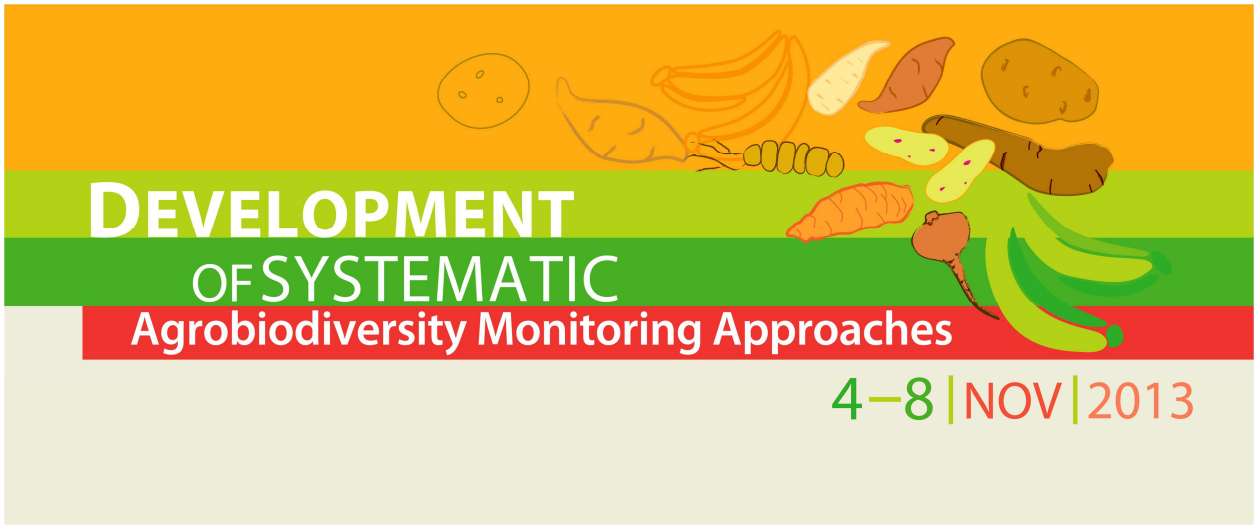

Compendium of *in-situ* monitoring methods for Agrobiodiversity

Compiled by

Severin Polreich (CIP) and Mary Thompson (Bioversity International)

Table of Contents

1. Monitoring Methods

1.1. Genetic Level

1.1.1. Crops

i Molecular Diversity and Population Genetics of Landraces in Diversity Hotspots

Stef de Haan, Severin Polreich, Marc Ghislain, Merideth Bonierbale, Flor Rodriguez

International Potato Center (CIP)

Purpose

The monitoring activities are conducted by Scientists in close collaboration with local stakeholder such as NGO's and communities. The main purpose is to fingerprint multiple household collections (thousands of accessions at the hotspot level for potato) for a representative sampling covering at least 90% of landraces.

The method is mainly applied for a baseline inventory and to document the population structure and allele frequencies in benchmark sites. Target crop: Potato (*Solanum spp.*).

Metrics used

Quantitative metrics

- Allelic diversity
- Allele frequencies
- AMOVA (to compare populations)
- Fixation Index (FST)
- No. unique genotypes (based on similarity analysis)

These metrics have been chosen because the SSR marker kit used for potato is robust and replicable. Most NARI in the crop's center of origin have access to the primers and the ability to apply them.

Additional metrics

Genetic fingerprints for profiling landraces (used for cataloging landrace diversity)

Duration of the method application:

Up to three years.

Approximate costs:
Field sampling: US$ 5,000 / year
Fingerprinting: US$ 20,000 / year (1500 samples)
Data analysis US$ 8,000 / year
TOTAL: approximately US$ 33,000 (per hotspot / year) *

**the real cost depends on the level of landrace diversity encountered in the hotspot and service costs of running SSR nuclear markers*

Sponsors:
Donor organizations (e.g. Government of Spain, CRP-RTB)

Application of the method:
The method is currently applied to fingerprint >90% of all the landraces present in approximately 10 hotspots (benchmark sites) covering the distribution range of potato species and landrace diversity (Central Chile to Northern Colombia).

Replicability rate: 3 (high)
*Strength*s: Methods are well established and without the need to ship DNA NARI can use and apply SSR marker kits need to generate the raw data for each hotspot. Comparability using a standard SSR marker kit is favorable as long as a uniform platform is used (e.g. Li-cor).

Constrains: Different platforms are used which can make comparison difficult among these difficult (Li-cor versus Abi for SSRs)
Relatively high costs to do extensive fingerprinting of a representative sample of landraces from a particular diversity hotspot

Information on community involvement
The communities where this method was applied had a long term relationship with either CIP or the local counterparts (NGO, NARI).

Activities conducted by the community
Planting household collections for characterization and fingerprinting

Focus on particular social group:
Basically work was / is conducted with farmer groups or individual households from diversity hotspots that are known to have particularly rich or representative landrace collections.

Data access and dissemination

An *in-situ* database for accessions from each hotspot is created and used as reference baseline data for time-series comparison (either based on multi-year sampling or comparison on in- versus *ex-situ* collections from a common geographical origin). Currently the database is maintained in-house at CIP, but soon it will be made accessible in line with the CG policies on intellectual assets. Some datasets from specific hotspots are already publically accessible.

Additional comments:

This method seems very basic for monitoring at the molecular / genetic level

Key references to the methods:

De Haan, S., Nuñez, J., Bonierbale, M. and Ghislain, M. (2010). Multilevel Agrobiodiversity and Conservation of Andean Potatoes in Central Peru: species, morphological, genetic and spatial diversity. Mountain Research and Development 30(3):222-231. http://www.bioone.org/doi/pdf/10.1659/MRD-JOURNAL-D-10-00020.1

De Haan, S., Nuñez, J., Bonierbale, M., Ghislain, M. and Van der Maesen, J. (2013). A Simple Sequence Repeat (SSR) Marker Comparison of a large *In-* and *Ex-situ* Potato Landrace Cultivar Collection from Peru Reaffirms the Complementary Nature of both Conservation Strategies. Diversity 5:505-521. http://www.mdpi.com/1424-2818/5/3/505

Contact for further information	
First name, Last name	Stef de Haan, Severin Polreich
Affiliation	International Potato Center (CIP)
List Area(s) of Expertise:	Genetic Resources, *In-situ* Conservation
Phone number	00-51-1-3496017
Email address	s.dehaan@cgiar.org / s.polreich@cgiar.org

ii Geographical Distribution of Allelic Diversity (DAD)

Lebot, V., Ivancic A. and K. Abraham

CIRAD, CTCRI, University of Maribor

Purpose
The monitoring activities are conducted by Scientists.

The method is mainly applied to monitor genetic diversity: population structure and allele frequencies. Target crop: *Colocasia esculenta*

Metrics used

Quantitative and qualitative metrics

- 30 scientists participating to the international edible aroids network
- 160 villages benefiting from the project germplasm distribution
- NARS counts conducted in farmers' fields
- 1000 samples analyzed at the DNA level
- 140 cultivars analyzed for their tolerance
- 1100 samples analyzed for their chemical analysis
- 300 samples virus indexed

These metrics have been chosen because they had been successfully tested in former projects (FFEM) see key references.

Additional metrics
N.A.

Duration of the method application:
Up to 5 years

Approximate costs:
N.A.

Sponsors:
FFEM and EU

Application of the method:
The method is now being implemented and monitored by INEA, see www.EdibleAroids.org

Replicability rate: 3 (high)
Strengths: The method can be easily combined with on-farm evaluation of varieties.

Constrains: Reliable, fully committed NARS staff at the field level.

Information on community involvement
Local communities were contacted directly by NARS.

Activities conducted by the community
Participatory evaluation

Focus on particular social group:
Women

Data access and dissemination
Annual reports

Additional comments:
N.A.

Key references to the methods:

Camus, P. and V. Lebot. 2010. On-farm assessment of clonal introduction of root crops diversity in Vanuatu, Melanesia. Experimental Agriculture, 46 (4): 541–559.

Sardos, J, Noyer JL., Malapa, R., Bouchet, S. and V. Lebot. 2012. Genetic diversity of taro (Colocasia esculenta (L.) Schott) in Vanuatu (Oceania): An appraisal of the Distribution of Allelic Diversity (DAD) with SSR markers Genetic Resources and Crop Evolution. Vol 59 (5): 805-820.

www.EdibleAroids.org

Contact for further information	
First name, Last name	Vincent Lebot
Affiliation	AGAP, CIRAD
List Area(s) of Expertise:	Genetics and breeding of tropical root crops
Phone number	678 25947
Email address	lebot@vanuatu.com.vu

iii Monitoring *In Situ* Diversity of Native Potato through Comparison with Reference Collections Using Molecular Markers and Morphological Characters

Julio Kalazich, Flor Rodríguez, Sandra Orena, Manuel Muñoz

INIA-Remehue

Purpose

The target potato landrace diversity was reintroduced through INIA to the custodian farmer group "Delicias de Lemuy para el mundo" from Puqueldón, Chiloé. The accessions are characterized by using molecular markers and morphologic descriptors. Custodian farmers continue to cultivate the introduced diversity *in situ*.
INIA- Remehue scientists study this germplasm with the aim of comparing *in-situ* diversity with INIA-Remehue's *ex-situ* collection and the collection at the Agricultural and Livestock Service of Chile (SAG) to establish a unique national collection of potato landraces.

The method is mainly applied for a baseline inventory. Target crop: *Solanum tuberosum ssp tuberosum*

Metrics used

Quantitative and qualitative metrics

- Presence / absence of alleles corresponding to microsatellite markers
- Polymorphism among accessions, genetic distance.
- Botanical descriptors such as plant type, phenological cycle length, thickness, pigmentation and number of stems, size, shape and color of leaves, color of flowers, fruit, tuber skin color, tuber flesh color.

These metrics have been chosen because the features are not influenced by the environment (molecular markers). Highly heritable morphological features allow to accurately assessing genetic diversity. Similarly, the majority of them are standard descriptors used to characterize germplasm and can be applied to diversity indices genetic distance etc., resulting in comparable results among different populations.

Additional metrics
N.A.

Duration of the method application:
The project is currently being implemented within the framework of the activities of the General Improvement Program of Potato of Chile, executed by INIA-Remehue

Approximate costs:
N.A.

Sponsors:
N.A.

Application of the method:
DNA profile analysis with microsatellite markers and comparison of morphological descriptors is recently planned to be conducted within the Chirapaq Ñan initiative in together with the farmer women group “Delicias de Lemuy para el mundo”, local development program for small scale farmers of Puqueldón, Lemuy Island, Chiloe (called Prodesal), Institute of Agricultural Research (INIA), Universidad Austral de Chile, CET (Center for Technological Studies) Potato Consortium Chile, and CONICYT. INIA has the responsibility to characterize landraces and link national genebanks. It is expected to homologate the Chilean potato collection with the collections at CIP and at the Vavilov Institute.

Replicability rate: 3 (high)
*Strength*s: comparison between collections from different origins or between populations will be possible and facilitates the future use of genetic resources, for example in the establishment of core collections for different breeding purposes.

Constrains: Relatively expensive, specialized equipment and personnel is required to perform molecular analyses. Morphological assessment might be biased by subjective perception, when qualitative indicators are applied.

Information on community involvement
Contact between INIA-Remehue and the community of Puqueldón started developing after extensive participation of INIA researchers in local projects and technology transfer groups that generated opportunities for collaboration. Additionally, the municipalities of Lemuy Island, Chiloe participate actively through Prodesal.

Activities conducted by the community
Maintenance, multiplication and evaluation of germplasm.

