of Cosmas Indicopleustes, a merchant and later a monk, who wrote about A. D. 540.

The wealth of Venice and Genoa largely depended on this spice for tribute was levied on pepper, when money was scarce; it was often enacted that rents should be paid partly in pepper, and the Easterlings, according to the Statutes of Ethelred (A. D. 978—1016), coming in their ships to Billingsgate, had to pay at Christmas and Easter for the privilege of trading with London, a small tribute of cloth, five pairs of gloves, ten pounds of pepper and two barrels of vinegar. Now the only survival of this practice is the 'peppercorn rent', which signifies a merely nominal payment. The merchants who trafficked in spices in England were known as pepperers, and existed as a guild in the reign of Henry II and later were incorporated in the Grocers' Company.

Pepper, gums, myrrh, frankincense and cardamoms reached Europe mainly either by the Persian Gulf through Mesopotamia and Syria to the Levant or by the Red Sea and the Gulf of Suez and thence overland to Alexandria, while some

consignments were conveyed by Arabian or Chinese traders to a port in southern Arabia and thence overland by the Frankincense route via Petra to Gaza and to Acre. From Alexandria or from the Levantine ports to which the spices had come overland they were shipped in the days of the Roman Empire to Rome, and later to Venice or Genoa, which cities for so many years held the monopoly of the traffic in spices.

During the Middle Ages the price of pepper was exorbitant. The high cost of pepper was one of the main inducements to the Portuguese to search for a sea passage to India, in order to break down the Venetian monopoly in this and other spices. Vasco da Gama anchored off Calicut in May 1498, and thus to pepper very largely, therefore, may be attributed the discovery of the Cape of Good Hope.

About the year 1500 the cultivation of pepper was taken up in the western islands of the Malayan Archipelago, especially in the islands of Rhio and Penang, and in Johore. The Dutch East Indies, Singapore, Penang, Ceylon, India and Indo-China are now the chief sources of supply.

The Venetians made every effort to retain the valuable traffic in their own hands, but in 1522, the first consignment of pepper reached Antwerp direct from India in a Portuguese ship, and the trade continued to be a monopoly of the crown of Portugal until the eighteenth century. With the development of the all-sea route the overland traffic gradually came to an end. With regard to India, the century of Portuguese conquest of the West Coast may be recalled, then their ousting by the Dutch, and finally, British dominion under the East India Company, and the efforts of the French and Danes to secure a share in the lucrative trade. Pepper thus was one of the principal economic products which has not only greatly enriched those who have held monopolies in its traffic, but has also incited geographical discovery, resulting in wars to secure possession of its native country.

Cloves, cinnamon, cassia, nutmegs and mace each have a history in which high enterprise, warfare, subterfuge and theft have all played their part. Cloves are the dried flower buds of *Eugenia caryophyllata*, which is said to be native only in the five small islands of the Moluccas proper (Ternate, Tidore, Mutir, Machian and Bachina). The tree was introduced to Amboyna before the arrival of the Portuguese and is still cultivated there and in some of the neighbouring islands. Cloves are probably one of the oldest known of the spices, for it was customary for the Chinese Court officers, under the Han Dynasty, 266 B. C., to hold cloves in their mouth before addressing the Sovereign, to give their breath an agreeable odour. Nicolo Conti, a Venetian merchant, 1424-48, discovered the source of origin, previous writers having assumed that the places whence the spice was shipped, Ceylon, Java, or Malacca, were the homes of the plant. To the Portuguese, however, we owe our first accurate localization and description of the clove-tree, furnished by Pigafetta, the companion of Magellan, as he saw it in 1521.

For nearly a century the Portuguese were in control of the Spice Islands and had the principal share in the clove trade, until 1605, when the Dutch took possession of the Moluccas, and attempted to control the trade. They tried to restrict the tree to the Amboyna Islands—as they did with the nutmeg—and destroyed trees that might be growing elsewhere. Supplies, however, managed to reach England independently, though the Dutch monopoly was nearly complete until the latter end of the eighteenth century. Intrigue and theft apparently have played a very important part in the history of the clove in more recent times, for in 1770, the Governor of Mauritius and Bourbon, M. Poivre, procured living plants, both of cloves and nutmegs, and established them in those islands.

