Eco-geographic survey of crop wild relatives

E CO-GEOGRAPHIC SURVEY AND PREPARATION OF DESCRIPTORS FOR PRIORITY CROP WILD RELATIVES OF RICE, *VIGNA*, BANANA, CINNAMON AND PEPPER.

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ECO-GEOGRAPHIC SURVEY OF CROP WILD RELATIVES

INTRODUCTION

- Eco-geographic survey – Ecological, Geographical, Taxonomic → Information gathering and synthesis process

Find Out:
- Present distribution
- Determination of genetic diversity
- Areas with high genetic diversity
- Risk habitats

Preparation → Inventories

Monitoring → Species/Population/Habitats/Eco-systems

Develop Appropriate Conservation strategies → ENSURE OPTIMUBALANCE BETWEEN IN-SITU AND EX-SITU CONSERVATION

Survey results can be predicted to find out new areas and it can be used to make collection and conservation priorities.

Priority Crops

- Rice – 5 Wild species
- Vigna – 10 Wild Species
- Banana - 2 wild Species
- Cinnamon – 8 wild Species
- Pepper – 9 Wild Species

Objectives

- To locate and map of wild relatives populations of rice, banana, *vigna*, cinnamon, and pepper.
- To collect of eco-geographical information from relevant areas.
- To identify potential sites for the establishment of genetic reserves to conserve priority crop wild species.
- To identify threatened species and populations.
- To study species diversity of priority crop wild relatives.
- To develop eco-geographic descriptors for priority crop wild species.

Activities

- Literature survey - accepted taxon name / Eco-geographic distribution.
- Preparation of the list of CWR - based on available information.
- Island wide Eco-geographic surveys.
- Preparation of - a list of important morphological characteristics
  -herbarium specimens of important taxa which have difficulties in identification.
- Collection of photograph - important characteristics habitat etc…
- Collection of ethno-botanical notes.
- Preparation of prediction maps and distribution maps - latitude and longitudes.
- Preparation of eco-geographic descriptors.

METHOD

- **Literature survey** -herbarium specimens, PGRC passport data, various publications, relevant institutes and internet.

- **Preliminary field survey** – based on a) literature survey b) herbarium data
  c) available information

Collected data were analyzed to estimate the high potential areas of CWR

- Systematic Field survey - Plan and implemented in target areas

Data and information

- Location data – GPS data (map datum WGS 84) - Latitude and Longitude, Altitude, address, habitat, population size and structure, associated species etc…
- Habitat and plant taxonomic data
- herbarium specimens
- Photographs – habitat, habit and specific characters
- Herbarium specimens in National herbarium / PGRC - geographic coordinates were assigned using gazetteer
- Ethno-botanical information - literature survey and direct interviews.
- Information of the wild populations - different intervals to understand changes in populations.
- Descriptor data - Level 1. Taxon information, Specific site information, Specific population level description, Geographic information

  Level 2. Site location - Site geomorphology, Site microclimate - Site geology and soil Site habitat

  Level 3. Coordinates - Longitude and Latitude, Altitude, Nearest named place

Data Analysis

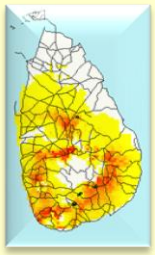
- all GPS data converted WGS 84, d^0 mm ss to WGS 84, d^0 dddd to be used in Diva -GIS and Flora map software.
- The distribution of wild species of priority crops occurring in Sri Lanka depicted in the maps.
- GPS data were analyzed by Diva- GIS and Flora map distribution modeling and mapped probable areas where wild species could be expected.
- Eco-geographic descriptors were prepared using available and collected information of priority crop wild relatives for all possible species.

MAPS

1.SPECIES DISTRIBUTION ON DISTRICT MAP LAYER – 1. LITRATURE DATA + PASSPORT DATA
2. LITRATURE DATA + PASSPORT DATA+ FIELD SURVEY DATA

2.PREDICTION by LITRATURE DATA + PASSPORT DATA -

1.FLORA MAP

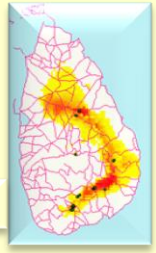


2. Diva - Gis

3.SPECIES DISTRIBUTION ON ALTITITUDE MAP LAYER

4.PREDICTION by LITRATURE DATA + PASSPORT DATA + FIELD SURVEY DATA

1.FLORA MAP



2. Diva - Gis

5.SPECIES DISTRIBUTION ON PROTECTED AREA MAP LAYER

6. POTENTIAL DISTRIBUTION ON AGRO-ECOLOGICAL MAP LAYER

Target Areas of Survey

- decided after the extensive literature surveys and information analyzed by Flora map and Diva-GIS software.
- target areas generally were all possible protected areas, unprotected areas, villages, remote areas and even in urban areas where wild species were reported and
- expected through prediction maps.