Focus on particular social group:
Farmers from Lemuy Island, Puqueldón, beneficiaries of the projects coordinated by the local Prodesal.

Data access and dissemination
The generated information is managed accordingly protocols of INIA, including newsletters, informative seminars and publications and online tools like Facebook. The collection and processing of specific information is still ongoing.

Additional comments:

The germplasm which is managed by “Delicias de Lemuy para el mundo” of Puqueldón corresponds to material that was formerly collected by the Universidad Austral de Chile in Puqueldon and reintroduced after the material *in situ* got lost.

Key references to the methods:

N.A.

Contact for further information	
First name, Last name	Manuel Muñoz David
Affiliation	Genetic Improvement Program of Potato at INIA-Remehue
List Area(s) of Expertise:	Molecular Breeding
Phone number	56-64-2-334815
Email address	manuel.munozd@inia.cl

1.1.2. CWR

i Molecular Wild Yam Genetic Diversity Monitoring

Hâna Chaïr and collaborators

Cirad

Purpose
Determine the genetic structure, analyze genetic dynamics in wild yam populations and identify threats and impact factors of diversity. The activities were conducted principally by scientist, community collaborated in sampling procedure.

Target species: *Dioscorea praehensilis* (wild yam relative of cultivated yam *Dioscorea rotundata*).

Metrics used

Quantitative metrics
- Five forests under different management strategies.
- Two bioclimatic zones
- 178 accessions genotyped

These metrics have been chosen because for the country targeted, they were the most representatives to analyze occurrence of *D. praehensilis.*

Additional metrics
N.A.

Duration of the method application:
Two years

Approximate costs:
The total funding was 28 000€.

Sponsors:
BRG (Bureau des Ressources génétiques) French funding organization.

Application of the method:
The project ended on 2010

Replicability rate: 3 (high)
Strengths: The use of genetic population approach is the most accurate in this case.
Constrains: Budget

Information on community involvement
Local communities were contacted by researchers from NARS collaborating to the project.

Activities conducted by the community
Give the permission for leaf sampling in their holy forest.
Participate in leaf sampling for genetic studies.
Provide information on forests management.

Focus on particular social group:
Local authorities in charge of forest management
Policy-makers.

Data access and dissemination
All outputs were given to NARS for local dissemination

Additional comments:
Analysis at landscape level is important, due to the prediction of potential habitat for target species.

Key references to the methods:

Molecular Ecology 20: 1612-1623, 2011.

Contact for further information	
First name, Last name	Hâna Chaïr
Affiliation	AGAP, Cirad
List Area(s) of Expertise:	Genetic diversity of root and tuber crops.
Phone number	00 33 4 67 61 55 48
Email address	hana.chair@cirad.fr

1.1.3. Not specific

i Participatory Long-Term Diversity Assessment in two Indigenous Communities of Brazil

Fábio Freitas

Embrapa

Purpose
The monitoring activities focused on current status, migratory and evolutionary process of agrobiodiversity and determine the long-term effects of impact factors. The monitoring was carried out by scientist

Target crop: *Arachis hypogea; Manihot esculenta; Cariocar brasiliense. Discorea*;

Metrics used

Quantitative and qualitative metrics

- Morphological and genetically differences
- Traditional knowledge

These metrics were necessary to raise the required information and data.

Additional metrics
N.A.

Duration of the method application:
Started 2004 and finished in 2013

Approximate costs:
US$ 40,000 / year

Sponsors:
Governmental Institutions, like EMBRAPA and part of the funds from the Italian government

Application of the method:
The project has ended, but the results will be used for a new study, including other objectives.

Replicability rate: 2 (medium)
Strengths: Comparability using standard genetic markers.
Constrains: legislation periods, human and cultural dynamics.

Information on community involvement
Personal contact to the community to carry out this study.

Activities conducted by the community
N.A.

Focus on particular social group:
Two indigenous communities in Brazil.

Data access and dissemination
The data were strictly treated accordingly the national laws for knowledge management.

Additional comments:
N.A.

Key references to the methods:

N.A.

Contact for further information	
First name, Last name	Fábio Freitas
Affiliation	Embrapa
List Area(s) of Expertise:	On farm conservation and Ethnobiology
Phone number	55-61-34484617
Email address	fabio.freitas@embrapa.br

1.2. Varietal/Species Level

1.2.1. Crops

i Landrace Catalogues and Database by Hotspot

Stef de Haan (coordinator), custodian farmers in Huancavelica (Central Peru), Cecilia Monteros, Fausto Yumisaca, Jorge Andrade-Piedra and Ivan Reinoso R., custodian farmers in Central-North Ecuador.

CIP, INIAP, also other institutions like PROINPA

Purpose

Participatory characterization trials are established together with custodians under on-farm conditions. Morphological characterization, evaluation of agronomic traits and photo-documentation is carried out by field assistants; genetic / molecular analysis is conducted by scientists. Information on utilization, cultural and etymological significance is provided by local farmers.

The method is mainly applied for a baseline inventory, to document the genetic diversity and local knowledge of potato landraces. Target crop: Potato / *Solanum spp*.

Metrics used

Quantitative and qualitative metrics

- No. of unique landraces / hotspot
- Fingerprints per landrace- microsatellite markers (SSR),
- Ploidy level
- Morphologic descriptors
- Plant photographs
- Nomenclature
- Uses

These metrics have been chosen because they provide a more or less complete picture of the landrace and species diversity present in pre-defined hotpots

Additional metrics

Agronomic information, such as yield (kg per plant), tuber per plant, stress tolerance, culinary uses. This information is important for farmers and consumers.

Duration of the method application:

Generally it takes about three 3 years to do a good baseline catalogue from a specific diversity hotspot.

Approximate costs:
Field work US$ 15,000
Fingerprinting US$ 10,000
Flow cytometry US$ 8,000
Editing US$ 5,000
Publication US$ 15,000
TOTAL: approximately US$ 53,000 (per hotspot)
**the real cost depends on the level of landrace diversity encountered in the hotspot and service costs of running SSR nuclear markers*

Sponsors:
Within CIPs *in-situ* conservation approach for potato, the landrace inventory is funded by projects (Papa Andina, CRP-RTB).

Application of the method:
The baseline documentation provides reference information for long-term monitoring. It indicates which landraces have been encountered in specific communities and the current characteristics of the genepool surveyed.

Replicability rate: 3 (high)
*Strength*s: Illustrative results and established descriptors give clear guidelines how to achieve desired results. The methods applied are standardized and do not require complicated analyses.
Constrains: Photographs and morphologic characterization require trained staff *in situ*.

Information on community involvement
Together with national experts potential diversity centers were identified and local organizations contacted. Together with local contacts, farming communities were approached and farmers with reputation as experienced custodians were visited and interviewed. After explaining objectives and future activities and procedures to local authorities, they were asked whether the community would participate. The approach was presented additionally at official community assemblies. It was decided whether participatory field trials was managed by single farmers or farmer groups. Responsibilities and roles of each partner were settled. The next steps consisted in determination of appropriate locations for the field trials. During harvest, local partners visited identified custodians and selected planting material, registering local names and assigning an accession number. The seed material was stored in farmers' own storages, labeled and in separate net bags.

Activities conducted by the community
On-farm management of germplasm, focus group and individual household interviews, seed fairs, workshops and trainings. Also, in publications as co-authors and through previous informed consent at household, community and federation level.

Focus on particular social group:
It was important that, both, women and men participated. The activities were focused mainly on custodian farmers, who have long-term experience in cultivating potato landraces

Data access and dissemination
The inventory is published as hard copy catalogue but also online. All data will be published by indicating the source and it is important that any information provided by communities underlies prior consents.

Additional comments:
Baseline cataloguing seems and essential step for monitoring at the landrace and species level.

Key references to the methods:

CIP (2009). Catálogo de variedades de papa nativa de Huancavelica - Perú. International Potato Center (CIP), Federación de Comunidades Campesinas de Huancavelica (FEDECCH). http://cipotato.org/publications/pdf/003524.pdf

Cecilia Monteros, Fausto Yumisaca, Jorge Andrade-Piedra and Ivan Reinoso R. (2010). Catalogo: cultivares de papas nativas, sierra centro-norte del Ecuador. Instituto Nacional Autónomo de Investigaciones Agropecuarios (INIAP), International Potato Center (CIP), Quito, Ecuador. http://cipotato.org/region-quito/informacion/inventario-de-tecnologias/catalogo_nativas_Iseccion.pdf

Scurrah, M., De Haan, S. and Winge, T. (2013). Cataloging potato varieties and traditional knowledge from the Andean highlands of Huancavelica, Peru. pp. 65-79. In: R. Anderson and T. Winge (eds.), Realising Farmers' Rights to Crop Genetic Resources: success stories and best practices, EarthScan, Abingdon, UK.

Also see:

BIOANDES (ed.) (2008a) Diversidad de papas en el distrito de Pitumarca, Cusco, ETC Andes, COSUDE, CEPROSI, BIOANDES

BIOANDES (ed.) (2008b) Variedades de papas nativas y conocimientos campesinos: microcuenca Shitamalca, San Marcos, Cajamarca, Cajamarca, ETC Andes, COSUDE, Centro Ideas, BIOANDES. Available at: http://www.etcandes.com.pe/bioandes2/herramientascomunicacion/CATALOGO%20PAPAS%20cajamarca.pdf

Cosio Cuentas, P. (2006) Variabilidad de papas nativas en seis comunidades de Calca y Urubamba – Cusco, Cusco, Asociación Arariwa

Gutiérrez, R. and Valencia, C. (2010) Las Papas Nativas de Canchis, Lima, Intermediate Technology Development Group (ITDG), FONTAGRO

Iriarte, V., Condori, B. Parapo, D. and Acuña, D. (2009) Catálogo etnobotánico de papas nativas del altiplano norte de La Paz – Bolivia, Cochabamba, Fundación PROINPA

Merino, R., Carballo, J., Vargas, F. Ortiz, N., Vargas, P., Rodríguez, E. Ortiz, M., Torrez, V., Carballo, F. and Vargas, D. (2004) Catálogo de las variedades locales de papa y oca en la zona de la Candelaria, Cochabamba, Fundación PROINPA, Lima, Centro Internacional de la Papa (CIP)

Stapleton, P. (2006) 'Tying the genome up in knots', Geneflow p. 51, Rome, Bioversity International

Terrazas, F. and Cadima, X. (2008) Catálogo Etnobotánico de Papas Nativas: tradición y cultura de los ayllus del norte Potosí y Oruro, Cochabamba, Fundación PROINPA

Ugas, R. (ed.) (2008) Pampacorral: catálogo de sus papas nativas, Lima, Universidad Nacional Agraria la Molina (UNALM)

Contact for further information	
First name, Last name	Stef de Haan, Severin Polreich
Affiliation	International Potato Center (CIP)
List Area(s) of Expertise:	Genetic Resources, *In-situ* Conservation
Phone number	00-51-1-3496017
Email address	s.dehaan@cgiar.org / s.polreich@cgiar.org

ii Indicators for Agrobiodiversity-Related Public Good Conservation Services

Adam Drucker and Trang Nguyen

Bioversity International and Wageningen University

Purpose

12 key indicators identified that could constitute a minimum indicator set with which to judge whether the maintenance of ABD is leading to the delivery of the ecosystem services. A combination of different actors would be needed to collected the required data for each of the indicators

The method is mainly applied for baseline inventory, red listing, to provide specific conservation goals beyond mere areas/ population numbers and assess impact factors of ABD. Target crop: N.A. Method still at a generic level of development.