The clove industry of Zanzibar and Pemba is due to an Arab from Zanzibar, who managed to obtain plants in Mauritius and took them about the end of the eighteenth century to his own island. Great Britain also took her share in what were probably illicit introductions of the spice plants, for, after Penang was founded in 1786 by Captain Light, the East India Company deputed Christopher Smith—one of the Kew collectors sent out by Sir Joseph Banks and George III—to visit the Moluccas and bring back spice plants (cloves and nutmegs) for cultivation.

The cultivation of cloves is now being extensively developed in Madagascar, which may prove a menace to the industry of Zanzibar and Pemba.

One of the present day problems of economic plants relates to cloves, since the trees in Zanzibar are affected by a die-back disease, which demands careful research into ways of combating the malady and possibly of finding forms or varieties that may be resistant.

Nutmegs, *Myristica moschata*, are natives of the eastern islands of the Moluccas (Ceram, Banda) and of New Guinea. Nutmegs and mace, the crimson network artillus surrounding the nut, were imported into India at an early date by the Arabians and thus reached the West.

The home of the nutmeg was mentioned by Masudi about A. D. 918, and by the middle of the twelfth century nutmegs and mace were being imported to Aden, and duty on them was being levied at Acre about A. D. 1180. Ten years later they, with other aromatic products, were used in fumigating the streets of Rome at the coronation of the Emperor Henry VI. By the end of the twelfth century, nutmegs and mace were well known in Europe, but very costly, for about 1284, 1 lb. of mace cost 4 s. 7 d., the value then of three sheep or half as much as a cow. The Portuguese discovered the plant in Banda in 1572 and held the trade until they were driven out by the Dutch. The Dutch tried to restrict the trees to Banda and Amboyna by destroying the trees in all the other islands. In this, however, they appear to have been frustrated by pigeons, which swallowed the seeds and deposited them in the neighbouring islands.

Great Britain occupied the Spice Islands during 1796—1802, and thanks to Christopher Smith's mission and the activities of Sir Stamford Raffles, nutmegs and cloves were introduced to Bencollen (Sumatra) and Penang. Plants were sent to Kew about that time and thence to St. Vincent and Grenada, where nutmegs now flourish.

Cinnamon (*Cinnamomum zeylanicum*), native of Ceylon, and cassia bark, the product of *Cinnomomum cassia* from southern China, are probably the earliest known of the spices. Frequent references occur to them in the Bible, and Theophrastus, Herodotus, Dioscorides, and other ancient writers refer to them as precious odoriferous substances. Cassia is mentioned in the earliest Chinese herbal, about the year 2700 B. C. To the Chinese may almost certainly be attributed the discovery of cinnamon in Ceylon, since they traded to Ceylon in very early times, and were no doubt familiar with the Chinese cassia-yielding species of *Cinnamomum*, which is very similar in appearance to the true cinnamon of Ceylon. An Arab writer Kazwini, mentions cinnamon as a product of Ceylon in 1275, as do Ibn Batuta, the Muhammadan traveller, 1340, and Nicolo Conti, a hundred years later. The Portuguese discovered Ceylon after circumnavigating the Cape, and occupied the island on account of the cinnamon. Then the Dutch captured Ceylon, again because of cinnamon, about 1656, and established a monopoly in the spice, burning, as they did nutmegs, the stocks in Holland when the supply was greater than the demand. The English took Ceylon from the Dutch in 1796, and the East India Company held the monopoly in cinnamon until 1833.

The history of the spice plants has been dealt with at some length since they have played so important a part in geographical discovery, territorial acquisitions, and wars between European nations. There are, however, several plants of great economic importance which have travelled far from their lands of origin, of the wanderings of which we have no certain records. Among these are the coconut, sugarcane, banana, cassava, groundnut, and possibly the West African oil palm.

