11. CROPS – INDIGENOUS AND INTRODUCED - HISTORY OF RICE, SUGARCANE AND COTTON

Since time immemorial, cereals, particularly wheat, rice, and maize are considered to be life sustaining crops for humans. Even in future these crops will play a pivotal role in food security system of several nations across the world. The utilization of cereals as food and feed, and for industrial purpose is around 1792 million out of which wheat, rice, and coarse grains contribute nearly 35.4%, 20.8%, and 53.7% respectively. In the past fifty years the world has witnessed structural change in cereal economics:

Long run trend towards wheat and rice and to some extent for maize, while replacement of coarse grain crops occurred.

Developing countries achieved higher growth in production and consumption and at the same time recorded rise in deficits.

Rapid expansion of cereals as feed in developing countries and increased share of cereals in world trade.

It has been projected that world demand for cereals will increase by 2-3% per annum in the next 25 years mainly due to increase in population as well as change in taste and income of the people. This projection clearly suggests that despite impressive growth the world community is still facing the daunting task to maintain adequate food supply for larger sections of population and this will further aggravate in future

History of agricultural development and food production.

Agricultural system	**Cultural stage/time**	**Cereal yield (t ha^{-1})**	**World Population (million)**	**Land holding (ha person^{-1})**
Hunting and gathering	Paleolithic	-	7	-
Shifting agriculture	Neolithic (10000 years ago)	1	35	40.0
Medieval rotation	500-1450 AD	1	900	1.5
Livestock farming	Late 1700s	2	1800	0.7
Improved farming	20th century	4	4200	0.3

1. Use of fertilizers, pesticides, and improved crop varieties.

Source: Tisdale et al. (1993).

In recent years, the concept of “sustainable agriculture development” has been introduced to the world community by the “Bruntland Commission”, which has been accepted by all the countries. It ensures that “long-term effects of development do not damage the rightful heritage of future generations.” More specifically referring to food security, it calls for “increasing production to satisfy growing demands while at the same time preserving basic ecological

integrity of production system." Such sustainable development in agriculture emphasizes conservation of land, water, plant, and animal genetic resources through technically appropriate, economically viable, socially acceptable methods. Presently, utilization and access to genetic resources have become an increasingly important issue because:

Technological advancement in molecular biology and biotechnology have opened new avenues for widening gene pool of several crops.

Legal situation concerning ownership of genetic resources have changed (patent law, state ownership)

The decline/less recognition in value of biological diversity has made risk of their extinction/shortages.

Agricultural development in the recent past has markedly accelerated erosion of plant genetic material, loss of genetic diversity, or heterogeneity on one hand while on the other hand it has increased uniformity and genetic vulnerability of cultivated species to diseases and pests. This necessitates indepth knowledge of the history of cereals involving the origin, process of domestication, and morpho-physiological changes that occurred during the evolutionary process. These aspects can help in conservation of primitive types and further improvement in genetic capabilities of these crops.

Rice

Rice is the most important tropical cereal and supplies a quarter of the entire caloric intake of the human race. About 90% of its area and consumption is in South and Southeast Asia, which support a major part of the world population. Rice belongs to the genus Oryza and there are two main cultigens, i.e., sativa in Asia and glaberrima in Africa. Rice is a semi aquatic graminaceous crop having great deiversity as it is grown in complex range of environments, i.e., from uplands at altitude of 3000m to rainfed lowland irrigated, tidal swamp, and deepwater areas. Besides these two species, aquatic rice species, i.e., Zizania aquatica and Z. palustris,

are endemic to North America, where it is the staple food of Indians.

Origin

The place of major diversity where rice might have domesticated is roughly the east west belt along the Himalayas and adjoining Asia mainland (from Assam, Bangladesh, Burma, Thailand, southern China, and northeren Vietnam). The archaeological evidence suggests that Asian rice culture was established around 7000 years ago. In India carbonized grains excavated from Hastinapur (New Delhi) suggest that it was in cultivation during 1100-800 BC. Subsequently, the grain samples collected at Atrankikar (Uttar Pradesh) were oldest (1500-1100 BC). It has been inferred from the excavation of rice samples belonging to 5000-4000 BC in Thailand that from this place rice spread to other countries.