Target areas were set using results of literature survey and prediction map constructed from literature data.

STRATEGY OF THE SURVEY

maximum use of time and to get optimum accuracy of the data.

- **Survey team-** principle investigator of the project, co-investigator, Technical and supporting staff – two number, Driver
- **Survey type** - 1. Single species survey 2. Multi species survey
- **Scale of Survey -**maximum number of species and locations
  extent of the area and distance of traveling.
- **Choose of areas for survey -** knowledge accumulated in literature survey and on that obtained during in the preliminary survey.
- **Choice of route and of maps -** road maps and detailed maps.
  1 to 50,000 scale maps were used in rural area surveys.
- **Suitable season for survey -** wild species are very seasonal and they are not seen in year round

- **Contact with Institution / Local Organization**

  related organizations in the area of survey.

  protected areas govern by Department of Wild Life, Department of Forest and Department of Archeology.

  local government organizations, NGOs, Farmer organizations.

- **Length of survey** depends upon the extent of distribution of species, the extent of the distributed area, transportation facilities, fund availability and season (species availability on a particular period)

  some administrative and external factors.

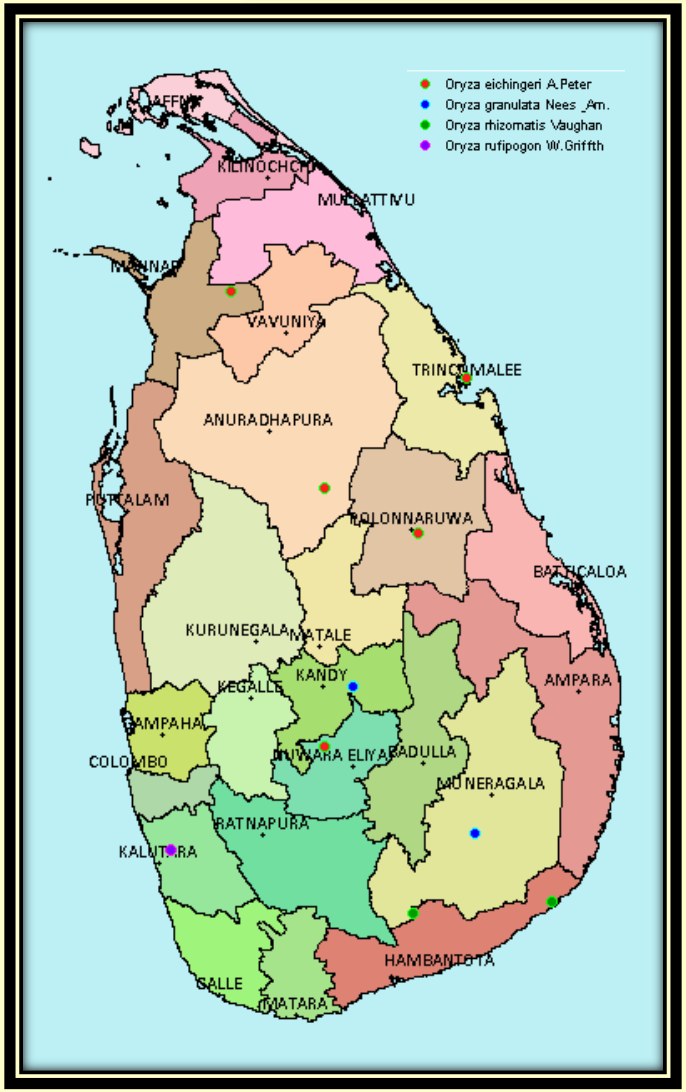
  Duration of survey trips 1-4 days

ECO-GEOGRAPHIC SURVEY OF WILD *ORYZA* SPECIES IN SRI LANKA

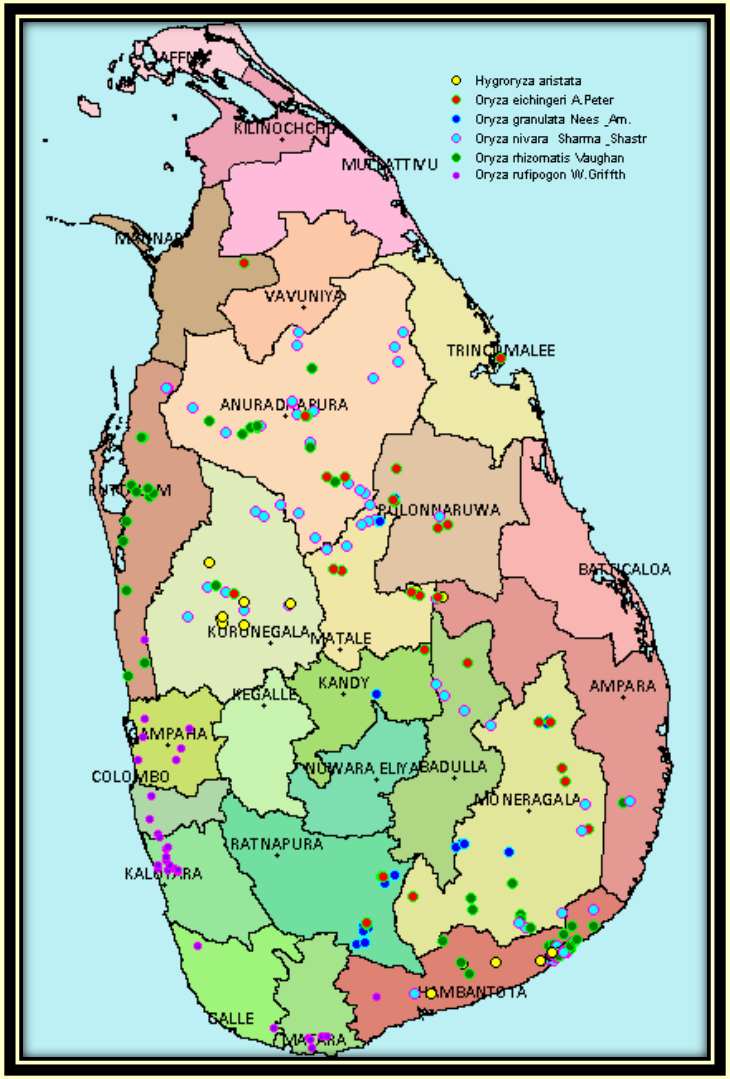
No. of GPS Locations for *Oryza* and *Hygroryza*

Species Name	Literature Data	Passport Data	Survey Data	Total
Oryza nivara	01	73	29	103
Oryza rufipogon	00	27	05	32
Oryza granulata	02	14	10	26
Oryza eichingeri	07	13	27	47
Oryza rhizomatis	00	23	29	52
Hygroryza aristata	00	18	11	29
weedy rice	00	02	00	02
Total	**10**	**170**	**111**	**291**

Distribution of *Oryza* Species – Districts Map Layer



Distribution of *Oryza* species by LS



Distribution of *Oryza* specie and related genera by PD,LS and FS

Eco-Geographic Survey of Wild Species of *Vigna* in Sri Lanka

Sri Lanka - 16 species of *Vigna* (4 sub species).
Ten wild species.

Wild species of *Vigna* in Sri Lanka

Species name	No. Of Location By field visits	No. Of location from herbarium	No. Of location from passport data	No. Of location from Literature
1. *V. trilobata*	21	1	15	16
2. *V. trinervia*	10	01	04	-
3. *V. dalzelliana*	04	-	07	-
4. *V. radiata* var. *sublobata*	01	-	01	-
5. *V. aridicola*	08	05	13	-
6. *V. stipulacea*	14	-	05	-
7. *V. marina*	05	-	09	-
8. *V. adenantha*	01	01		
9. *V. grahamiana*	-	01		

