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Status of Underutilized Horticultural Biodiversity in Andaman & Nicobar Islands: Challenges for Utilization

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Introduction

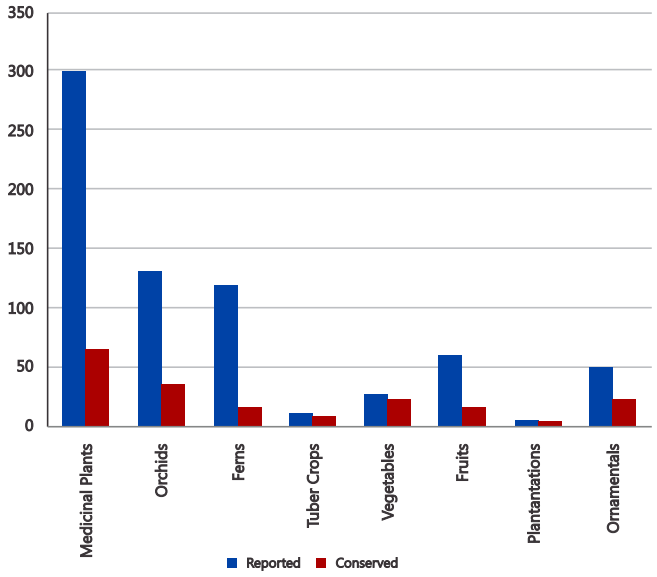
Andaman & Nicobar Islands are an archipelago of 572 islands located in Bay of Bengal. The islands are spread from 6°N latitudes to 14° N latitude on 92° E to 94°E longitudes which bestow with humid tropical climate. The existing climatic conditions and geographical isolation are important factors behind abundance of biodiversity in these islands. Their richness in biodiversity is well reflected in terms of existence of nearly 3000 angiospermic species. Recently, their biodiversity worthiness is well recognized by depicting Islands on the Network of World Biodiversity Hot Spots. Though, large number of species were brought into Islands from different parts of the adjoining countries/regions through natural and anthropogenic factors but, existing environmental pressure and geographical isolation modified their genome and levels of survival. These islands are rich centre of horticultural crops including plantations, orchids, ferns, medicinal plants, underutilized fruits, vegetables and ornamental plants. These resources are among important factors which helped in developing horticultural sector in islands economy.

Native germplasm of horticultural crops

The native germplasm of horticultural crops have played great role in development of present day horticultural sector and society in islands. They have also contributed greatly in tribal food and health system as food, feed and medicine. They are well used by local population for various traditional medicines and appear as 'potential source of phytoceuticals compounds'. The importance of indigenous crops increases in islands, where outer world support becomes impossible. Their 'low input but ensured income' feature makes them tools for livelihood improvement. Besides, in islands where climatic conditions remain unfavourable for most of crops, local crops have great scope under such conditions. The research and developmental activities on such crops will directly benefit the marginal and sidelined strata of our society. The indigenous/local germplasm has pivotal role in environmental sustainability of islands ecosystems as 'low incidence of diseases and pests' demands lesser pressure of chemicals, one of the key factor of environmental degradation in present era.

Little efforts were made to explore and commercialize locally available germplasm even there is huge population which prefers local food resource. Earlier efforts documented the **117 species of orchids, 120 species of ferns, 300 species of medicinal plants** and **more than hundred species of fruits** and **vegetables are present in different islands**. But, still efforts are required to collect wild relatives of horticultural crops from different islands (Singh *et al.*, 2003, Sharma *et al.*, 2006). The prevalence of species diversity of orchids, ferns, tuber crops, vegetables, fruits is well accepted. The **islands are rich in species diversity of mango, banana, *Annona* spp.**, wild fruits, vegetables, medicinal and aromatic plants, mushroom etc. However, proper collection and conservation is immediate requirement for such precious natural resources. They also need to be protected from increasing pressure of biopiracy and extinction. The collected germplasm usually has poor productivity and consumer's acceptance which needs to be processed through suitable breeding procedures for its improvement in respect to agronomical and consumer acceptance.

The archipelago, like its 'composite culture' also have 'composite biodiversity' due to its geographical adjacency with two centres of diversity *i.e.* Indo-Chinese-Indonesian and Hindustani regions. Further, in colonization era, several new world domesticates were introduced into Islands by Britishers, Japanese and mainlanders. In reciprocity, Island cultigens were also introduced into Indian and international gene banks. The prevalence of great ethnic diversity and primitive agriculture also point out to the rich heritage of these islands. The review of earlier studies on Andman and Nicobar Islands in this direction shows richness of islands in germplasm of different horticultural crops.