Evolutionary history

The evidences from diverse disciplines including biosystematic and paleogeology suggest that the genus Oryza arose from a common ancestor. The evolutionary path was from wild perennial to wild annual to cultivated annual, and the closely related wild relatives contributed differentiation of two cultigens. In oryza sativa, the evolution of different geographical races, i.e., japonica, javanica, and indica (the latter forming aman, aus, and indica types in the Ganges belt) took place assisted strongly by human selecton. There is general agreement that in both Asia and Africa elongation and floating ability in two cultigens was derived from their wild relatives. Regarding transformation from perenial to annual types, a theory has been advanced which suggest that climatic changes during the Pleistocene period induced physiological stress in herbaceous flora, which accelerated evolution of annuals from perennials. In rice, change might have occurred in the following sequence:

Perennial->climatic stress->seasonal->human selection-> cultivated rice.

Future strategies

The primitive cultivars and allied wild species of cultivated rice constitute a store house of rare and valuable genes but their use in the breeding programme is limited because these possess many undesirable characters such as shattering of grains, sterility, and red grains.In recent years, the precise elimination of undesirable characters while maintaining vital characteristics has been found possible as evident from the fact that:

Four different spontanea types (O.rufipogon) subjected to different chemical mutagens treatment, produced short plants with thick, erect leaves, and profuse tillering and possessed a different source of dwarfening gene.

Short culm mutants induced in the Assam type of O. rufipogon produced higher yield and proved more adaptable under waterlogged conditions during the monsoon compared to the variety IR 8.

Rice species growing under marshy areas provide excellent sources of resistance to drought and waterlogged conditions.

Agri-history of Cotton in India : An Overview

The antiquity of cotton in the Indian subcontinent has been traced to the 4th millenium BC. The fabrics dated approximately 3000 BC , recovered from the Mohenjo-daro excavations in Sind (Pakistan), were identified to have originated from cotton plants, closely related to the Gossypium arboreum species. The lint-bearing species of the genus Gossypium, the true cottons, are four, out of which the diploid (2n=26) species G. arboreum and G. herbaceum are indigenous in Asia and Africa.

The history of introduction into India of the new world cottons (tetraploid species of G. hirsutum and G. barbadense with 2n=52) dates back to the 18th century AD. By the last decade of the 20th century, India had gained a pride of place in the global cotton statistics with the largest cropped area of 8.9 million in 1996-97, growing the most diverse cultivars in terms of botanical species and composition, producing the widest range of cotton fiber quality suitable for

spinning 6’s to 120’s counts yarn, and supporting the largest agrobased national industry of the country.

Origin of the indigenous cottons

The cotton textiles of the Harappan civilization (2300-1750BC) were produced by sophisticated textile craftsmanship. Thus at the earliest agricultural levels yet discovered, true cottons were already present in the Indian subcontinent.

Wild and weedy types have been found to be associated with primitive cultivated types in both the old world species of G. herbaceum and G. arboreum.

Species of G. herbaceum, have been found from the coastal strip northwest of Karachi (Pakistan), through northern Baluchistan to south Yemen, Ethiopia, and Sudan and even in West Africa south of the Sahara. Species of G. arboreum. have been recorded by in Kathiawar, Gujarat, Khandesh, and the Deccan in India. It seems likely that it was in Gujarat (India) or Sind (Pakistan) that G. arboreum cottons were first brought into cultivation (Hutchinson, 1971).

It may further be surmised that the differentiation of the three perennial races of G. arboreum, namely burmanicum of northeastern India, indicum of western India and the Penninsula, and sudanense of northern Africa, ante-dated domestication and that each contributed separately to the cultivated cottons in Asia and Africa.

Agri-history of cotton production development

Until the middle of the 18th century, only indigenous arboreum and herbaceum varieties of cotton were grown in different regions of the country. Due to the human skills and dexterity of the local artisans, very fine yarns were produced by them, from even the short staple and coarse cottons grown in India.

In 1788, the Governor General (at Calcutta) was requested by London to encourage growth and improvement of Indian cottons to meet the requirements of the Lancashire textile

industry. The figures for exact area under indigenous cottons and production in India during this period are not available, although it is reported that the local production had stabilized by 1900 AD.

Sugarcane

The origin of sugarcane was India. The species saccharum officinarum was first domesticated in India and the spread to other countries by Arab merchants. Evidences revealed that 3000-7000 years ago, Atarna veda indicated that sugarcane originated from the area Sakkaram and then later it was indicated as sakkra in Sanskirit. Earlier indications in Kautilya Artha Sastra also mentioned about the cowdung sett treatment for sugarcane.

List of major plant species domesticated, introduced and cultivated in India.