Distribution of *Vigna* Species – Districts Map Layer

Distribution of *Vigna* species by LS

Distribution of *Vigna species* by PD,LS and FS

ECO-GEOGRAPHIC SURVEY OF *MUSA* SPECIES IN SRI LANKA

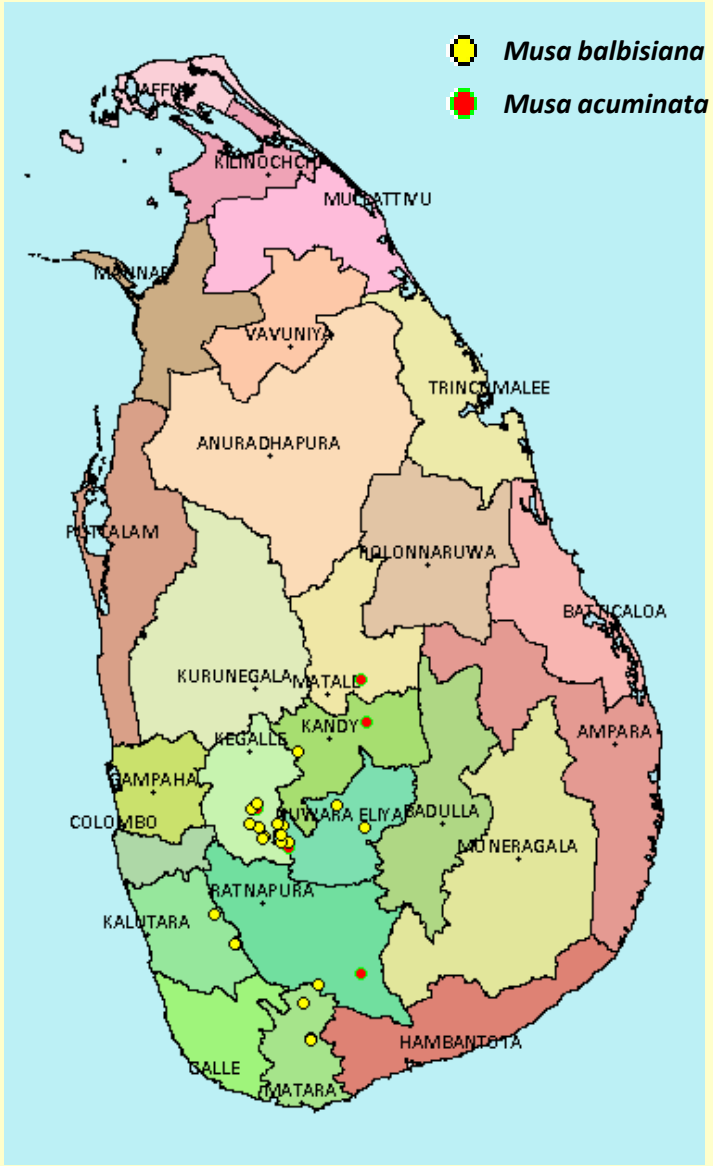
Two diploid wild species of *Musa* - AA and BB genomic groups.
M. acuminata (AA- genome and locally known as "Unel" or "Una-Khehel")
M. balbisiana (BB-genome- locally known as "Ati-Khehel")
The edible bananas originated from these two wild species.

GPS locations of *Musa* from different sources

Species name	No. Of Location By field visits	No. Of location from herbarium	No. Of location from passport data	No. Of location from Literature
Musa acuminata	8	-	-	1
Musa balbisiana	25	-	-	2

A total of 36 wild *Musa* locations were found by Eco-Geographic survey.

Distribution of *Musa* Species – Districts Map Layer



Distribution of *Musa species* by FS

ECO-GEOGRAPHIC SURVEY OF *PIPER* SPECIES IN SRI LANKA

Family -Piperaceae - 2000 species of shrubs, herbs and lianas

Genus - *piper* - 11 indigenous
- 7 introduced

P.nigrum (black pepper), *P.betle* (betel) and *P.longum* (Thippili) - economically important species in Sri Lanka

P.nigrum and *P.betle* - largely cultivated for domestic consumptions and for export market

Flora of Ceylon - Two cultivated species and eight wild species

No of Locations of genus *Piper* from different sources

Species Name	Literature Data	Field Survey Data	Total
Piper argyrophylum	15	00	**15**
Piper chawya	02	03	**05**
Piper hymenophylum	02	00	**02**
Piper longum	04	30	**34**
Piper nigrum	00	13	**13**
Piper siriboa	07	07	**14**
Piper sylvestre	39	67	**106**
Piper trineuron	08	11	**19**
Piper zeylanicum	23	44	**67**
Piper spp.	00	65	**65**
Total	**100**	**240**	**340**