Underutilised horticultureal biodiversity in islands

The tropical and humid climate of Andaman & Nicobar Islands is very much apposite for the promotion of tropical and subtropical fruits. Many of the labeled "underutilized fruits" are abundantly available in islands but in dispersed phase with poor scientific information. Some of the identified under-utilized fruits in Andman and Nicobar Islands are Alligator apple (*Annona glabra*), Governor's plum (*Flacourti ramomtchi*), Khatta phal (*Bauccaria vamiflora*), Bethphal (*Calamus andamanica*), Khariphall (*Ardisia solanaceae*), Madhuphal (*Salacia chinensis*), Custard apple (*Annona squamosa*), Soursop (*Annona reticulata*), Carambola (*Averrhoa carambola*), Bilimbi (*Averrhoa bilimbi*), Wild passion fruit (*Passiflora foetida*), *Pandanus lerum*, *Pandanus andamanensium*, *Pandanus tectorius*, Wild jamun (*Syzyium claviflorum*), Bullock heart (*Annona reticulata*), wild mangoes like *Mangifera griffithi*, *M. andamanica* and M. *camptosperma*, jambose (*Syzyium jambos*), Rambutan (*Nephelium lappaceaum*), Rose apple (*Syzyium aqueum*), Velvet aqple (*Diospyrous discolour*), Mangosteen (*Garcinia mangostana*), Chalta (*Dillinea indica*), Sapida (*Bauccaria sapida*), Wild amra (*Dracontomelon dao*), Bread fruit (*Artocarpus sp.*), Kendu (*Diospyrus sp*), *Morinda citrifolia* etc.

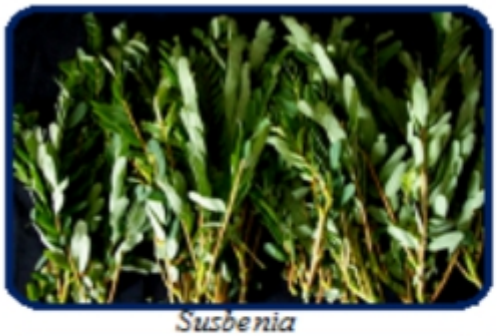
Underutilized fruits of Andaman and Nicobar Islands

Orchid's diversity in Andaman and Nicobar Islands

In spices, nine taxa under four genera of nutmeg are listed in islands and three of them *viz*. ***Myristica andamanica***, Hook f., ***Knema andamanica*** and ***Knema andamanica*** spp. *nicobarica* (warb) de **Wild are commercially important.** Betelvine is locally consumed by Shompen tribe in Nicobar Islands but still its food value needs to be evaluated for commercialization.

The orchids, ferns and zingebers are dominating the ornamental group of plants. In islands, 19 genera with 25 species of orchids are reported as endemic. The important species *viz*. *Eulophia* sp., *Dendrobium formosum, Geodorum densiflorum, Dendrobium apyllum* have been identified for commercial exploitation. While ferns like *Microsorium punctatum, Glechnia microphylla, Lygodium, flexuosum, Heterogonium sagnoides* were identified for commercialization. Some other ferns like *Cyclopeltis spp, Adiantum flabellulatum, Devallis spp., Pteries spp., Asplenium nidus, Adiantum spp.* also have been recognized for commercial cultivation. For this, experiments are under progress to standardize protocols for rapid mass multiplication of potential ferns.

The tropical warm and humid climate of Andman and Nicobar Islands islands favours richness of orchid diversity in this region. **So far, 132 species from 59 genera have been reported from Andaman and Nicobar Islands.** Interestingly **60 species are from the Great Nicobar Island** alone of which 30 species are found to be endemic. The economic importance of orchids lies mainly in their ornamental value, but many orchids are used in the traditional system of medicine for curing a number of ailments. There is a wide range of variations in the host preference and distribution of orchids in the island ecosystem. Wide variations are also found to occur in the size, shape, colour and attractiveness of the leaf as well as flower and its structure, besides growth habit and quality and number of flower/spike. Wide genetic diversity present in the wild orchids of Andaman and Nicobar Islands may be utilised in the breeding programme for producing new hybrids free of pest and diseases, besides conserving the rare, endemic and threatened species. Some common orchids are *Eulophia andamanesis, Cymbidium aloifolium, Dendrobium*


Susbenia


Basella spp.


Corchorus spp.


Enhydra sp.