Metrics used

Quantitative and qualitative metrics

Overall twelve 12 key indicators from four different groups are considered (see attachment):

- Area
- Number of farmers
- Knowledge
- Seed
- Overall measure of diversity
- *Ex-situ* measures

These metrics have been chosen based on literature review and focus specifically on agrobiodiversity-related public good ecosystem services (i.e. those related to resilience at the landscape level, future option values and traditional knowledge/cultural practices).

Additional metrics

As per literature review. Many other indicators not specifically agrobiodiversity-related

Duration of the method application:

N.A.

Approximate costs:

N.A.

Sponsors:

N.A.

Application of the method:
N.A., not as monitoring per se but as a proposed list of indicators for monitoring.
Indicator development is on-going and opportunities to apply them in project situations are being sought.

Replicability rate: Potentially high but response to question not currently applicable
Strengths: Indicators may be applied across a wide range of contexts
Constrains: Need to define agrobiodiversity conservation goals and how specific levels of conservation (e.g. area, farmer numbers, etc.) may be related to the associated public good ecosystem services that we wish to secure.

Information on community involvement
N.A. but indicator development based on payment for agrobiodiversity conservation services work carried out in Peru and Bolivia. Communities approached through a competitive tender for threatened quinoa varieties

Activities conducted by the community
Cultivation of threatened quinoa varieties

Focus on particular social group:
No

Data access and dissemination
The inventory is published as hard copy catalogue but also online. All data will be published by indicating the source and it is important that any information provided by communities underlies prior consents.

Additional comments:
Work relates to potential indicator development of relevance to future monitoring of agrobiodiversity conservation goals but is not yet a monitoring method per se and specific levels for each indicator remain to be defined

Key references to the methods:
References in the attached. Complete literature review references provided in full report,

Contact for further information	
First name, Last name	Adam Drucker
Affiliation	Bioversity International
List Area(s) of Expertise:	Economics of Agrobiodiversity Conservation and Use
Phone number	+39 06 6118 391
Email address	a.drucker@cgiar.org

Attachment 1: Proposed list of ADB indicators

Indicator group	Measures found in literature	References	Proposed Indicator number	Proposed indicators for "in situ conservation of agrobiodiversity on-farm and in the wild"	Notes	Services
Area	Area under specific farming or management practices aiming at landscape conservation (traditional agricultural land use practices)	(Piorr, 2003)	1	Cultivation area (relative or absolute) of traditional varieties (including those of neglected and underutilized species) managed under traditional practices	Sthapit's 4 cell analysis use participatory approach to identify what is "large" and "small" cultivation area of certain crops, rather than using pre-set definite number	Option value + Resilience
	Area under management practices potentially supporting biodiversity	(Martin, Henrichs, & Francis, 2012)				
	Areas under cultivation (as percentage of the total regional area for the species)	Negri et al. (2009), Sthapit et al. (2012)				
	Area of low production/high biodiversity (characterized by wild species and/or old varieties)	(Eaton, Windig, Hiemstra, & Veller, 2006)				
Number of farmers	Use of local crops, varieties and animals used in a community	(Bergamini et al., 2013)	2	Number of farmers (differentiated by gender) growing traditional varieties	Gender dimension is considered	Traditional knowledge + Resilience
	Number of breeders (including farmers and households involved in on-farm breeding)/crop)	(Eaton, Windig, Hiemstra, & Veller, 2006)				
	Number of cultivating farmers	Negri et al. (2009), Sthapit et al. (2012)				
	Number of farmers participating in training programmes concerned environmental friendly management practices, landscape conservation, etc.	(Piorr, 2003)	3	Number of participating farmers (differentiated by gender)		

Indicator group	Measures found in literature	References	Indicator number	Proposed indicators for "in situ conservation of agrobiodiversity on-farm and in the wild"	Notes	Services
Knowledge	Cultural traditions practiced by community members including youth	(Bergamini et al., 2013)	4	Existence of documentation of farmers' traditional knowledge of crops and farming practices		Traditional knowledge
	Documentation of traditional ecological knowledge	(Oudenhoven, Mijatovic, & Eyzaguirre, 2011)				
	Description of the cultivars based on IPGRI descriptors (through the farmer)	(Dennis et al., 2012)	5	Key characteristics of traditional varieties recognized by farmers: uses, reasons for use, distinguishing traits		
	Existence of traditional knowledge registers, resource classification systems, and community biodiversity registers, farmer field schools.	(Bergamini et al., 2013)				
Seed	Existence of community seed banks, seed fairs, local markets, formal and informal exchange networks	(Oudenhoven, Mijatovic, & Eyzaguirre, 2011)	6	Frequency of exchange and extension of seed networks		Option value + Resilience
	Maintenance of heirloom seeds	(Cabell & Oelofse, 2012)	7	Percentage of seeds originating from own farm per season		
	Percentage of seeds originating from own farm	(Eaton, Windig, Hiemstra, & Veller, 2006)				
	Percentage of new seed per season.	(FAO, 2002) as in (Buiteveld, 2009)				

Indicator group	Measures found in literature	References	Indicator number	Proposed indicators for "in situ conservation of agrobiodiversity on-farm and in the wild"	Notes	Services
Overall measure of diversity	Number of traditional cultivars or species preferred for distinct uses	(Oudenhoven, Mijatovic, & Eyzaguirre, 2011)	8	Number of traditional cultivars and crop wild relatives		Option value
	Number of varieties per crop by region	(Herzog et al., 2012)				
	Number of crop species in use	(Eaton, Windig, Hiemstra, & Veller, 2006)				
	Percentage of landraces (across all crop species and varieties) per farm	(Herzog et al., 2012)	9	Percentage of landraces (across all crop species and varieties) per farm		
	Number of landraces and crop wild relatives employed per breeding target environment.	(FAO, 2002) as in (Buiteveld, 2009)				
Ex-situ measures	Number of characteristic (low production) varieties stored in gene bank	(Eaton, Windig, Hiemstra, & Veller, 2006)	10	Number of traditional cultivar accessions incorporated and preserved ex-situ in genebank relative to total		
	Number of accessions characterized	(Eaton, Windig, Hiemstra, & Veller, 2006)				

Indicator group	Measures found in literature	References	Indicator number	Proposed indicators for "in situ conservation of agrobiodiversity on-farm and in the wild"	Notes	Services
Spatial distribution	Diverse agricultural systems: intercropping, agroforestry, silvo-pastoral integrated farming and cultivation systems, polyculture	(Oudenhoven, Mijatovic, & Eyzaguirre, 2011)	11	Number of dissimilar farming communities* maintaining traditional cultivars, in terms of geographic location, physical, environmental and socio-economic features (e.g. altitude, precipitation and temperature, soil quality, access to markets, cultural features, etc.)		Resilience + Knowledge
	Geographical diffusion of knowledge (exchanges between different communities)	(Oudenhoven, Mijatovic, & Eyzaguirre, 2011)	12	Institutions and connections between farming communities that facilitate the diffusion of knowledge and seed exchange		
	Seed exchange networks, local markets and animal and seed fairs regularly operating within and between communities across different cultures and landscapes	(Bergamini et al., 2013)				

* More research is needed to confirm the hypothesis that not only compositional heterogeneity (number of landscape components, number of agricultural systems) in agricultural landscape matters, but also configurational heterogeneity (spatial distribution, patterning or arrangement of the components) matters for agrobiodiversity. Evidence on this heterogeity has mostly referred to wild biodiversity, or plant species richness, other than on infra-specific diversity in managed agricultural landscape as a socio-ecological system

iii Five Cell Analysis Method

Sthapit, B.R., Ram Rana, A., Subedi, S., Gyawali, S., Bajracharaya, J., Chaudhary, P., Joshi, B.K., Sthapit, S., Joshi, B.K. & Upadhyay, M.P.

LIBIRD (Nepal)and Bioversity International

Purpose

This is an evolution of the Four Cell Method which has been used by LIBIRD/Bioversity/other NARS in south Asia since 1996. Modification which took place in 2011 consisted in the inclusion of a fifth cell (Red List Species) to the existing four. The method is carried out by the community members themselves prior modest training on method done by practitioners.

The method is mainly applied for baseline inventory, red listing, monitoring of factors impacting conservation, and documentation of collective knowledge associated to the species / landraces. Target crop: The method is NOT crop specific and it can be applied to all species. It is being currently tested out on underutilized crops such as finger millet (*Eleusine coracana*), Italian millet (*Setaria italica*), *Chenopodium quinoa* (quinoa), *Chenopodium pallidicaule* (cañihua) and *Amaranthus caudatus* (amaranth).

Metrics used

Quantitative and qualitative metrics

- Number of varieties grown;
- App. size of cultivated field where target crop is being cultivated (small vs. large areas- threshold between these two groups is to be identified by community members based on type of crops- f.i. in Nepal this was 0.2 ha);
- App. number of households growing target crop in focus area (few vs. many - threshold between these two groups is to be identified by community members based on type of crops- f.i. in Nepal this was 5 households);
- Name of varieties lost; With regard to the size of the area (large or small).

These metrics have been chosen In order to develop a flexible approach that would best suit the need for monitoring cultivated species (having in mind 3 main points: 1) flexibility and dynamic of target system; 2) simple and practical approach; 3) involving least amount of time by people)

Additional metrics

The inclusion of number of lost varieties to the four cell approach was added in order to test out participatory monitoring of genetic erosion/ loss of varieties.

Duration of the method application:
The project will be ending in early 2015. However we aim at making the process self-sustainable through its institutionalization by national research agencies.

Approximate costs:
Overall costs are difficult to assess. We are still testing out validation methods across region/ national level which might be more onerous that the community-based actions.

Sponsors:
N.A., as not monitoring per se but a proposed list of indicators for monitoring.

Application of the method:
The method is an ongoing effort.

Replicability rate: 3 (high)
Strengths: Its simplicity.
Constrains: Its limitation is represented by the focus on pilot sites- validation beyond target sites need to be further tested out.

Information on community involvement
Communities were already part of ongoing rural livelihood projects

Activities conducted by the community
Participatory assessment of frequency/ rarity of crops during group sessions; maintenance of CBR.

Focus on particular social group:
No, but participation of women was essential.

Data access and dissemination
Data are being shared within the Project- All data included in CBR data are being shared in accordance to community's decision.

Additional comments:
This monitoring approach for cultivated species is based on a totally different paradigm from that used for the monitoring of wild species. First, it is important to clearly distinguish between cultivated and wild species. For wild species, it is the taxonomic identity of a species that is the unit being monitored. In the case of cultivated species, the monitoring unit is the variety, often the local variety or landrace of a crop, which by virtue of the location where it evolved has unique and distinctive characteristics compared with other varieties of the same crop elsewhere. This in itself is a big challenge for developing a monitoring system. The ultimate objective of monitoring cultivated species is to secure their effective use by people so as to sustainably meet their livelihood needs, as well as to prevent genetic erosion in order to ensure future options for the diversity present in

locally cultivated varieties. This objective is thus quite different from that pursued through the IUCN Red Listing approach for wild species, where attention is directed towards the conservation of the species itself. Our central argument is that when dealing with the monitoring of cultivated species we should aim at surveying and inventorying the local varieties of cultivated species, mapping their distribution, identifying the relevance of their use by people, assessing the maintenance of associated knowledge and traditions associated with them, and documenting extent of use. Possible drops in their use below a certain threshold implies a variety or species no longer providing the expected benefit to the community as a whole, but to just a few of its members, and thus leading to varietal extinction. In such a scenario we are not interested in monitoring the-last-plant-standing or last population of a certain crop or variety, but instead we are aiming at assessing current trends and possible decline in its cultivation over time. This approach would allow to 'raise the red flag' whenever such a decline goes below a certain level where its benefits (nutritional, income generation, etc.) are no longer reaching the community members at large, and are confined to a small number of users. In other words, while the IUCN-driven approach would possibly detect vulnerability or endangerment only when the variety or species has reached a certain population size, this use-driven approach is meant to raise the alarm for intervention at a much earlier stage. In our view, when use of a variety has declined dramatically and its benefits are no longer reaching the local users at large, such a variety in real terms is de facto already lost, and listing it into a Red List for cultivated species would be very helpful to guide its rescuing, promotion and effective use, and in so doing possibly prevent its complete disappearance. The idea behind this approach is to build an initial baseline that can be useful for awareness purposes and for further refining. This approach would serve the purpose of guiding on-farm conservation to maintain uses (and their benefits for the community) alive so as to prevent the decline in the use of species and varieties from affecting people, depriving them of an important livelihood asset. Obviously the outcome from such a monitoring process would also serve conservationists and guide sampling strategies for possible ex situ conservation purposes.