Crops domesticated in Indian sub-continent	
Cereals	Oryza sativa (Rice)
Millets and Forages	Cenhrus ciliaris (bunch grass), Coix lacrymz-jobi (job's tears), Digitaria cruciata (Digitaria), Echinochloa colona (Deccan grass), Echinochloa crus-galli (cockspur grass), Panicum arntidotale (blue panicum), Panicum miliaceum (french millet), Panicum sumatrense (little millet), Paspalum scrobiculatum (kodo-millet), Sesbania bispinosa syn. Sesbania aculeata (dhaincha)
Grain legumes	Cajanus cajan (pigeonpea), Dolichos biflorus syn. Macrotyloma uniflorum (horse gram/kulthi), Dolichos lablab (hyacinth bean), Mucuna utilis (velvet bean), Psophocarpus tetragonolobus (Goa bean), Vigna aconitifolia (moth bean), Vigna angularis (adzuki bean), Vigna mungo (black gram), Vigna radiata (green gram), Vigna triloba (jungi bean), Vigna umbellata (rice bean)

Oilseeds	Brassica juncea (indian mustard), Brassica rapa ssp. trilocularis (yellow sarson or Indian Colza), Brassica rapa var. toria (Indian rape), Brassica rapa var. dichotoma (brown sarson), Sesamum indicum (sesame)
Fibre crops	Agave cantala (kantala), Bombax malabaricum (red silk cotton), Corchorus capsularis (white jute), Corchorus olitorius (tossa jute), Crotolaria juncea (sun-hemp), Gossypium arboreum (tree-cotton), Gossypium obustifolium (Asiatic cotton), Hibiscus cannabinus (Deccan hemp), Hibiscus sabdariffa (Jamaica sorrel)
Vegetables	Abelmoschus esculentus (okra), Amaranthus blitum (sag chulai), Amaranthus tricolour (lal sag), Amorphophallus campanulatus (elephant-foot yam), Chenopodium album (common pigwheat), Coccinia indica (kovai fruit), Colocasia esculenta (taro), Cucumis sativus (cucumber), (Indian lett) (ridge gourd), Luffa cylindrica (sponge gourd), Momordica charantia (bitter gourd), Momordic cochinchinesis (kakora), Momoridica dioica (balsam apple), Moringa oleifera (drumstick), Praecitrullus fistulosus (round gourd), Raphanus caudatus (rat-tail Radish), Rumex vesicarius (bladder dock), Sesbania grandiflora (agathi), Solanum melomgena (brinjal), Spinacia oleracea (spinach), Trichosanthes anguina (snake gourd), Trichosoanthes dioica (pointed gourd)
Fruits	Aegle marmelos (Bengal quince), Areca catechu (areca nut), Artocarpus heteophyllus (jack fruit). Carissa congesta (karaunda), Citrus limon (lemon), Mangifera indica (mango), Musa paradisiaca (plantain/banana), Phoenix sylvestris (date sugar palm, Indian palm), Zizyphus jujuba (Indian jujube), Zizyphus nummularia (wild jujube)

Some important medicinal and aromatic plants	Abelmoschus moschatus (muskmallow), Atropa acuminata (Indian belladona), Azadirachta indica (margosa tree), cassia fistula (Indian laburnum), Cymbopogon marini (palmarosa), Cymbopogon nardus (citronella grass), Cymbopogon pendulus (lemon grass), Cynodon dactylon (Bermuda grass), Datura metel (datura), Emblica officinale (Indian gooseberry), Patchouli (patchouli), Rauvolfia serpentina (serpentine root), (costus), Vetiveria zizanioides (vetiver)
Narcotics Spices and condiments	Cannabis sativa (hemp) Cinnamomum tamale (Indian cassis) Cinnamomum verum (cinnamon), Crocus sativus (saffron), Curcuma amada (mango ginger), Curcuma caesia (black turmeric), Curcuma domestica syn. C. longa (turmeric), Curcuma zedoaria (zedoary), Elettaria cardamomum (small cardamom), Kaempferia galanga (chandramula), Mentha piperita (mint), Murraya koenigii
Spices and Condiments	(curry leaf tree), Myristica malabaricum (nutmeg), Piper betel (betel pepper), Piper longum (long pepper), piper nigrum (black pepper), Trigonella foenum-graecum (fenugreek), Zingiber officinale (ginger)