Distribution of *Piper* Species – Districts Map Layer

Passport and Literature Data

PD,LS & FS

Eco-geographic survey of *Cinnamomum* species in Sri Lanka

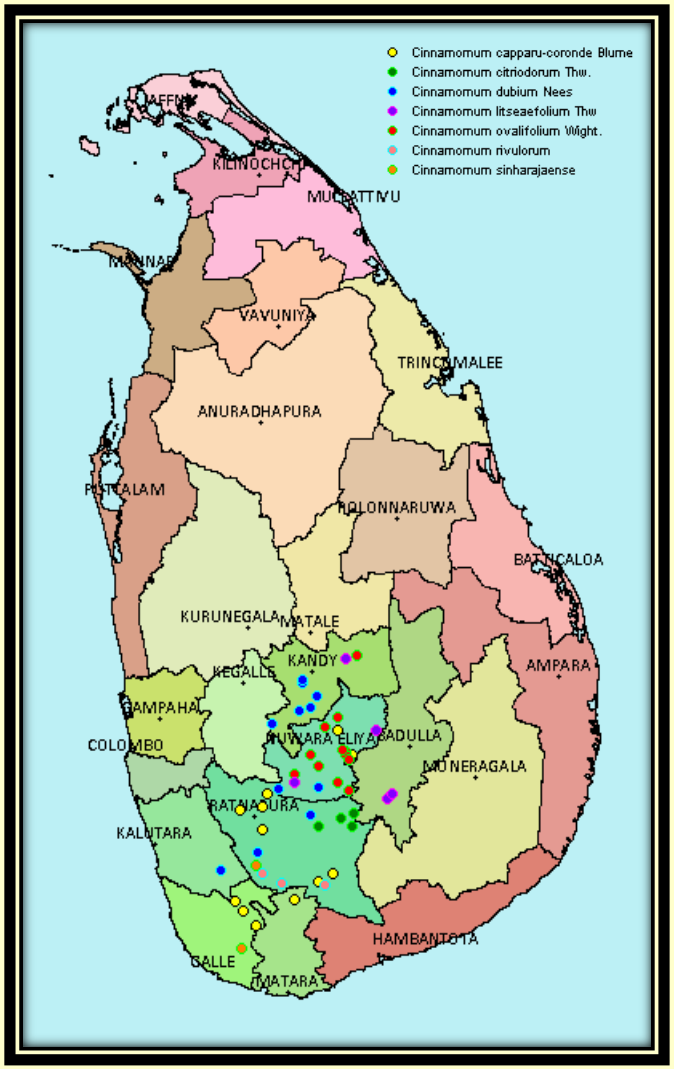
Cinnamomum - large genus - over 300 species - distributed in tropical and subtropical regions of North America, Central America, South America, Asia, Oceania and Australasia.

Sri Lanka - nine *Cinnamomum* species

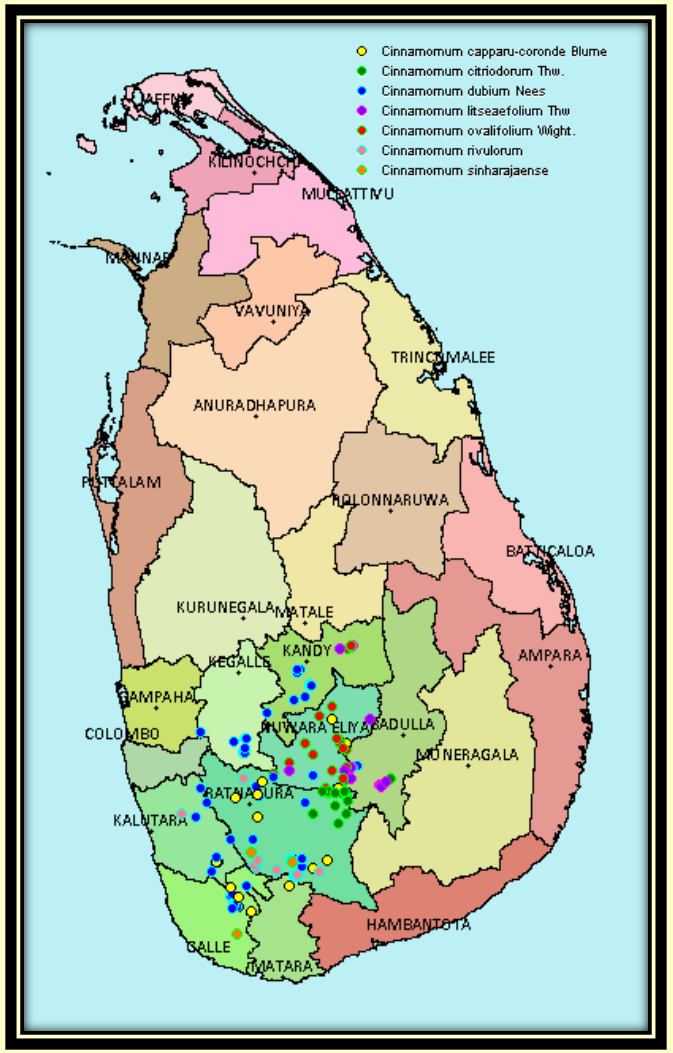
NO. Of GPS Locations - *Cinnamomum* and other related genera