The system should be managed by community members in order to be really effective and sustainable. Community members are the people most familiar with their traditional crops; they are also familiar with the territory where these crops are grown, besides being depositaries of the IK associated with their cultivation, use and valorization. Another reason for involving communities reflects the sheer number of species and varieties of local crops that still exist on-farm: the task of documenting and monitoring such a wealth of biodiversity would be impossible if restricted to experts and researchers.

Key references to the methods:

Padulosi S. and E. Dulloo. 2012. Towards a viable system for monitoring agrobiodiversity on farm: a proposed new approach for red Listing of cultivated plant species. In S. Padulosi, N. Bergamini and T. Lawrence editors. 2012. On farm conservation of neglected and underutilized species: trends and novel approaches to cope with climate change. Proceedings of an international Conference, Frankfurt, 14-16 June 2011. Bioversity International, Rome. Downloadable at http://bit.ly/H7w7Zo.

Sthapit, B.R., Ram Rana, A., Subedi, S., Gyawali, S., Bajracharaya, J., Chaudhary, P., Joshi, B.K., Sthapit, S., Joshi, B.K. & Upadhyay, M.P. 2005. Good Practice 3: Participatory four-cell analysis (FCA) for local crop diversity. pp. 14–17, in: B.R. Sthapit, P.K. Shrestha and M.P. Upadhyay (editors). On-farm management of agricultural biodiversity in Nepal. Good practices. IPGRI, Rome, Italy.

Contact for further information	
First name, Last name	Stefano Padulosi
Affiliation	Bioversity International
List Area(s) of Expertise:	Agronomy, Plant Taxonomy, PGR surveying, collection and documentation, gene bank management, ex situ / in situ conservation, marketing, networking, agricultural development, capacity building, sustainable livelihood approaches, international cooperation.
Phone number	0039-06-6118366
Email address	s.padulosi@cgiar.org

iv Participatory Rural Appraisal

Robert Chambers

Institute of Development Studies, Brighton

Purpose
The monitoring activities are conducted by group of actors including farmers, local communities, extension workers, NGO agents, researchers.

The method is mainly applied for baseline inventory, red listing, monitoring of factors impacting conservation, and documentation of collective knowledge associated to the species / landraces, and local seed systems and seed dissemination. Target crop:. Target crop: *Digitaria exilis*, *Digitaria iburua*, *Lagenaria spp*., *Telfairia occidentalis*, *Citrulus lanatus*, *Cucumeropsis manii*, etc.

Metrics used

Quantitative and qualitative metrics

- Diversity indices: richness, evenness and divergence
- Species have been used in the past but not anymore.

These metrics have been chosen because they allow direct comparison within areas and across time scales.

Additional metrics
The 4-square analysis to identify species at risk or threatened in the production systems. This metric combines the proportion of farmers growing the crop and the proportion of community land planted with the crop species.

Duration of the method application:
Three 3 years

Approximate costs:
N.A.

Sponsors:
Government and Private Sector and other donors.

Application of the method:
Currently the method is not applied but local communities were very much interested in taking part in the activities and provided more easily accurate information. Non-participating villages and farmers were also interested and wished that activities be expanded to their areas.

Replicability rate: 2 (medium)
Strengths: Flexibility, adaptation to local condition.
Constrains: Time and resources needed.

Information on community involvement
Community was approached through development and research agents already engaged with them.

Activities conducted by the community
Focus Group Discussions and key informant interviews on diversity of crops, field experiments, etc.

Focus on particular social group:
No.

Data access and dissemination
Data were collected by field technicians and reports produced. Scientific papers were published to disseminate findings and also approached used to yield the results.

Additional comments:
N.A.

Key references to the methods:

Robert Chambers, 1994. The Origins and Practice of Participatory Rural Appraisal in World Development , Vol. 22. N°7, pp. 953-969.

Contact for further information	
First name, Last name	Raymond, VODOUHE
Affiliation	Bioversity International, West Africa
List Area(s) of Expertise:	Resistance to diseases, adaptation to climate variation (drought, flood, low temperature etc.), seed systems.
Phone number	229 95 71 33 33 or 96 30 03 97
Email address	r.vodouhe@cgiar.org

v Farmer surveys on variety dissemination in Cauca, Colombia

Dominique Dufour, Luis Augusto Becerra

CIAT

Purpose

Together with scientists and field assistants, supported by local farmers, morphological variety characterization has been carried out.

The method is mainly applied for a baseline inventory, to document the genetic diversity and local knowledge of Manihot. Target crop: *Manihot esculenta*

Metrics used

Quantitative and qualitative metrics

- Morphological traits
- Farmer knowledge

These metrics have been chosen because these are the easiest and lowest cost metrics, and funding has not been available for genetic marker work.

Additional metrics

The application of genetic marker technology is desired in order to obtain more precise varietal description, and also to identify genealogy of materials introduced from the CIAT breeding program.

Duration of the method application:

This project has been ongoing for about ten years, beginning with an effort to collect, clean and multiply varieties used by farmers in the north Cauca region of Colombia, including both landrace varieties and hybrids from the CIAT breeding program that have been informally distributed and adopted since more than 20 years ago.

Approximate costs:

Total cost (personnel, travel, operations) over ten years has probably been on the order of $US40,000

Sponsors:

CRP-RTB and CIRAD

Application of the method:

The work is ongoing on a very low level basis. We are looking for funding to support genotyping of all the materials to confirm identification of landraces and parentage of hybrids, and patterns of distribution, as a model that could be applied more broadly.

Replicability rate: 3 (high)

Strengths: We propose use of genetic markers as a tool for tracking varietal change over time, and also for identifying parentage of introduced materials whose identification is not well documented or known. This is a common situation in cassava where varieties are informally distributed by farmers without knowledge of researchers or extension agents, and original identification may be lost.

Constrains: The main constraint is availability of scientist time to do the field work. A secondary constraint is the funding for the molecular analysis in the lab.

Information on community involvement

CIAT has worked with this community of cassava producers for more than 20 years, especially to provide improved varieties, develop sustainable production systems, and support processing technologies. The region is known for the specialty fermented cassava starches, and relies heavily on cassava for their livelihoods.

Activities conducted by the community

Sharing information about their varieties and to provide samples as needed for research.

Focus on particular social group:

Smallholder having from less than one to a few hectares. Women are an important part of the processing.

Data access and dissemination

Data has been managed as internal data sets by the cassava genetics and utilization sections of the CIAT Cassava Program.

Additional comments:

This work has been carried out without any formal funding. When completed, it will provide an excellent model for scaling out to many other cassava growing regions, and also for other species.

Key references to the methods:

It is expected that this work will be published after the next step – the genetic analysis – is performed and analyzed.

Contact for further information	
First name, Last name	Clair Hershey
Affiliation	CIAT
List Area(s) of Expertise:	Genetic Resources, Breeding
Phone number	
Email address	c.hershey@cgiar.org

vi Red Listing of Potato Landraces (Based on five cell analysis)

Merelyn Valdivia-Díaz, Severin Polreich and María de Los Ángeles La Torre-Cuadros.

Agrarian National University La Molina (UNALM), CIP

Purpose

A survey in potato farming communities was carried out by scientists to determine the conservation status *in situ* and to assess local knowledge on landraces. Focus groups were interviewed to gather information about the species/varieties that farmers believe they have, have had or have been lost during harvest. Target crop: Potato / *Solanum spp*.

Metrics used

Quantitative and qualitative metrics

- Sample unit: No. Family per community
- Strata: Farm size (large and small) and the number of plots of each household
- Varity: Estimated share of specific variety on total area cultivated with potato (measured by number of sacks sown (1 sack = 69-92 kg).

These metrics have been chosen because they are the most accurate in that case and depended on local perception (particularly to estimate plot size etc.).

Additional metrics

Perceived effects of climate change, the principal threat of agrobiodiversity, farming experience of interviewees, adaptation measures, the most resistant potato to the principal threat, the most vulnerable potato to the principal threat, variety related uses, preferences and purposes.

Duration of the method application:
Nine months

Approximate costs:
Field work US$ 1000

Sponsors:
CRP-RTB, self-funded.

Application of the method:
The method is part of a larger monitoring approach. The technique as applied can be repeated relatively frequent

Replicability rate: 3 (high)
Strengths: Relatively cheap and does not require much and expensive equipment.
Constrains: Language can be a problem, in this specific case the interviewees were Quechua-speakers. Many people had different perceptions, when it was asked for specific numbers or values.

Information on community involvement
The local authorities were visited to introduce the researcher and to explain the study. The authorities were asked for permission to carry out the survey. During the survey, the researcher stayed in respective communities.

Activities conducted by the community
Identification of landrace names, provided information, acted partly as translator and local guides

Focus on particular social group:
Potato farmers with long-term experience.

Data access and dissemination
Thesis

Additional comments:
N.A.

Key references to the methods:

Padulosi S. and E. Dulloo. 2012. Towards a viable system for monitoring agrobiodiversity on farm: a proposed new approach for red Listing of cultivated plant species. In S. Padulosi, N. Bergamini and T. Lawrence editors. 2012. On farm conservation of neglected and underutilized species: trends and novel approaches to cope with climate change. Proceedings of an international Conference, Frankfurt, 14-16 June 2011. Bioversity International, Rome. Downloadable at http://bit.ly/H7w7Zo.

Contact for further information	
First name, Last name	Merelyn, Valdivia
Affiliation	
List Area(s) of Expertise:	Ecosystems of Mountain
Phone number	Agrobiodiversity
Email address	merelyn.valdivia@gmail.com

vii Landrace Harvest Survey

Raul Ccanto, Edgar Olivera, Maria Scurrah

Grupo Yanapai

Purpose

We “visit” custodian farmers during the harvests, (previous agreement in assemblies) and separate varieties, and ask farmer to name them. When we do this in a “sectorial fallow system” (turno) we can cover many families in a short period of time, Often instead of harvesting a set amount of land, we pick a set amount of weight from a harvested pile. (12kg). and classify the varieties. The aim is to monitor dynamics in landrace diversity across time

The method is mainly applied for a baseline inventory, to document the genetic diversity and local knowledge of potato landraces also in context with nutrition and food security. Target crop: Potato / *Solanum spp*.

Metrics used

Quantitative and qualitative metrics

- Variety names
- Yield
- Uses

These metrics have been chosen because it is what farmers and we relate to potato diversity.

Additional metrics

Morphological characteristics, to distinguish very close varieties.

Duration of the method application:

Since 2002 the method is used, however a recurrent monitoring using systematically the same method has not yet been carried out.

Approximate costs:

Possibly around US$ 2,000.00

Sponsors:

Ongoing projects.

Application of the method:
This method is applied in Huancavelica a final evaluation is still pending. The method can complement other methods such as participatory GIS assessment.