The coconut has no doubt been transported partly by ocean currents and partly by natives voyaging from island to island in the remote past when they took the nuts with them for food and planted them in the islands or coastal regions to which they migrated. Of ocean transport we have recent evidence in the germination of coconuts washed up on Anak Krakatau IV in 1932. The original home of the coconut seems definitely to have been the East Indian Islands, whence it has travelled to the West Indies and to America.

Sugarcane, also East Indian, must have been similarly conveyed by natives for food on their voyages and then planted by the settlers in their new homes. In this way it has been distributed throughout the tropics before the existence of historical records. The edible banana, probably native in Thailand and Malaya, must also have been transported in much the same way.

Both the groundnut (*Arachis hypogaea*) and the oil palm (*Elaeis guineensis*) afford puzzling problems. The groundnut is now the staple product of The Gambia, but all its near allies are natives of Brazil and there is none in Africa. Similarly, the closely related species of *Elaeis* occur in Brazil, but there is an allied species in Madagascar. It is an open question whether either economic plant is truly native in West Africa; if not, then it seems probable that natives voyaging from Brazil to West Africa may have brought over both the groundnut and oil palm, and also the American cassava (*Manihot utilissima*), as food in their vessels, and so they became established on the west coast of Africa.

The cashew nut (*Anacardium occidentale*), much used in confectionery and like salted almonds and pine kernels on our dinner tables, which is a native of tropical South America was introduced into South India in early days probably by the Portuguese. South India now supplies the major part of the world demand, and particularly the large markets of the United States of America. Nearly all the nuts imported to Great Britain and to the United States come from the south-west coast of India. Cheapness in the preparation of the product is the main reason for this somewhat anomalous condition of affairs.

Two misconceptions as to the original homes of economic plants may be mentioned here. First, the Jerusalem artichoke had nothing to do with the Holy Land—the name Jerusalem probably being a corruption of Terneusen in Holland, as Sir David Prain has ingeniously suggested, where tubers were first landed when they were brought over from America. Nor were either the New World pine-apple or prickly pear to be found in the Garden of Eden as figured by Parkinson on the title-page of his "Paradisus".

Coming to more recent times, one is reminded of the attempt by Captain Bligh in the ill-fated voyage of the *Bounty* to introduce the bread fruit (*Artocarpus*) from Tahiti to the West Indies, and of the success of his efforts on his second voyage, and of the introductions of economic plants and also, alas, of weeds to Australia and New Zealand as impurities in the seeds of the imported crop plants.

A brief reference must be made to the introduction of Cinchona and Para rubber from South America to Kew, and thence to India, Jamaica, Ceylon and Malaya in 1861 and 1876 respectively, Flourishing plantations of Cinchona

exist in the Nilgiri Hills and at Mungpoo and Munsong near Darjeeling, but those in Jamaica have not been maintained. Attempts are now being made to extend the cultivation in East Africa and also in Panama and Porto Rico. Java, however, is the chief source of the drug, mainly because the climate of the island is particularly favourable for the cultivation of the species which yield the greatest amount of quinine. Java, unlike India, has two rainy seasons, the south-west and north-east monsoons, which produce conditions very like those which occur in the Andes. The soil also is very favourable, but Java's success with *Cinchona Calisaya* types is mainly due to climate. Java has also been fortunate in obtaining seed of a high-yielding form of *C. Calisaya*--*C. Ledgeriana*--which has flourished under Javan conditions.

After the stocks of *C. succirubra* and *C. Calisaya* had reached India, Mr. Charles Ledger, who had obtained seed of a high-yielding form of *C. Calisaya* collected near Pelechuco, to the east of Lake Titicaca, offered this seed to the superintendent of the Government Cinchona Plantations at Ootacamund, who rejected it. He then offered it to the Dutch, who had been experimenting, somewhat unsuccessfully, with Cinchona in Java. The Dutch bought the seed, and so came about the flourishing industry in the island.