Species Name	Literature Data	Passport Data	Survey Data
Cinnamomum capparu -coronde	23	00	14
Cinnamomum citriodorum	08	00	16
Cinnamomum dubium	15	00	51
Cinnamomum litseaefolium	05	00	09
Cinnamomum ovalifolium	30	00	22
Cinnamomum revulorum	03	00	13
Cinnamomum sinharajaense	05	00	03
Cinnamomum verum	00	00	15
Cinnamomum spp.	00	00	34
Litsea glutinosa	00	00	01
Neolitsea spp.	00	00	03
Celtis cinnamomea	00	00	01
Total	**89**	**00**	**182**

Distribution of *Cinnamomum* Species – Districts Map Layer



Distribution of *Cinnamomum* species in Sri Lanka based on literature data



Distribution of *Cinnamomum* species in Sri Lanka based on field data

ECO-GEOGRAPHIC DESCRIPTORS

- ***O. nivara* Sharma & Shastry, Ind. J. Genet. Plant Breed.25:161 (1965)**
- **Reference to a published description**: Sharma, S.D. and S.V.S. Shastry, 1965. Taxonomic studies in genus *Oryza* L. III.*O. rufipogon* Griff.sensu stricto and *O.nivara* Sharma et Shastry nom.nov. Indian J.Genet. 25:157-167
- **Vernacular names**: Wal wee, Uru wee (S), Pandi Nelli (T)
- **Habit and lifespan**: Semi erect to erect, Some times decumbent, annual.
- **Flower color**: Anthers cream, Stigma purple
- **Habitat**: Swampy areas, edge of the ponds and tanks and beside streams or occasionally in the middle of the streams. In shallow water or periodically flooded areas. Usually sunny areas.
- **Associated species**: *Hygrophila spinosa* (Neeramulliya – S)
- **Altitude**: 0 m to 290 m
- **Distribution**: Mainly in low country dry zone, and intermediate zone, very common in North Central Province
- **Phenology:** December to July
- **Uses**: One collection from Faizabad, India was found to be the only known source of resistance to
- the Grassy stunt virus. Some collected accessions in Sri Lanka also reported resistant to different biotypes of brown plant hoppers. There are some accessions in IRGC resistant to green leaf hopper, zigzag plant hopper, white backed plant hopper and biotypes of BPH. Sometimes seeds are collected for food.
- **Taxon vulnerability**: Less
- **Conservation Notes**: Ex-situ collection is representing samples collected from populations in agro ecological zones of DL1, DL5, IL3, IL2 and IM1. These accessions are conserved at field gene bank and seed gene bank of the PGRC. Rice Research Development Institute, Bathalagoda is also maintaining few accessions of *O. nivara* collected from the separate locations.
- Tropical dry mixed evergreen forest, thorn forest, inland wetlands, flood plain, swamp forest streams and rivers and ponds are the *O. nivara* growing eco-systems of Sri Lanka. These eco-systems are existing in different protected areas and as well as out side the protected areas. Ecosystems influenced by humans may be more difficult to manage as in –situ conservation sites than eco-systems existing in protected areas. However, *O. nivara* is occurring in protected areas. Therefore, *O. nivara* is safe under the *in situ* management. Rhunu National Park, Wilpattu National Park, Wasgamuwa National Park, Lahugala National Park and Sigiriya forest are the some protected areas where the *O. nivara* conserved as *in situ*. Also, it is growing inside ancient city of Polonnaruwa. As this species is annual, forest clearing may affect to its survival in nature as compare to other four species occurring in Sri Lanka. However, *O. nivara* is safe in many locations, where it grows with "Katu Ikiriya" (*Asteracantha longifolia*) which has tiny spines (Fig.4). This prevents herbivores from feeding on *O.nivara*.
- **Additional Notes:** Poor tillering to very high tillering. partially to high spikelet fertility, red and straw
- colour lengthy awns were reported.