Replicability rate: 3 (high)
Strengths: It is reliable, but is limited in time. It shows the dynamics/changes that occur. Monitoring intervals can be kept flexible.
Constrains: Demands a lot of time.

Activities conducted by the community
We did not ask them to participate except to help us classify their varieties by name during the day of harvest or later on at storage. We need to seriously ask the question what farmers get out of monitoring.

Focus on particular social group:
All farmers who cultivated various potato varieties.

Data access and dissemination
Poor, we share excel files. We wrote up the Quilcas experience in an unpublished workshop held at CIP. We wrote up the baseline study in a SEPIA paper.

Additional comments:
After evaluation we think, we would get more reliable data when we do the same exercise in storages, rather than during harvest in the fields. Often farmers harvest more than only one plot so that we may miss the diversity harvested in the other plots that are harvested when we are not present.

Key references to the methods:

M. Scurrah Ccanto Raúl Olivera Edgar y Noemí Zúñiga: 2002-Autosuficiencia y Sostenibilidad del Cultivo de Papas Nativas en la Comunidad de Quilcas, en el Valle del Mantaro, en los Andes Centrales del Perú. CIP (organized by G. Prain unpublished)

R.Valdivia,N.Arce. E. Huallpa F. de Mendiburu, M. Holle. 1999. Descriptive statistics for oca (oxalis tuberos) variety mixtures in Salcedo and Imicate, Puno Peru. 1999.

2012 Scurrah.M.,DeHaan, Olivera.E.,Ccanto.R.,Creed.H.,Carrasco.M.,Veres.E.,Barahona,C. Ricos en Agrobiodiversidad, pero Pobres en Nutrición: Desafíos de la mejora del Seguridad alimentaria, en Huancavelica SEPIA XIV Peru Problema Agrario en Debate. Eds. Asensio R, Eguren, F Ruiz M. pp362-407.

Contact for further information	
First name, Last name	Maria Scurrah
Affiliation	Grupo Yanapai, CIP,
List Area(s) of Expertise:	Breeding, plant nematology,
Phone number	51 1 4467065, cell 995292389
Email address	scurrah@gmail.com, m.scurrah@cgiar.org

viii Monitoring Agrobiodiversity through Seed Fairs

Mario Tapia

GEF, INIA

Purpose
The method is mainly applied for a baseline inventory, to document the genetic diversity and conservation status of specific potato landraces. Target crop: 17 different crops in Quilcas, and mainly potato / *Solanum spp*. in Huancavelica.

Metrics used

Quantitative metrics

- Number of species
- Number of varieties
- Number of families participating in the fairs.

Not possible to really use other indicators by this method.

Additional metrics
Local knowledge on crop management and varieties.

Duration of the method application:
10 years

Approximate costs:
US$200-500

Sponsors:
N.A.

Application of the method:
Not recently applied.

Replicability rate: 2 (medium)
Strengths: The low cost and the enthusiasm of participants.
Constrains: Families who do not see the possibility to win a price do not participate. The amount of seed exchange among the farmers is low or does almost not occur.

Information on community involvement
Together with local authorities the seed fairs were organized and promoted.

Activities conducted by the community

Bringing their seed, setting up stands, cooking local dishes, having the children draw pictures of farms, etc.

Focus on particular social group:

The whole community.

Data access and dissemination

Poorly, we lost much information by not having proper recording methods.

Additional comments:

An odd result of these fairs, but also of the harvest is that many families have accessions that only show up once. In other words seem to be very rare. The question is whether this might be a side effect of the fairs, as farmer compete and try to collect rare varieties.

Key references to the methods:

M.Scurrah,; E.Fernandez-Baca; R.Ccanto; E.Olivera; E. Nuñez; 2000. Una muestra de biodiversidad y conocimiento en los Andes del Perú. LEISA. Vol.15 No3-4.26-28.

Mario Tapia. 1999 Agrobiodiversity fairs. CIP-report.

Contact for further information	
First name, Last name	Maria Scurrah
Affiliation	Grupo Yanapai, CIP,
List Area(s) of Expertise:	Breeding, plant nematology,
Phone number	51 1 4467065, cell 995292389
Email address	scurrah@gmail.com, m.scurrah@cgiar.org

ix LR *In-situ* Monitoring

N. Maxted, S.P. Kell, j. Magos Brehm, V. Negri (however, many more people contributed ideas over time, including E. Dulloo, Bioversity)

University of Birmingham, UK; University of Perugia, Italy

Purpose

The method is mainly applied for long-term monitoring on density, frequency, cover and genetic diversity to feedback into on-farm management regime, particularly considering local knowledge. Target crop: Wide range of food and forage crop LR from cereals to vegetables to fruit.

Metrics used

Quantitative and qualitative metrics

- Nomenclatural diversity
- Demographic diversity
- Genetic diversity

These metrics were the most effective at giving time series data for assessment of the impact of the management implemented and changes in genetic diversity, they were better than purely narrative estimates of population size.

Additional metrics

N.A.

Duration of the method application:

On-going (there is little point to short term monitoring)

Approximate costs:

Very variable

Sponsors:

National governments, projects

Application of the method:

Should always be on-going. Plot sampling methods and transect or intercept sampling methods, GPS, demographic modeling (PVA), molecular markers, and descriptors for morphology, phenology, and quality assessment are applied.

Replicability rate: 2 (medium)
Strengths: Has already been used for LR populations in projects and by national PGR programmes. It is most effective to combine a narrative and genetic approach.
Constrains: Sustainable funding, and to a lesser extent monitoring skills. The former is too often based on short-term projects which do not provide the necessary long-term sustainability. The latter can be learnt so is not such a serious problem.

Information on community involvement
This is site dependent, but for LR monitoring the farmer / local community are the focus of planning, management and monitoring LR diversity, possibly working as field assistant

Activities conducted by the community
Planning, management and monitoring, working as field assistants.

Focus on particular social group:
PGR rich farmers within the local community.

Data access and dissemination
Collected in data loggers or paper sheets and then transferred to Excel or other databases ready for analysis.

Additional comments:
N.A.

Key references to the methods:

Veteläinen, M., Negri, V. & Maxted, N. (eds.), (2009). European Landraces: On-farm conservation, Management and Use. Bioversity Technical Bulletin 15. Pp. 1-359. Bioversity International, Rome, Italy. ISBN: 978-92-9043-805-2.

Maxted, N., Magos Brehm, J. & Kell, S. (2013). Resource book for the preparation of national plans for conservation and use of crop wild relatives and landraces. Commission on Genetic Resources for Food and Agriculture, FAO, Rome, Italy. 340 pp.

Maxted, N., Guarino, L., Myer, L. & Chiwona, E.A., (2002). Towards a methodology for on-farm conservation of plant genetic resources. Genetic Resources and Crop Evolution 49: 31-46.

Maxted, N. & Scholten, M.A. (2007). Methodologies for the creation of National / European inventories. In: Del Greco, A., Negri V. & Maxted, N. (compilers) Report of a Task Force on On-farm Conservation and Management, Second Meeting, 19-20 June 2006, Stegelitz, Germany. Pp. 11-19. Bioversity International, Rome, Italy.

Contact for further information	
First name, Last name	Nigel Maxted
Affiliation	University of Birmingham
List Area(s) of Expertise:	PGR Conservation
Phone number	+44 1297 678 774
Email address	Nigel.maxted@dial.pipex.com

1.2.2. CWR

i Core Descriptors for *In-situ* Conservation of CWR

Alercia, Adriana, Boller, Beat, Chapman, Arthur, Dias, Sonia, Fajardo, Juan, Germeier, Christoph, Heywood, Dulloo, Ehsan, Vernon, Hilton-Taylor, Craig, Iriondo, Jose, Kell, Shelagh, Knüpffer, Helmut, Lane, Annie, Lee, Choon Pei, Le Hunte Ward, Fynvola, Maxted, Nigel, O'Carroll, James, Quek, Paul, Rao, V. Ramanatha, Roscher, Sabine, Salokhe, Gauri, Scheldeman, Xavier, Strahm, Wendy, Thormann, Imke.

Bioversity International, Italy; BGCI (Botanic Gardens Conservation International), BLE (German Federal Office for Agriculture and Food), FAO (Food and Agriculture Organization of the United Nations), IUCN (International Union for Conservation of Nature), UNEP-WCMC (United Nations Environmental Program World Conservation, Monitoring Center), ECPGR; Armenia (Ministry of Nature Protection), Bolivia (Viceministerio de Biodiversidad, Recursos Forestale y Medio Ambiente,, Ministerio de Desarrollo Rural, Agropecuario y Medio Ambiente), Madagascar (Centre National de la Recherche Appliquée au Développement Rural, (FOFIFA), Sri Lanka (Ministry of Environment and Natural Resources), Uzbekistan (Institute of Genetics and Plant Experimental Biology (IGPEB), Academy, of Sciences)

Purpose

The method facilitates to monitor the *in-situ* conservation status and threats of the target population.

Target species: the descriptors are general valid.

Metrics used

Quantitative and qualitative metrics

- Genus
- Species,
- Species authority
- Country code
- Latitude, Longitude and Elevation of site
- Monitoring date
- Population identifier
- Monitoring institute code,
- Total number of individuals in the population
- IUCN threat classification
- Conservation actions in place.

These metrics have been chosen because they constitute the minimum essential information intended to capture key data on in situ conservation status and threats of the population.

Additional metrics
N.A.

Duration of the method application:
N.A.

Approximate costs:
N.A.

Sponsors:
N.A.

Application of the method:
We developed the methodology based on expertise, literature research and contributions from international experts and national partners of the UNP/GEF project. A web portal has been developed and ontology will be integrated soon.

Replicability rate: 3 (high)
Strengths: Allows sharing, storing and exchange of information, thus data comparability amongst countries.
Constrains: N.A.

Information on community involvement
N.A.

Activities conducted by the community
N.A.

Focus on particular social group:
N.A.

Data access and dissemination
An *in-situ* database for accessions from each hotspot is created and used as reference baseline data for time-series comparison (either based on multi-year sampling or comparison on in- versus *ex-situ* collections from a common geographical origin). Currently the database is maintained in-house at CIP, but soon it will be made accessible in line with the CG policies on intellectual assets. Some datasets from specific hotspots are already publically accessible.

Additional comments:
N.A.

Key references to the methods:

Thormann I, Alercia A, Dulloo ME. 2013. Core descriptors for in situ conservation of crop wild relatives v.1. Bioversity International, Rome, Italy. Available from Bioversity web site.

Contact for further information	
First name, Last name	Adriana Alercia
Affiliation	Bioversity International
List Area(s) of Expertise:	Descriptors, standards, methodologies
Phone number	+39066118410
Email address	a.alercia@cgiar.org

ii Recurrent Population Surveys and Population Ecology Monitoring

Many people have contributed to this field but the most thorough manual is by John Harper 1977 Population biology of plants

Bangor U, Wales

Purpose

The method facilitates to monitor impact factors for the target population.
Target species: the descriptors are not crop specific; however the most recent approach is for *Saussurea laniceps* and *S. medusa.*

Metrics used

Quantitative metrics

- Number and size of individuals
- Growth rates
- Reproduction rate
- Germination rate

These metrics have been chosen because they are needed to produce a life history matrix model that simulates population growth (or demise).

Additional metrics
N.A.

Duration of the method application:
> 5 years necessary

Approximate costs:
Depends on who is doing it. I had a graduate student who did population ecology to estimate sustainable harvests for <US$20,000.

Sponsors:
Many funding sources: NSF has a whole panel for population biology.

Application of the method:
Very common and often utilized.