Hibiscus sabdariffa


Nymphaea stellata


Ipomea aquatica


Piper serpentum


Portulaca oleracea


Araranthus sp.


Murraya koenigii


Enhydra flactuans


Centella asiatica


Colocasia esciulenta


Eryngium foetidum

formosum, Cymbidium bicolour, Dendrobium crumenatum, Pholidota impricata, Rhynchostylis retusa and Dendrobium secundum.

Islands are also rich centre of diversity for vegetables *i.e. Centella asiatica*, *Enhydra fluctuans*, *Amaranths* sp., *Ipomea aquatica*, *Momordica dioica*, *Oxalis corniculata*, *Alternanyara philocus* ridous, *Colocasia* sp. *Portulaca* sp., *Saursopus endrogynus*, *Capsicum annum*, *Solanum melongena etc.* (Singh *et al.*, 2009).

There are several lesser known leguminous vegetable crops also in islands such as tree bean (*Parkia roxburghii*), sword bean (*Canavalia gladiata*), faba bean (*Vicia faba*), velvet bean (*Mucuna pruriens*), and Mucuna (*Mucuna gigantea*) which are reported from these islands and needs proper attention. Besides, some of wild relatives including endemic cultigens of legume vegetables i.e. *Atylosia cajanifolia, A. grandiflora, A. nivea, Canavalia stocksii, Cicer microphyllum, Dolichos bracteatus, D. purpureus, Lignosus forms* were reported from these islands (Sharma *et al.*, 2006; Singh *et. al.*, 2009, 2011a).

Traditional and tribals of islands still rely more upon native wild plants for medicinal purposes, apart from several of them being taken up for industrial use such as the *Rauvolfia serpentine*, *Morinda citrifolia*, *Centella asiatica* etc. Botanical Survey of India (BSI) identified nearly 300 medicinal plants in these Islands.

Due to existence of great diversity of me
nearly 14 of these medicinal plants wer
priority basis by the ANMPB(S) for commercial cultivation. These plants are Amla, Ashok, Arjuna, Bael, Brahmi, Kalihari, Kalmegh, Pippali, Patcholi, Citronella, Lemon grass, Tulsi, Stevia and Vannilla. Furthermore, islands are rich centre of diversity of mushrooms which need to be properly explored and utilized. Islands are very much suitable for tropical mushroom cultivation of oyster, milky and paddy straw mushroom. *Cantherellus cibtarius*, *Lycopordon pyriformae*, *Scleroderma verucosum*, *S. ctrinum* and *Clitocybe floccida* have been identified and catalogued (Kumar *et. al.*, 2009).The diversity in Noni has been used as base for development of four high yielding varieties.

Survey and exploration efforts

Survey and explorations in islands for horticultural crops were conducted through various national research institutes as well as CARI. The collected germplasm are conserved in national gene banks and germplasm blocks as *in situ* as well as *ex situ* conservation. A number of genotypes were registered at national level for further use by scientific community. So far, Central Agricultural Research Institute (CARI) have made efforts towards utilization of these genetic resources in form of releasing as a variety (coconut, aracenut, sweet

Diversity in noni in islands

potato) or using as parent in breeding programme (amaranthus, brinjal, chilli) The documentation of indigenous knowledge about selected horticultural crops has been completed.

Nutritional and phytochemical analysis

The nutrients and phytochemicals were analyzed for potential native fruits and vegetables and indentified rich sources of such compounds (Singh *et al.*, 2011a; Singh *et al.*, 2011b). The identification of phytochemical rich genotypes in indigenous vegetables has contributed in development of varieties in Broad Dhaniya. The genotypes were also indentified in other vegetables such as *Basella alba*, *Amaranthus, Hibiscus sabdariffa,* chilli, West Indian cherry, Bael etc. Furthermore, a phytochemical profile of Noni (*Morinda citrifolia*) has been done and a profile of germplasm was developed using these biochemical traits. Further work in under progress to develop nutritional and phytochemical base for these potential crop resources.

Threats to island biodiversity

Island agriculture changed from nomadic to subsistence and then towards commercialization. It created immense pressure on island biodiversity due popularization of invasive alien species, habitat change and over-exploitation, increasingly pressure from climate change and pollution. Such factors make Islands most vulnerable for conservation and sustainable use of existing biodiversity.