One of the assistants in the Nilgiris, however, a gardener from Kew, extracted some of Ledger's seed, and sowed half of it in the Nilgiris and sent the other half to Mungpoo. When the superintendent saw the seedlings and learnt their origin he had them all thrown away. Those at Mungpoo, however, were under the care of Mr. Gammie, who appreciated their value and kept them; they proved to be as valuable as had been stated by Ledger. This form and other good-yielding strains of *C. Calisaya* are still in cultivation at Mungpoo and Munsong. In any event, as it has since been found, *C. Calisaya* and its forms do not succeed under the conditions in the Nilgiris, nor do they thrive quite as well in northern India as they do in the better climatic conditions of Java.

More recently Kew has taken an active part in the growing and distribution of species of *Hydnocarpus* (Flacourtiaceae), native in Burma, Indo-China and the East Indies, the seeds of which yield chaulmoogra oil, a specific for leprosy. With regard to this product it is interesting to mention that the resident physician of an asylum at Bangkok was treating the lepers there and trying to get chaulmoogra oil for the purpose when a botanist visiting the hospital was able to point out that supplies were close at hand, a tree was actually growing in the hospital compound, and it grows plentifully in Thailand.

Seeds of *Aleurites* (Euphorbiaceae), the source of the Chinese tung oil, a high class drying oil used for paint and varnish, have also recently been distributed by Kew to suitable parts of the Empire.

The recent widespread introduction of plants of economic importance to the tropical possessions of Great Britain and other countries has opened up political, as well as botanical, problems of considerable difficulty.

The growing of the West African oil palm in the Dutch East Indies where they have been fortunate in establishing a pure-breeding type of good quality oil palm, is a case in point which may set up a state of economic warfare, as also the establishment of the clove industry in Madagascar and cocoa in West Africa versus Trinidad. The effect of the sugar beet subsidy on sugarcane cultivation in the West Indies, the competition of sisal in East Africa with the native product from Mexico, and the plantations of uniform varieties of New Zealand flax in the Argentine afford further examples where economic botany and policy may conflict.

Then again, the case of transport and the cultivation of economic plants under plantation conditions disclose serious botanical problems. Not only may

insidious diseases be easily transported by air, but also large areas of crops grown under plantation conditions afford a very ready means for the spread of any insect or fungus disease. Among the diseases which now threaten important economic products may be mentioned the Panama and the leaf spot diseases of bananas. Cacao witchbroom of cocoa, mosaic of cassava and other economic crops, wither tip of limes and cloves in particular. Such maladies necessitate researches in order to try to produce forms and varieties which may be immune to the diseases, and research in this direction is being undertaken especially by the Imperial College of Tropical Agriculture in Trinidad (see *Nature*, March 9, p. 282; March 15, p. 313; March 22, p. 344; March 29, p. 380) and the East African Research Station, Amani, as well as by specialist officers in the Departments of Agriculture in the Dominions, Colonies, and in India. Attempts are also being made to discover higher-yielding forms of such economic plants as sugarcane, rice, para rubber and cacao, by cross-breeding and selection, and when found, propagating them by budding and grafting, cuttings or seed.

With regard to bananas, research is being undertaken to find wild types of *Musa* in the original home of the edible banana, in the hope of finding types immune to Panama disease, which can be used for cross-fertilizing with cultivated forms; similar work is also being undertaken in Trinidad with regard to Cacao. As we have recently found at Kew that young shoots of Cacao strike fairly rapidly, it will be possible to take cuttings from pure races of high-yielding plants, and so save the labour of budding and grafting.

Other economic plants which are receiving the attention of Kew at the present time for the benefit of our tropical possessions include passion fruit, papaw, cassava, Ephedra, Derris and tuba root or barbasco. The first three mentioned are affected by virus diseases and various types have been sent out to Amani in order that forms resistant to the virus disease may be raised in East Africa. Ephedra, Derris and tuba root yield important insecticides, and attempts are being made to cultivate plants yielding the highest quantity of rotenone, which is very variable in different strains and species. Socks obtained at Kew have been sent to the West Indies in the hope that a profitable industry may be established to meet the demand.