Replicability rate: 2 (medium)
Strengths: Statistical significance.
Constrains: Different environmental conditions and genetics may influence the outcome.

Information on community involvement
We asked for community members most familiar with target species to work with us.

Activities conducted by the community
Tibetan doctors assessed plant threat and importance of sustainability.

Focus on particular social group:
The community told us that Tibetan doctors knew most about plants, so we worked with them.

Data access and dissemination
All data and results are published in peer reviewed literature available to scientists. To the local community, results were presented by posters in meetings. Results were shared with the government to encourage intervention (the respective species was red listed but our sustainable harvest recommendations were not followed.).

Additional comments:
Sustainability and threat status is best quantified by this method. A life history matrix model that simulates population growth, survey to assess number and size of individual is required.

Key references to the methods:

http://en.wikipedia.org/wiki/Population_ecology

Contact for further information	
First name, Last name	Jan Salick
Affiliation	Missouri Botanical Garden
List Area(s) of Expertise:	Wild Crop Relatives Ethnobotany
Phone number	314-577-5165
Email address	Jan.salick@mobot.org

iii Conservation of native grasses *in situ*

Genaro Condori Choque

INIAF

Purpose

INIAF has established reserves for native grassland recovery in five eco-regions of the Bolivian altiplano (Sajama, Quetena and Llica) and intends to implement these reserves to Ulla Ulla and Calientes. These are the sites where species associated to the native grasslands are conserved and characterized. Aim is to establish red listing and monitor impact factors of diversity

edades nativas

Target species: Parastrephya lepidophylla, Adesmia espinossisima, Festuca orthopylla, Stipa ichu, Fabiana densa, Baccharis incarum, Acantholippia deserticola, Chuquiraga atacamensis, Parastrephia lucida, Distichia muscoides, Distichia filamentosa, Alchemilla pinnata, Calamagrostis curvula, Plantago rigida, Plantago tubulosa, Werneria sp y Hypochaeris sessiliflora.

Metrics used

Quantitative and qualitative metrics

- Frequency
- Percentage of coverage
- Weight of dry matter
- Density
- Growth habit
- Number of tillers
- Position of tillers
- Plant size
- Canopy
- Leaf shape and petiole length.

These metrics have been chosen because they are established parameter to distinguish grass species.

Additional metrics

- Days to germination
- Days to maturity
- Days to flowering

Duration of the method application:
It has just started.

Approximate costs:
50 000 bolivianos per year approximately.

Sponsors:
INIAF and World Bank

Application of the method:
The method is an ongoing effort.

Replicability rate: 3 (high)
Strengths: not very expensive and not labor intensive.

Constrains: N.A.

Information on community involvement
Five Conservation Production Units jointly work with farmers, responsible for the conservation of llamas and alpacas in the highlands of the Andean region in Bolivia.

Activities conducted by the community

Building fences for recovery sites of native grasslands

Focus on particular social group:
Holders of llamas and / or alpacas, wild species of native grasses are the main food source for these animals.

Data access and dissemination
Data is currently collected and stored in INIAF's database.

Contact for further information	
First name, Last name	Genaro Condori Choque
Affiliation	Genetic Resources
List Area(s) of Expertise:	Conservation of genetic resources of native grasses
Phone number	71955102
Email address	gencond@hotmail.com

1.2.3. Not specific

i Conservation at Urban Backyards

Fernanda Vidigal Duarte Souza and Maria Angélica Carvalho Costa

Embrapa Cassava and Fruits and Federal University of Recôncavo da Bahia (UFRB).

Purpose

The method is developed to screen the genetic variability in urban backyards. The aim was to identify which species are cultivated by common citizens in their backyard and try to develop a method or a model to preserve important genetic resources from the region and native species. This model could be the smallest "cell" of conservation. This method can be used for crops and CWR.

Metrics used

Quantitative and qualitative metrics

- Number of custodians
- Diversity of species and cultivars
- Morphologic and molecular parameter.

Additional metrics

N.A.

Duration of the method application:

Permanent activities

Approximate costs:

N.A.

Sponsors:

N.A.

Application of the method:

This method could be useful and important to preserve important genetic resources specific for the region and mainly to avoid the establishment and spread of exotic species throughout the city.

Preliminary results obtained in this study were very interesting and showed that more than 80% of the species cultivated in the backyards were exotic.

Replicability rate: 3 (high)
Strengths: Participatory character, the diversity of the seeds and the research staff from Embrapa Temperate Climate are very favorable factors.
Constrains: Without apparent constraints; just some internal constraints related to staff availability and the structure for multiplication and evaluation of the landraces, and the lack of renew/extension of the Seed Custodians Project under the Embrapa Macro-project of Small Farming Systems (MP6).

Information on community involvement
The community has been approached through surveys and workshops.

Activities conducted by the community
N.A.

Focus on particular social group:
Urban citizens from different social classes

Data access and dissemination
N.A.

Additional comments:
N.A.

Key references to the methods:

Keywords: Urban citizens, cell conservation, urban backyards,

Contact for further information	
First name, Last name	Fernanda Vidigal Duarte Souza
Affiliation	
List Area(s) of Expertise:	Cell biology and genetic resources.
Phone number	75 33128059
Email address	Fernanda.souza@embrapa.br

1.3. Landscape Level

1.3.1. Crops

i Participatory GIS for determining the spatial distribution of potato landraces and red listing

Stef de Haan, Henry Juarez, Severin Polreich, Alejandra Arce, Franklin Plasencia and Raul Ccanto

International Potato Center (CIP), Grupo Yanapai, INIA Peru and CADEP J.M.A.

Purpose

Scientists together with locally trained surveyors and approximately 150 randomly selected farmers households per hotspot generate a geo-referenced data set to assess the abundance and frequency of potato landrace diversity at landscape level. Target crop: Potato / *Solanum spp.*

Metrics used

Quantitative metrics

Spatial distribution:

- No. landraces / altitudinal belt
- Altitudinal range / landrace (min. / max)
- No. landraces / field (within field diversity)
- No. landraces / household

Red listing:

- Overall Cultivar Frequency (**OCF**) = (CCF community 1 + CCF community 2 + …..) / N communities sampled; Very few households: OCF < 1%, Few households: OCF < 5%, Many households : OCF < 25%, Most households: OCF > 25%. The **OCF** is measure of **evenness** based on the number of households conserving a specific cultivar.
- *Community Cultivar Frequency (**CCF**) = (Number of households conserving a specific cultivar / total household sample size of the community) * 100%. The **CCF** is an input to calculate the **OCF**.*
- Relative Cultivar Frequency **(RCF)** = (HCF household 1 + HCF household 2 + …..) / N households sampled; Very scarce: RCF < 0.05; Scarce: RCF < 0.10; Uncommon: RCF < 0.25; Common: RCF < 1.00; Abundant: RCF > 1.00; The **RCF** is a measure of relative **abundance** based extensive field sampling.

- Household Cultivar Frequency (**HCF**) = (sample size of a specific cultivar / total tuber sample size of the household) * 100%; The **CCF** is an input to calculate the **OCF**.

These metrics were chosen, because few quantitative indicators are known for the spatial distribution and relative abundance of landraces. These indicators were applied in several sites in Peru with good results. The indicators are objective and replicable.

Additional metrics

In the case of potato the methods can be applied to quantify and differentiate cultivars categories: (i) improved varieties, (ii) bitter landraces, (iii) floury landraces and their spatial distribution patterns, such as no. cultivars / household, no. cultivars / field, distribution range / category.

Duration of the method application:
1 to 3 years for those projects that have included these methods as a key component

Approximate costs:
High resolution satellite image: US$ 2,000 (per hotspot)
Survey team: US$ 5,000 (per hotspot)
Data processing: US$ 8,000 (per hotspot)
TOTAL: approximately US$ 15,000 (per hotspot)

Sponsors:
Donor Agency (e.g. SPIA, CRP-RTB)

Application of the method:
This method could take one cropping season per hotspot, yet is ongoing in the case of CIP because we aim at baselines for approximately 10 hotspots (benchmark sites) covering the distribution range of potato species and landrace diversity (Central Chile to Northern Colombia).

Replicability rate: 3 (high)
*Strength*s:

- Objectivity / neutralism
- Straightforwardness of its application
- Robustness of the metrics

Constrains:

- Relatively high costs
- Need for training the survey team
- Concentration of work (sampling) during harvest time

Information on community involvement
The communities where this method was applied had a long term relationship with either CIP or the local counterparts (NGO, NARI).

Activities conducted by the community

- Suggesting local (young) members of the community to be part of the survey teams (remunerated).
- Informing all community members in a community meeting / assembly.
- Guiding the survey staff to fields and allowing for random sampling of tubers (n= 200 / field) at harvest.
- Workshop to define synonyms and homonyms as for the vernacular landrace nomenclature.

Focus on particular social group:

Not specifically. Basically at random with households in previously defined hotspots.

Data access and dissemination

Data storage is currently internal at CIP. Maps with results are shared with the communities where the data was collected. In the near future the database will be made accessible in line with the CG principles on intellectual assets.

Additional comments:

The method is robust and can be part of a set of standard procedures for systematic monitoring.

Key references to the methods:

De Haan, S., Bonierbale, M., Juarez, H., Poma, J. and Salas, E. (2009). Annual spatial mangement of potato diversity in Peru's central Andes. pp. 91-115. In: S. de Haan, Potato Diversity at Height: multiple dimensions of farmer-driven in-situ conservation in the Andes. PhD Thesis. Wageingen University, Holland.

De Haan, S., Nuñez, J., Bonierbale, M. and Ghislain, M. (2010). Multilevel Agrobiodiversity and Conservation of Andean Potatoes in Central Peru: species, morphological, genetic and spatial diversity. Mountain Research and Development 30(3):222-231. http://www.bioone.org/doi/pdf/10.1659/MRD-JOURNAL-D-10-00020.1

Contact for further information	
First name, Last name	Stef de Haan, Severin Polreich
Affiliation	International Potato Center (CIP)
List Area(s) of Expertise:	Genetic Resources, In-Situ Conservation
Phone number	00-51-1-3496017
Email address	s.dehaan@cgiar.org / s.polreich@cgiar.org

ii Agrobiodiversity Assessment per Landscape Unit

Giovanni Figliuolo

Università degli Studi della Basilicata.

Purpose
This method is suitable to establish a baseline inventory, assess the conservation status and factors impacting conservation and conduct genetic reserve delineation in a participatory way. Target crop: suitable for different crops or species.

Metrics used

Quantitative and qualitative metrics

- Cultivar and Species richness-abundance/landscape unit

These metrics were chosen because they provide the best information at spatial scale.

Additional metrics

Socio-economic metrics.
Specialized vs. traditional farming needs to be evaluated to better understand the most appropriate measures for *in-situ* biodiversity conservation.

Duration of the method application:
Time frame in our latitudes (Mediterranean Region) depends on seasonality, landscape area, and gene-pool target. Multi-species surveying requires at least two key seasons. In this case the key season is the year "windows" in which it is possible to score *in situ* the maximum richness within species and within genus.

Approximate costs:
Depends on the remoteness of survey site.

Sponsors:
Co-financing through the University (personnel usual public salary + travel costs) and partner's budget (when allowed) for survey works.

Application of the method:
N.A.

Replicability rate: 2 (medium)
Strengths: Standard sampling strategy, use of satellite image and GIS technology.
Constrains: Accuracy depends very much on the capacity of local people and the accessibility of the territory.

Information on community involvement
N.A.

Activities conducted by the community

- Public biodiversity show
- Local meetings
- "Grafting" days

Focus on particular social group:
Public show of biodiversity focused especially on students and teachers.
Meetings were held with local public administrators.
In situ surveys were focused especially on retired persons and women.