Others	Acacia catechu (kattha), Acacia nilotica (India acacia), Bambusa arundinacea (thorny/spiny bamboo), Bambusa tuldo (Bengal bamboo), Bauhinia purpurea (camel foot tree), Borassus flabellifer (palmyra-palm), Caesalpinia sappan (Indian redwood), Camellia sinensis var. assamica (tea), Cedrela toona (red cedar), Cordia myxa (Indian cherry), Coffea bengalense (coffee), Curcum angustifolia (Indian arrowroot), Dendrocalamus hamiltonii (Dendrocalamus), Dendrocalamus strictus (Calcutta bamboo), Dioscorea alata (greater yam), Dioscorea esculenta (lesser yam), Ficus bengalensis (banyan tree), Ficus elastica (Indian rubber), Ficus religiosa (peepal), Garcinia sylvestris (wild mangosteen), Indigofera tinctoria (indigo), kochia indica (bui), Lawsonia alba (henna), Maoutia puya (pua, poi), Marsdenia tinctoria (rion), Morinda angustifolia (ban haldi), Morinda citrifolia (Indian mulberry), Nephelium longana (anshaphal), Nerium indicum (kaner), Nyctanthes arbortristis (Tree of Sadness), Ochlandra travancorica (elephant grass), Oroxylum indicum (sonapatha), Pluchea indica (pludina), Rubia cordifolia (Indian madder), Saccharum officinarum (sugarcane), Saccharum sinense (sugarcane), Sapindustrifoliatus (soap nut tree), Sida rhombifolia (Cuba jute), Sinocalamus giganteus (Sinocalamus), Tamarindus indica (tamarind)

Crops introduced by Portuguese

Pseudo cereals Amaranthus caudatus (amaranth)

Oilseeds Arachis hypogeae (groundnut)

Vegetables Cucurbita moschata (pumpkin), Ipomoea batatas (sweet potato), Solanum tuberosum (potato)

Fruits	Anacardium occidentale (cashew nut), Anona squamosa (custard apple), Psidium guajava (guava)
Narcotics	Nicotiana tabaccum (tobacco)
Spices and condiments	Capsicum annuum (chilli)

Crops introduced by Britishers

Pseudo cereals	Avena sativa (oat)
Grain legumes	Castanospermum australe (black bean), Pisum sativum (pea)
Fiber crops	Gossypium barbadense (cotton)
Vegetables	Allium tuberosum (leek), Asparagus racemosus (satawar), Beta vulgaris (beet root), Brassica oleracea var. botrytis (cauliflower), Brassica oleracea var. gemmifer (Brussels pekinensis (celery), Capsicum frutescens (sweet pepper), Cichorium intybus (chicory), Cucurbita maxima (squash), Daucas carota (carrot, orange type), Lactuca sativa (lettuce), Lycopersicon esculentum (tomato), Pisum sativum (sweet pea)
Fruits	Averrhoa bilimbi (bilimbi), Averrohoa carambola (carambola), Carica papaya (papaya), Eugenia jambos (rose apple), Fragaria ananassa (strawberry), Garcinia mangostana (mangosteen), Helianthus tuberosus (artichoke), Manihot esculenta (cassava), Malus pumila (apple), Prunus armeniaca (apricot), Prunus avium (cherry), Prunus communis syn. P. domestica (plum), Prunus persica (peach), pyrus communis (pear), Ribes rubrum (red currant)

Medicinal and aromatic plants: Cinchona officinalis (quinine), Origanum vulgare (majoram), Papaver somniferum (opium poppy), Pelargonium capaitatium (Geranium), Salvia officinalis (sage), Thymus vulgaris (thyme), Vanilla aromatica (vanilla)

Crops introduced from West and Central Asia by Mughals or Arabs

Allium cepa (onion), Allium sativum (garlic), Brassica rapa (turmip), Brassica oleracea var. capitata (cabbage), Coriandrum sativum (coriander), Cucumis melo (sweet muskmelon), Daucas carota (carrot, black & red type), Phoenix dactylifera (date palm), Pisum sativum (pea), Syzygium aromaticum (clove), Vitis vinifera (grape)

Crops introduced by Spaniards

Phaseolus vulgaris (French bean)

Crops introduced from China

Aleurites fordii (tung-oil), Glycine max (soyabean), Eriobotrya japonica (loquat), Juglans regia (walnut), Litchi chinensis (litchi), Sapium sebiferum (tallow-tree)

Crops introduced from Latin America

Hevea brasiliensis (Rubber), Ananas comosus (pineapple)

Crops introduced from Southeast Asia and Pacific islands

Arenga pinnata (sugar-palm), Artocarpus communis (breadfruit), Citrus decumanus (pomelo), Citrus paradisi (grapefruit), Durio zibethinus (durian) and Metroxylon sagus (sago)

Some recent introductions

Humulus lupulus (hops), Helianthus annuus (sunflower), Simarouba glauca (simarouba), Cyphomandra betacea (tree tomato), Carya illinoensis (pecan nut), Corylus avellana (hazel nut), Macadamia tetraphylla (macadamia nut), Parthenium argentatum (guayule), and Mentha arvensis (spearmint, USA) Acacia senegal (Australia), Acacia mangium (Australia) and Actinidia chinensis (kiwifruit, New Zealand)