In 1947, island population was just one forth of present day but increased enormously to approximately 4.0 lakhs. This phenomenal rise in population affected the Island ecosystem through clearing forest areas-habitat of diversity and adding hazardous pollutants. Further, natural disasters in the form of tsunami, cyclones, floods *etc.* also considered as major threats to island biodiversity. During tsunami in 2004, smaller islands like Truncate Island were completely washed out by sea water which caused complete destruction of its biodiversity. Besides, a large portion of costal region was permanently inundated by sea water and submerged the existing plant diversity in this region. However, predicted threat from climate change and tectonic movements of earth increases vulnerability of this wonderful hot spot towards possible sea encroachment and habitat destruction.

Tapping horticultural biodiversity

Most of biodiversity hot spots are situated in tropical belt of the world. Tropical regions are well known for forests and habitats of aboriginal tribes. These tribes have their food and medicinal sources from wild plants from forests which have great potential for commercial exploitation. The islands have rich diversity of fruits, vegetables, ornamentals, tuber crops, spices, mushroom, ferns and orchids, medicinal and aromatic plants and microbes which can be exploited for generating new avenues for livelihood security and economic development of the islands. CARI has initiated efforts for tapping biodiversity of horticultural crops through generating information of nutritional value and phytochemical profiles of underutilized fruits and vegetables. Significant progress has been made on bioprospecting of indigenous vegetables and orchid and ferns.

Island biodiversity in eco-tourism

Tourism is the largest service industry in India with a contribution of 6.23% to the national GDP and 8.78% of the total employment in India. The tourism industry in India generated about US$100 billion in 2008 and that is expected to increase to US$275.5 billion by 2018 at a 9.4% annual growth rate. But, commercial tourism is also posing threat to the fragile ecosystems like islands, coastal and mountain regions. Under such fears, eco-tourism is one the best option for benefit of local people as well as sustainable development of the region. Kerala has made significant progress for exploiting eco-tourism on large scale which has benefited even small farmers. Andaman & Nicobar Islands are having scenic beauty and abundance of biodiversity which can be utilized for promoting these islands as tourist destination of eco-tourism.

Efforts for utilizing horticultural biodiversity of islands

Most the islands in Andaman Islands were surveyed for plantations, ornamental plants (orchids & ferns), fruits, vegetables, medicinal plants and oil yielding plants. The systematic surveys for germplasm collection and augmentation resulted in collection of 77 accessions in 15 traditional vegetables, 33 accessions in noni (*Morinda citrifolia*), 20 accessions of early flowering and 47 accessions of multiple seasons flowering mangoes, 8 accessions of bael, 32 accessions of tuber

Nephrolepis fern

Bird's Nest Fern

crops, 2 accessions of macapuno type of coconut, 25 accessions of karanja and 26 accessions of jatropha. The collected germplasm were mostly conserved in Germplasm Blocks for respective crops at CARI. The collected germplasm of 10 traditional vegetables, 15 underutilized fruits, 20 mangoes and 33 *Morinda citrifolia* were evaluated for nutritional and phytochemical properties using standard procedures. Significant variations were observed in the crops/accessions for some of the dietary nutrients and phytochemicals. The extent of diversity in germplasm of noni, colocasia, chilli, orchids, mango, bael, jatropha, arecanut and coconut was analysed using morphological traits and molecular markers. The identified superior genotypes of ground orchid, broad dhaniya, noni and mango were also characterized using DNA markers (RAPD and ISSR). The genetic resources were documented through publications and developing database using bioinformatics software.

Genetic improvement of island horticultural crops

The improved varieties (developed in mainland) of commercial horticultural crops are being cultivated in islands. These varieties have low level of tolerance and adaptation to island conditions which results in low productivity and high input cost (particularly for chemical pesticides). Moreover, islands have rich diversity of horticultural crops and high preference for some of local genotypes/crops which need to be improved for commercial utilization. Significant efforts for breeding of island specific genotypes/varieties for various horticultural crops resulted in development of varieties in sweet potato (CARI-SP1 & CARI-SP2), coconut (CARI-Annapurna, CARI-Surya, CARI-Omkar & CARI-Chandan), Orchid (Pretty Green Bay) Greater Yam (CARI-Yamini) and Broad Dhaniya-(CARI Broad Dhaniya). The developed varieties have better tolerance to diseases and pests, significantly higher yield than local checks or base materials. Further, 15 genotypes in different crops including Morinda (seven), Centella (one), Basella (one), arecanut (one), chilli (one), amaranthus (one), jatropha (two), west indian cherry (one) were identified and further breeding programme is under progress. Varietal evaluation trials were conducted under AICRP (Vegetable Crops) and significant number of promising entries were identified for island conditions such as in French bean (Contender, IIHR-909, Arka Anoop), Cowpea (Shwetha, Indira Hari, Swarna Harita), Dolichos bean (Gomuchi Green, Ankur Goldy, IIVR Sem-8, IIVR Sem-11), Hybrid okra (09/OKHYB 10, 09/OKHYB 9, 09/OKHYB 9, 09/OKHYB 2), Chilli (LCA-353, Arka Lohit, CARI-Sel-1, PC-7, KA-2) and Brinjal (CARI Brinjal-1, PB-69, PB-60).