Important protected areas

Species name	Protected area
O.nivara	Yala NP, Sigiriya forest, Wilpattu NP, Lahugala NP, Wasgamuwa NP
O.rufipogon	Muturajawela
O.eichingeri	Mihinthale Archeological Reserve , Manikdena AR, Wasgamuwa NP, Minneriya NP, Ritigala forest, Galoya NP, Sigiriya forest, Samanala wawa, Udawalawa NP
O.granulata	Sigiriya forest Minneriya NP, Galoya NP
O.rhizomatis	Yala NP, Lahugala NP, Wilpattu NP
V. aridicola	Yala NP, Polonnaruwa archeological site, Galoya NP, Wilpattu NP
V. dalzelliana	No
V. marina	No
V. radiata Var sublobata	No
V. stipulacea	Yala NP
V. trilobata	Yala NP, Wilpattu NP
V. trinervia	No
M.acuminata	Knuckles range
M. balbisiana	Sinharaja, Laxapana PH
P. longum	Waulpane forest (proposed), Bodinagala Aranniya area
P.chuvya	No
P.siriboa	Waulpane forest (proposed)
P.sylvestre	Waulpane forest, Knuckles range, Pahiyangala area, Thangappuwa, Horton plain, Kanneliya forest, Sinharaja forest, Ritigala, Sripada, Galoya NP, Manikdena Archeological site
P. zeylanicum	Thangappuwa, Sinharaja, Sripada, Kanneliya forest, Metirigala Aranniya, Dunhinda forest
P. trineuron	Kanneliya forest, Sinharaja, Waulpane forest (proposed)
P.walkeri	No
C.capparu-coronde	Kanneliya forest, Sinharaja.
C.citriodorum	Peak wilderness, Corbets gaps
C.dubium	Peak wilderness, Kanneliya, Sinharaja Hantana,Gilimale,
C.litseaefolium	Peak wilderness, Horton plain, Thangappuwa
C.ovalifolium	Black pool, Peak wilderness ,Thangappuwa, Horton plain, Sri Pada
C.rivulorum	Sinharaja forest
C.sinharajaense	Sinharaja forest

IMPORTANT LOCATIONS FOR CWR (OUT SIDE THE PROTECTED AREAS)

1. **Maradankadawela- Habarana rd.7km post-** ***O.rhizomatis***- morphologically plant show both *O.rhizomatis* and *O.eichingeri* characteristic. But, at the molecular level this population is more similar to *O.eichingeri*
2. **Kalugala forest, Palinda Nuwara- 2km east from Kalugala Aranniya- Baduraliya- Kalutara district -** ***C. capparu coronde* -** most typical plant
3. **Thumbathanna- Hale –Balangoda -*C. Citriodorum*** –large populations –but under threat due to forest clearness for housing scheme
4. **Waulpane forest** – Six priority species are present – ***O. granulata, O. eichingeri, P. sylvestre, P. chuvya, P. zeylanicum, P.longum***
5. **Welpallewela, east of Mahiyanganaya-Badulla dist. *V. radiata* var *sublobata*-** only confirmed location
6. **Pottuvil, Talawila** (Typical Population.) ***V. trilobata***
7. **Near mountain at Hakgala BG, *V. trinervia***
8. **Kiribathkumbura, Kandy dist**. ***V. trinervia***
9. **Polonnaruwa sacred area – *O.nivara* and *V.aridicola***
10. **89 Km. post Mahiyanganaya - Ampara rd**.-Type specimen- ***V.aridicola***
11. **Magma- Tissamahramaya** (Mixtures of distinctive plants in a population), ***V. stipulacea***
12. **Kalutara-Payagala - *V. marina***
13. **Kalupahna, Puhulpola**, - very few populations present in the country and no any population is found so far in protected areas. Immediate action should be taken to protect these populations -***V. dalzelliana***
14. **Knuckle region - *M. acuminata***
15. **Yatiyantota- *M. acuminata***
16. **Kurulugala division-Sinharaja estate - *M. balbisiana***
17. **Bolgoda river bank, Kalutara - *O. rufipogon***
18. **Battarmulla – Colombo** - ***O. rufipogon***
19. **Muthurajawela-Ja-ala- *O. rufipogon***
20. **Kurulugala división - Sinharaja estate -*C. rivulorum***
21. **Madolkale estae – Kandy district- *P. hymenophyllum***

Eco-Systems & Species richness of CWR

Ecosystem	Provisional extent (ha)	Crop wild relatives
Forest and related ecosystems		
Tropical wet lowland evergreen forest (lowland rain forest)	141,506	Wild banana, Cinnamon spp .
Tropical moist evergreen forest	243,886	Wild banana, Cinnamon spp
Tropical dry mixed evergreen forest	1,090,981	*O.eichinegeri,O.granulata, O.rhizomatis,O.nivara*
Tropical thorn forest	na	*Vigna* species
Savannah	na	
Riverine forest	22,435	
Tropical sub montane forest	68,616	*Piper* spp,. *Cinnamomum* spp,. *Musa* spp.
Tropical montane forest	3,108	*Vigna* species, *Piper* species
Grasslands	na	*Vigna* species
Inland wetland ecosystems	na	*O.nivara*
- flood plains	na	*O.rufipogon,*
- swamps	5,913,800	*O. eichingeri*
- streams and rivers	179,790	*Hygroryza*
- reservoirs and ponds	na	*Vigna* species
- wet villu grasslands	na	*Piper* species
- wet montane grasslands wet patanas		
Coastal and marine ecosystems		
- mangrove habitats	12,500	*O.rufipogon*
- salt marshes	23,819	*Vigna* species
- sand dunes and beaches	19,394	*Vigna* species
- mud flats	9,754	
- sea grass beds	na	
- lagoons and basin estuaries	158,017	
- coral reefs	na	
- coastal seas	na	
Agricultural ecosystems	491,129	*O.rufipogon, Vigna species*
- paddy land	97,000	*Piper* species
- fruit cultivations	128,000	*Piper* species
- small crop holdings or other field crops (pulses , sesame etc)		*Piper* species, *Musa* species, *Cinnamomum* species
- crop plantations	772,000	*Piper* species, *Cinnamomum* species,
- home gardens (cultivated)		*Vigna* species
- chena lands (slash and burn cultivation)	367,800	
	na	