Data access and dissemination
Each survey has been externally reported (meetings + printed reports).

Additional comments:
N.A.

Key references to the methods:

www.diva-gis.org

Contact for further information	
First name, Last name	Giovanni Figliuolo
Affiliation	Università degli Studi della Basilicata Dipartimento delle Culture Europee e del Mediterraneo: Architettura, Ambiente, Patrimoni Culturali (DICEM); Via S.Rocco, 5 - 75100 Matera – Italy
List Area(s) of Expertise:	Diversity analysis; Landscape genetics; Ecogeographic studies
Phone number	+39 0971205534
Email address	giovanni.figliuolo@unibas.it

1.3.2. CWR

i CWR *In-situ* Monitoring

N. Maxted, J.M. Iriondo, B. Ford-Lloyd, L. De Hond, S.P. Kell, J. Magos Brehm, F. Lefèvre, H. Korpelainen (however, many more people contributed ideas over time, including E. Dulloo, Bioversity)

University of Birmingham, UK; Universidad Rey Juan Carlos, Madrid, Spain; INRA, Avignon, France; University of Helsinki, Finland

Purpose

The method is mainly applied for long-term monitoring on density, frequency, cover and genetic diversity to feedback into on-farm management regime. Target species: Wide range of food and forage crop CWR from cereals to vegetables to fruit

Metrics used

Quantitative and qualitative metrics

- Density
- Frequency
- Cover
- Genetic diversity

These metrics were chosen because they were the most effective at giving time series data for assessment of the impact of the management implemented and changes in genetic diversity.

Additional metrics

Population demographics (Narrative estimates of population size, threat status, Population structure, vital rates).

Duration of the method application:

On-going (there is little point to short term monitoring)

Approximate costs:

Very variable

Sponsors:

National governments, projects

Application of the method:
Within the method techniques like plot sampling methods and transect or intercept sampling methods, GPS, demographic modeling (PVA), molecular markers are applied.

Replicability rate: 3 (high)
Strengths: Has already shown to be applicable for any CWR populations in projects and is now being widely applied in the CWR and broader plant conservation community.
Constrains: Sustainable funding, and to a lesser extent monitoring skills. The former is too often based on short-term projects which do not provide the necessary long-term sustainability. The latter can be learnt so is not such a serious problem. A slight diffident problem is the disjunction between CWR and broader protected area conservationists.

Information on community involvement
This is site dependent, but they should be involved in planning, management and monitoring, possibly work as field assistant.

Activities conducted by the community
Planning, management and monitoring, working as field assistant.

Focus on particular social group:
No

Data access and dissemination
Collected in data loggers or paper sheets and then transferred to Excel or other databases ready for analysis.

Additional comments:
N.A.

Key references to the methods:

Iriondo, J.M., Maxted, N. and Dulloo, E. (eds.), (2008). Conserving Plant Genetic Diversity in Protected Areas: Population Management of Crop Wild Relatives. CAB International, Wallingford. ISBN: 97-818-459328-24.

Maxted, N., Ford-Lloyd, B.V., Kell, S.P., Iriondo, J., Dulloo, E. & Turok, J. (eds.), (2008). Crop wild relative conservation and use. CAB International, Wallingford. ISBN: 97-818-4593099-8.

Maxted, N., Dulloo, M.E., Ford-Lloyd, B.V., Frese, L., Iriondo, J.M. & Pinheiro de Carvalho, M.A.A., (eds.) (2012). Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces. CAB International, Wallingford. ISBN 978-1-84593-099-8.

Maxted, N., Magos Brehm, J. & Kell, S. (2013). Resource book for the preparation of national plans for conservation and use of crop wild relatives and landraces. Commission on Genetic Resources for Food and Agriculture, FAO, Rome, Italy. 340 pp.

Maxted, N., Ford-Lloyd, B.V. & Hawkes, J.G. (eds.), (1997). Plant genetic conservation: the in situ approach. Chapman & Hall, London. pp. 451. ISBN 0-412-63400-7.

Contact for further information	
First name, Last name	Nigel Maxted
Affiliation	University of Birmingham
List Area(s) of Expertise:	PGR Conservation
Phone number	+44 1297 678 774
Email address	Nigel.maxted@dial.pipex.com

1.3.3. Not Specific

i Monitoring of the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA)

Members of the Commission for Genetic Resources for Food and Agriculture. Work coordinated by the Seeds and Plant Genetic Resources team, FAO.

Coordinated by FAO and executed by National Governments of Member Countries.

Purpose

To monitor the GPA that are carried out by National Governments of Member Countries, where a nationally appointed focal point has the leading role. Target crop: Not specific.

Metrics used

Quantitative and qualitative metrics

- Number of in situ (including on farm) surveys/inventories of PGRFA carried out
- Number of PGRFA surveyed/inventoried
- Percentage of PGRFA threatened out of those surveyed/inventoried
- Number of farming communities involved in on-farm PGRFA management and improvement activities
- Percentage of cultivated land under farmers' varieties/landraces in areas of high diversity and/or risk
- Number of farmers' varieties/landraces delivered from national or local gene banks to farmers (either directly or through intermediaries)
- Number of households that received seeds for planting as an aid after disaster situations
- Percentage of seed produced at the local level out of that made available through disaster
- response interventions
- Existence of disaster risk management policies for restoring crop systems that include seed
- security provisions
- Number of crop wild relatives and wild food plants in situ conservation and management
- actions with institutional support
- Percentage of national in situ conservation sites with management plans addressing crop wild relatives and wild food plants
- Number of crop wild relatives and wild food plants species actively conserved in situ

NB! A full list of indicators can be found in:

http://www.fao.org/docrep/meeting/027/mf557e.pdf

Considerations, to choose these indicators were, in particular, related to the availability and accessibility of data required as well as the importance of maintaining continuity in reporting through a country-led participatory process. FAO held consultations with the Secretariats of the Commission and the International Treaty, the Global Crop Diversity Trust and the CGIAR, the National Focal Points (NFPs) as well as other experts, and presented these during the 14th Session of the Commission in 2013.

Additional metrics

N.A.

Duration of the method application:
On a regular basis, approximately every four years, towards the second GPA implementation assessment and the State of the World Reports.

Approximate costs:
To establish/update 120 National Information Sharing Mechanisms and help to produce snapshot assessments is estimated to US$1,800,000.

Sponsors:
National Governments of Member Countries.

Application of the method:
Efforts of implementing the Second GPA and monitoring its progress is continuously ongoing in Member Countries, however, a formal request will not be circulated until the Commission requests it.

Replicability rate: 3 (high)
Strengths: Internationally agreed. A system is in place for reporting (National Information Sharing Mechanism), already established in 70-80 countries.
Constrains: Financial priorities

Information on community involvement
All stakeholders involved in PGRFA management in a country is involved in the reporting progress. Farmers are represented by their associations.

Activities conducted by the community
N.A.

Focus on particular social group:
No

Data access and dissemination

Data management done centrally by a designated person associated with the National PGRFA Programme. Data gathering is highly participatory process, involving all stakeholders in the country.

Additional comments:

More information about the Second GPA and the monitoring of it can be found at http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/gpa/en/

Contact for further information	
First name, Last name	Linn Borgen Nilsen
Affiliation	FAO
List Area(s) of Expertise:	Conservation and management of plant genetic resources
Phone number	-
Email address	Linnborgen.nilsen@fao.org

ii Functional Phylogenetic Entropy

Phylogenetic entropy was proposed by Benjamin Allen et al. (2009; Boston University), and independently invented by Chris Schmidt. Maud Mouchet and David Mouillot (2011; Montpellier) extended it to break out alpha, beta and gamma components of diversity. Chris Schmidt added an additional optional weighting scheme to capture differences in the relative values of crop varieties (yield, nutrition, etc.), though this is experimental.

Purpose

The method is mainly applied to provide an index of the functional diversity and functional value of an agricultural ecosystem, compare sites spatially or temporally, understanding the potential impact of various risk factors and for identifying appropriate interventions. Target crop: The method could be potentially applied to any crops/CWR, even multiple species simultaneously.

Metrics used

Quantitative and qualitative metrics

The method calculates a single index value for the site under consideration, so ultimately this is the sole indicator of the method, though this index can be calculated at multiple scales and with a focus on different measures of functional distinctiveness and usefulness within the system under consideration.

The index is calculated as follows:

Hp = - Sum[over branches b of a tree T] l(b)*p(b)*lnp(b)

where l(b) is the branch length and p(b) is the relative abundance of the descendents of a node in the tree. Optionally, an additional multiplicative factor v(b) can be added to the statement on the right which weights each node by the functional value of its descendents.

The particular inputs used to calculate this indicator will vary depending on use case. In some instances, molecular data may be employed to derive phylogenetic relationships. In other cases physical, evaluative, or use data may be used to derive a distance tree showing functional relationships. Relative functional value such as yield or nutritional value may be incorporated to weight the results. Abundance data may be derived from planted area, numbers of households, or an index combining both values. These metrics were chosen because they were the most effective at giving time series data for assessment of the impact of the management implemented and changes in genetic diversity.

These metrics were chosen because they capture not just the number of types and their relative abundance, but also their distinctiveness and usefulness. All four aspects of diversity are important in understanding and managing crop diversity in situ so that households and communities gain real practical value in addition to resilience and options values.

Additional metrics

N.A.

Duration of the method application:
N.A.

Approximate costs:
Given the various types of inputs to this method, the cost could be high, especially if molecular techniques are employed to infer a phylogeny. Even in the absence of this approach, a good deal of effort would be involved to ascertain the functional distinctiveness of the varieties in question.

Sponsors:
This will vary depending on circumstance.

Application of the method:
It is not sure that this exact approach has been applied to analyze crop diversity (though I am not especially familiar with this literature), it is presented here simply as a proposal for an approach that could be valuable and to encourage the inclusion of phylogenetic approaches in the workshop discussions.

Replicability rate: 2 (medium)
Strengths: The method is theoretically quite flexible and should be adaptable and extensible in a great diversity of use cases.
Constrains: The method requires an extensive amount and diversity of data inputs.

Information on community involvement
N.A.

Activities conducted by the community
N.A.

Focus on particular social group:
N.A.

Data access and dissemination
Uncertain; this will likely vary significantly from case to case.

Additional comments:

This method simultaneously captures the distinctiveness, richness, evenness, and practical value of crop varieties present at various spatial scales from individual farms to entire regions, and should be quite flexible in its application.

The addition of a functional value multiplier potentially enables a vast new array of uses for this method. For example, simulation studies could be conducted to predict the resilience of a system under drought conditions or disease outbreaks and to identify appropriate interventions to increase that resiliency.

Where actual phylogenetic relationships are lacking, a simple distance tree derived from a character matrix can be used to estimate distinctiveness of individual varieties. These characters could be physical descriptors, evaluative data, or a mix, as appropriate to the particular application. As with any index, perhaps its greatest value is in guiding deeper analysis of the underlying components.

Key references to the methods:

Allen, B., K. Mark, and Y. Bar-Yam. 2009. A new phylogenetic diversity measure generalizing the Shannon Index and its application to phyllostomid bats. American Naturalist 174(2): 236–243.

Mouchet, M. A. and D. Mouillot. 2011. Decomposing phylogenetic entropy into α, β and γ components. Biology Letters 7: 205–209.: the in situ approach. Chapman & Hall, London. pp. 451. ISBN 0-412-63400-7.