Identification and commercialization of noni

Noni (*Morinda citrifolia*) was identified as potential crop in islands. Systematic experiments on production technology revealed the better performance of noni as an intercrop in coconut and arecanut plantations. Spacing level of 4 × 4 meter (out of 1 ×1, 1.5 ×1.5, 2 × 2, 3 ×3, 4 × 4m), application of vermicompost (5

kg/plant/year), canopy management (5 primary branches/plant) and organic mulching with banana leaves were identified as best treatments for noni in islands. Noni has poor self life, so appropriate measures should be identified for post harvest management. Further, the high level of salinity tolerance of noni was utilized for utilization of Tsunami (sea water) affected lands in islands through noni cultivation on soil mount (1 × 1 × 1m size), however, further efforts are required for its large adoption.

Challenges for utilization of island biodiversity

Though, Andaman and Nicobar Islands achieved significant milestones in horticultural sector but still much remain to be done. This can be increased through introduction of suitable cultivars and exploitation of indigenous/local genetic resources. Undoubtedly, there is a growing awareness for utilization of these indigenous and underexploited plant genetic resources in Islands but, certain constraints are prevalent such as:

- Unpredictable climatic vagaries like heavy rains high humidity create problems to germplasm surveyors.
- Geographical fragmentized Islands with poor infrastructure bases hamper proper survey and exploration activities.
- Consumer's acceptance of directly domesticated local/ indigenous vegetables, fruits, mushroom *etc.* is less due to their poor quality.
- Lack of coordinated programmes between related institutions i.e. Botanical Survey of India, ICAR, and Forest Survey of India (FSI) *etc.*
- Poor emphasis on conducting survey and explorations in Islands by various national organizations.
- The germplasm strategies need to developed with cliamte change reseliant practices.
- The high throughput laboratories need to be developed in biochemistry and biotechnology for developing database on these crops.

Future strategies for sustainable utilization of island biodiversity

It is rightly said that "Food storage are for present generation but gene garden for coming generations". In the Vision 2025 document CARI, Port Blair has included biodiversity conservation and utilization in form of "Biodiversity richness of the island should be preserved and exploited for national benefit" including of horticultural crops as one of the vision for accomplishment in near future. The initiatives have been taken to accomplish the said vision in the project modes for collection and conservation of local vegetables, orchids, ferns, rapid multiplication and habitat enrichment. The horticultural crops have great potential in these islands but some of the issues need to be tackled to ensure cost effective supply of quality vegetables to Islanders. But more thrust area are still need urgent attentions are:

- *In-situ* and *Ex-situ* conservation of rare plants with horticultural importance traits.
- Establishment of field gene bank/Germplasm repositories in Islands.
- DNA signaturing of important germplasm/ species for Islands.
- Development of island biodiversity database for all these crops.
- Geospatial mapping of Islands for distribution of horticultural crops plants.
- Multi-institutional project/ collaboration needs to be developed for sustainable utilization of genetic resources from Islands.
- Systematic and detailed evaluation, characterization and documentation of indigenous vegetables, ferns, orchid, fruits *etc.* should be completed to protect it from possible natural or anthropogenic threats.
- Genetic enhancement and pre-breeding of these crops using indigenous and introduced varieties or wild relatives.

Conclusion

The islands have rich biodiversity of horticultural crops. However, genetic erosion, genetic vulnerability and genetic wipeout are important processes that affect the crop genetic resources. These are not mutually exclusive but interlocked by the demands of burgeoning population. Besides, wild relatives are on the threat of extinct due to natural and anthropogenic forces in Islands. To preserve this pristine natural treasure under Vision-2025, CARI has taken various steps to conserve large number of horticultural genetic resources.

The nutritional and phytochemical profiles were developed for a number of fruits and vegetables of islands. Research efforts are still under way to develop complete information n the native species of islands. The development of field gene banks, standardization of micro-propagation protocols, sensitization of local crops, molecular characterization of important crop plants are some initiative to meet its visionary objectives. Exploitation of the potential of under utilized fruit crops will not only benefit the countries in which they are produced, but also cater to the increasing demand for exotic products in the developed world.

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