na - Not available
* Sinhala name

Existing and Potential threats

Species	Existing and Potential threats
Cinnamon spp.	Harvesting for commercial use and medicine ,Extraction from wild - flood tolerant types are removing from the habitats in Kalutara district
C. capparu coronde	Single or few plants in a population
O.rufipogon	All populations in unprotected and urban areas Development schemes in Muthurajawela and Battaramulla
V. dalzelliana, V. radiata var. sublobata P.walkeri, P.hymenophyllum	Reduction of suitable habitats, Very few locations(Rear)
Vigna spp.	Decreased populations in YNP- Natural disasters- Tsunami
O.rhizomatis.	Reduction of number of populations in Wanathwilluwa Puttalam dist -Decreased rainfall - dryness to long periodFires -populations at Maradankadawala-Habarana rd. and Tabbowa area
V. trinervia and *V. dalzelliana*	lost of habit at NuwaraEliya- Gumpola road, Manmade- Habitats fragmentation
O.nivara	population in Situlpauwa - Forest and water body clearance
V. dalzelliana	Landslides of population at Puhulpola
Vigna marina	Inundation by seawater

Endanger CWR species

Species	Causes
O. granulata	few locations
C. citriodorum	few locations, low plant density
C. sinharajaense	limited distribution, few plants
C.capparu-coronde	few plants, unprotected areas
V. dalzelliana	Few locations- unprotected areas- limited distribution
V. grahamiana	not found
V. adenantha	not found
P. hymenophyllum	not found
P. walkeri	one location
M. acuminata	decreasing no. of populations
M. balbisiana	decreasing no. of populations

Results used

- To prepared an inventory of priority CWR
- To televised a documentary film of CWR
- To developed participatory habitat conservation program
- To launch an in-situ conservation program of wild Rice
- To study the protection of wild banana and wild pepper species in plantation areas
- Red listing of CWR species
- To study the accuracy of using prediction maps in eco-geographic survey

CONSTRAINS FOR SURVEYS

- **Inaccessibility to some areas in the north and eastern provinces** -Present genetic and ecological diversity of these areas are not well known
- **least priority is given to survey activities**
- **lack of transportation facilities,**
- **lack of trained staff such as taxonomist,**
- **insufficient funding**
- **difficulty in getting permission to enter the protected areas from the relevant authorities.**

Technical difficulties

- **Season -** Some species of crop wild relatives are annual and seasonal.- Funds not available in correct perioed
- **Single or Few plants in a population** - Intra population variation cannot be obtained
- **Preparation of herbarium specimens** - Different species of CWR are having different flowering times. -several visits
- **Distribution in Specific areas**.- some species were distributed in very specific regions or areas.
- **Unavailability of past survey information** - gaps are not clear and one should have to do entire survey of a given species.
- **Incorrectly identified and old herbarium specimens**
- **Weak Satellite Signal** - difficult to receive satellite signal inside the forest
- **Lack of awareness** - managers in protected areas / authorities
- **Identification of threatened factors** - Within a short period, it is difficult to identify threatened factors to wild populations.
- **Preparation of maps** - GPS coordinates were unable to plot on provided SL survey department digital maps

Publications

1. **Eco-geographic survey of wild species of Vigna in Sri Lanka** – A.S.U. Liyanage, W.M.D. Wasala, D.K. Edirisinghe, A. Wijesekera-Eleventh annual symposium proceedings Part 1. International Forestry and Enviornment Symposium 2006,Department of forestry and Environmental Science, University of Sri Jayawardenepura, Sri Lanka
2. **Use of Prediction maps for Survey, exploration and collection of wild species**- A.S.U. Liyanage, W.M.D. Wasala – Thirteenth annual symposium proceedings Part 1. International Forestry and Enviornment Symposium 2008,Department of forestry and Environmental Science, University of Sri Jayawardenepura, Sri Lanka
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