It may be useful to summarize, in conclusion, some of the more important economic plants which now form the principal industries of the countries to which they have been introduced.

Cacao, which is native of South and Central America, has been introduced to Trinidad and other West Indian islands and has for many years been one of their staple crops. More recently it has been introduced to the Gold Coast and is now the mainstay of that Colony.

Cinchona, also from South America, has been of great benefit to India and to Java.

Para Rubber (Hevea), which was brought from South America, is now an important source of revenue to Malaya.

Sisal (Agave), native of Central America, is now extensively planted in Kenya and Tanganyika and is a staple product in East Africa.

Cloves from the Spice Islands are the chief product to Zanzibar and Pemba.

Cotton has been introduced to various parts of the Empire, and is now a very important source of revenue to the Sudan, Uganda, Nigeria, etc.

The introduction of Tea from China to Ceylon and India has transformed vast areas of these countries and is a very important source of their revenue, while the introduction of Coffee to Jamaica and Costa Rica has resulted in important economic developments in those countries.

Reference may also be made to the introduction of wheat to Canada and Australia, which has added so largely to the prosperity of these Dominions. Nor should we forget what the introduction of the potato from South America, and the American tomato has meant in the way of valuable foodstuffs and financial benefit to the growers of these plants in Great Britain and Eire, on the Continent of Europe and elsewhere.

Then, as one further example, there is the great bulb industry of Holland, where the growing of hyacinths and tulips, especially, natives of the near East, has brought so much wealth to the country.

The problems raised by the introduction of economic plants from one country to another and their cultivation under plantation conditions provide ample occupation—apart from political considerations which may arise—for the plant pathologist, physiologist, agricultural chemist, the geneticist, and systematic botanist. As the writer of the book *Ecclesiasticus* has so truly said, "when a man thinketh he hath finished, then he is but at the beginning, and when he ceaseth, then shall he be in perplexity". (*Nature*, Vol. 148, No. 3740, pp. 15–16; Vol. 148, No. 3741, pp. 42–44.)

ABSTRACTS

Root Fibre Production of Some Perennial Grasses. T. M. Stevenson and W. J. White. *Scientific Agriculture*, Vol. 22, No. 2, Oct. 1941. In Western Canada soil drifting has increased in extent and has become one of the major problems confronting agriculture. As a consequence of this soil drifting there is less of fertility, a reduction in water absorbing and water holding capacity and an increased tendency to erode. Wind erosion is mainly responsible for water erosion and consequent drought. The basic cause of wind erosion is the small size of the soil particles or aggregates. Any soil in powdery or in a single grain condition will drift. Large aggregates on the other hand are not removed by wind. While on most soils drifting can be held fairly well in check by cultural practices, such procedures do not eliminate the above underlying cause of erosion, and at best provide only, a temporary means of control.

The growing of grasses has been found to increase the size of soil aggregates. It has also been noted that grass species differ in their ability to influence soil structure and control soil drifting. From the data presented in the paper the authors conclude it is clear that grasses can and should be used extensively in Western Canada as a means of building up the soil, to prevent soil erosion. The practice of including grasses in rotations would not necessarily involve a drastic change from the present wheat farming methods. The inclusion of grasses in the rotation with the object of improving the soil may well be looked upon as a means of enabling the farmer to continue wheat growing through the control of erosion and maintenance of fertility as well as by aiding in the control of weeds, insect pests and diseases.

T. V. R.

Effect of mulching on evaporation of soil moisture. Certain laboratory experiments were carried out by Dr. H. L. Penman of the Rothamsted Experimental Station on evaporation from freely drained soils. He concludes from the data obtained (*J. Agri. Sci.* 1941, 31, 454–65), that mulching will be beneficial when the soil surface and air temperatures are equal and that it will have little effect on water conservation where the soil will be self-mulched by the action of summer sunshine. He has further found that evaporation from a saline soil is much greater than from a non-saline soil and is also greater than from a non-saline soil under isothermal conditions.

V. R.