Contact for further information	
First name, Last name	Chris Schmidt
Affiliation	Native Seeds/SEARCH
List Area(s) of Expertise:	Ex situ crop conservation; indigenous agriculture in SW US and NW Mexico; database/web development for crop conservation; phylogenetics; entomology
Phone number	(US) 520-622-0830 x111
Email address	cschmidt@nativeseeds.org

1.4. Collective Knowledge Level

1.4.1. Crops

i Memory Banking – Participatory linkage of collective knowledge to education

Nayruth Triveño, Carmen Alvarez, Stef de Haan, Veronique Durroux, Severin Polreich, Maria Scurrah, Raul Ccanto

HoPe Foundation, Grupo Yanapai, CADEP-JMA, CIP

Purpose

Teacher and students of primary and secondary schools with support from researchers, NGO's and the Ministry of Education establish a memory bank for potato landrace diversity that will be used for education of agrobiodiversity management *in situ*. Target crop: Potato / *Solanum spp*.

Metrics used

Qualitative metrics

- Documented collective knowledge though participatory videos, photographs, audio recordings, drawings of interviews, varieties and agricultural / predictive practices.
- Vernacular nomenclature (No. of names)
- Cuisine and recipes (No. and type of preparations)
- Predictive practices (No. and type of practices)
- Myths and legends (No. and type of stories)
- Uses (medicinal, processing, etc.)
- Management practices (No. and type of practices)
- Others

Qualitative information about collective knowledge can be transmitted in a didactic way to a next generation users. Trangenerational "informal" transfer from mother-to-daughter / father-to-son can be reinforced through a link with bilingual intercultural education.

Additional metrics

N.A.

Duration of the method application:

2 years approximately for specific curricula.

Approximate costs:
Materials and equipment: US$ 2,000
Support team: US$ 5,000
Transformation: US$ 5,000
Editing and publication: US$ 15,000
TOTAL: approximately US$ 27,000
* The real cost depends on the type of education material to be developed and the extent of the effort

Sponsors:
Basically donor organizations, including CRP-RTB, IICD, HoPe

Application of the method:
Different knowledge contents can be systematized and converted into education materials such as books, interactive DVD's, online curricula: (i) farmer cuisine, (ii) uses, (iii) traditions, (iv) elders knowledge, etc.

Replicability rate: 3 (high)
Strengths: The effort of curricula building based on a linkage between "collective knowledge" and "formal education materials" includes also a section with specific instructions for teachers on how to conduct participatory diversity assessment with students from rural primary and secondary schools (the so-called "teachers environment" with lessons and procedures). The dissemination of the material will be possible online as well offline.
The Peruvian Ministry of Education (as well as other's in the Andean region) is very much in favor of developing locally adapted curricula. There is government support.
Constrains: Motivation of rural teachers (they often perceive a lack of motivation), complexity of the work and specialized expertise required (e.g. programming, transformation of raw material into didactic exercises with a learning purpose).

Information on community involvement
In a first meeting with stakeholders from the rural education sector, such as Local Education Management Units (UGEL, government), the municipality, and community authorities, the idea of linking collective knowledge about potato with formal curriculum building was explained and a chronogram of activities was presented. In Dialog with the UGEL it was discussed how to integrate the approach and how to define which primary and secondary schools would participate in the monitoring. It was important that UGEL and the local community signed an agreement to collaborate in development of the education materials (particularly for the teachers). The next step was to visit proposed primary and secondary schools and to introduce the method. In subsequent workshops, teachers were trained to assess the monitoring with students and sub-projects were programmed to conduct "classroom research". The students are the main protagonists.

Activities conducted by the community

Interviews, storytelling, videography, and visual recording with the young people from the same community.

Focus on particular social group:

Students of primary and secondary schools (nine years and older), teachers and custodian farmers.

Data access and dissemination

Local Education Management Units and the ministry of education are supporting the dissemination of the interactive encyclopedia at national level.

The material is digitized (in HTML 5 format) and accessible online as well as offline.

Additional comments:

Collective knowledge about landraces and related aspects should ideally be registered at the community level where it originated. Linking local ("informal") knowledge systems to formal education and curriculum building is an appropriate bottom-up approach for baseline documentation and possibly monitoring if the effort is systematic and results in a school register of knowledge domains.

Key references to the methods:

DVD Papas Nativas http://rsr.akvo.org/project/1340/

T'iraqanchi Kawsayninchik, Fundación HoPe http://www.hopeperu.org/publicaciones.html

Contact for further information	
First name, Last name	Stef de Haan, Severin Polreich
Affiliation	International Potato Center (CIP)
List Area(s) of Expertise:	Genetic Resources, *In-situ* Conservation
Phone number	00-51-1-3496017
Email address	s.dehaan@cgiar.org / s.polreich@cgiar.org

1.4.2. CWR

N.A.

1.4.3. Not Specific

i Descriptors for Farmers' Knowledge about Plants

Aknazarov, Ogonazar, Alercia, Adriana, Bellon, Mauricio, Eyzaguirre, Pablo, Hunter, Danny, Jarvis, Devra, Matthews, Peter, Maundu, Patrick, Quek, Paul, Rao, Ramanatha V., Smith, Francisca, Sthapit, Bhuwon, van Oudenhoven, Frederik, Williams, David

Bioversity International, Italy; various scientists from Japan, Russian, Kenya, Malaysia, and Nepal

Purpose

A descriptor list that is based on personal expertise, memory banking and literature research. It is expected that farmers or extensionists will monitor activities, e.g. teachers, local scientists, other community members, etc. Target crop: Fruit trees but for both, crops and CWR.

Metrics used

Quantitative and qualitative metrics

- Identifiers (field work date, information provider's name, age, ethnic group, etc.)
- Plant identification (Genus, Species, landrace, cultivar name, biological status)
- Site (Ecogeographical context, latitude, longitude, elevation)
- Relative abundance; Traditional knowledge about plants (part of the plant used)
- Uses of the plant; farmers' distinguishing traits, marketability, quality
- Agronomic traits, biotic and biotic stresses information, etc.

These metrics were chosen because of their importance and mainly their user-friendliness.

Additional metrics

N.A.

Duration of the method application:

N.A.

Approximate costs:

N.A.

Sponsors:
N.A.

Application of the method:
This descriptors list has been tested with 10 Asian countries during a workshop to assess the feasibility of getting the information requested.

Replicability rate: N.A.
*Strength*s: Allows sharing, storing and exchange of information, thus data comparability amongst countries.
Constrains: Incentives for farmers to provide their information

Information on community involvement
N.A.

Activities conducted by the community
N.A.
Focus on particular social group:
N.A.

Data access and dissemination
N.A.

Additional comments:
N.A.

Key references to the methods:

Bioversity and The Christensen Fund, 2009. Descriptors for farmer's knowledge of plants. Bioversity International, Rome, Italy and The Christensen Fund, Palo Alto, California, USA. Available from Bioversity web site.

Contact for further information	
First name, Last name	Adriana Alercia
Affiliation	Bioversity International
List Area(s) of Expertise:	Descriptors, standards, methodologies
Phone number	+39066118410
Email address	a.alercia@cgiar.org

ii Surveys in Indigenous Communities

Surveys are a standard technique, and the particular details of how Native Seeds/SEARCH conducted past surveys were determined by the particular context in which they were performed. Here it is attempted to synthesize and summarize three different projects conducted in indigenous communities by or in collaboration with Native Seeds/SEARCH to establish diversity baselines. The Hopi survey dealt with crop varietal diversity, the Southern Sonora project dealt with crop varietal diversity and risk assessment, while the Cultural Memory Bank (CMB) project focused largely on traditional knowledge.

Native Seeds/SEARCH

Purpose

Interviews of indigenous farmers were conducted *in situ* by NS/S staff scientists or, in the case of the Southern Sonora project, by a Yale Master's student working in collaboration with NS/S to establish a diversity baseline and assess the current varietal conservation status.

Target crop: Most of the emphasis in these projects was on cultivated species, but wild species (including crop wild relatives) were also addressed to a lesser extent (especially in the Cultural Memory Bank). Numerous taxa, including *Zea mays*, various *Phaseolus* and *Cucurbita, Lagenaria, Citrullus* and *Cucumis, Proboscidea, Vigna, Capsicum annuum, Helianthus*, etc.

Metrics used

Quantitative and qualitative metrics

In all of these projects, individual farmers were asked to indicate the crop species and varieties that they currently grew or had grown in recent years. For the CMB, farmers were also asked about the traditional uses of the crops and about traditional agricultural practices. Examples of CMB questions included "Are there other crops that you used to traditionally grow that you no longer do?", "When do you plant this crop?", "Does this crop play a role in ceremonies?", and "What is the crop used for?"

These metrics are relatively straightforward to assess and do not require specialized techniques beyond an ability to interview farmers using appropriate cultural sensitivity (not an easy task!).

Additional metrics

Unknown. It is possible that some consideration was given to measuring the relative area grown for each crop species or variety, but it may have been decided that this was too difficult to determine accurately.

Duration of the method application:
The Hopi survey was conducted in 1988–1989, the Southern Sonora survey was performed in 2004–2005, and Cultural Memory Bank efforts were undertaken from 1996–2004.

Approximate costs:
Difficult to estimate but primarily entails the cost of staff time and travel to sites, documentation needs (including photographic, video and audio equipment) and data storage and analysis.

Sponsors:
All three projects were largely funded by granting agencies. The Hopi and Cultural Memory Bank projects were also partially funded by NS/S from private donations, membership dues and seed distribution revenue.

Application of the method:
These efforts are not ongoing, and the methods definitely influenced the longevity of the projects. This is because on-site visitation and interviews is time-consuming and expensive, and NS/S has been unable to afford continuous in situ programs structured around farmer surveys.

Replicability rate: 2 (medium)
*Strength*s: Direct farmer surveys are attractive because they can yield a great quantity and diversity of information, and can be performed by trained members of the community (helping with community buy-in). Once a local participant is trained to conduct interviews, surveys can be conducted repeatedly from year-to-year, with the same or different interviewees. Scalability is dependent on the training of additional interviewers but this could be done efficiently in some contexts.
Constrains: Without local trained interviewers (or even with them, sometimes), one-on-one surveys are potentially expensive and time-consuming and can require a great deal of up-front relationship building with the community or with individual farmers to build trust in advance.

Information on community involvement
In general, relationships already existed between NS/S and the communities in which the interviews were conducted. These were established over years of contact during collecting trips and other research fieldwork. In many cases, though, individual farmers/families did not have a history of any relationship with NS/S and de novo relationships had to be formed, often with the help of a local representative. In our experience, this was rarely a problem, though we found during germplasm collecting trips that some traditional farmers kept their most special or unusual varieties a secret until they had known our collectors for years. This is a potential risk in any strategy for assessing crop diversity that depends on self-reporting from farmers.

Activities conducted by the community

Community members agreed to be interviewed about their crop portfolios and/or traditional knowledge, as appropriate to the particular project.

Focus on particular social group:

Generally, these efforts tended to be biased toward older farmers who were disproportionately maintaining traditional varieties and traditions. To try to remedy this in the Hopi survey, an attempt was made to get a more representative cross-section of farmers, but it is believed that some farmers disqualified themselves out of a belief that their farming activities or experience was inadequate (i.e., they thought that the interviewers should only talk with the "best" farmers).

Data access and dissemination

The data collected through these activities were generally relatively simple and straightforward. Data on varietal diversity could be summarized in table form, though documentation of traditional knowledge is more qualitative and cannot be summarized quite as simply. Interviews for the CMB were recorded on voice recorder and often had to be translated later into English. CMB information from the Diné people of Arizona and New Mexico was compiled into an interactive computer program that was distributed back to Diné schools and communities as an educational tool.

Additional comments:

N.A.

Key references to the methods:

N.A.

Contact for further information	
First name, Last name	Chris Schmidt
Affiliation	Native Seeds/SEARCH
List Area(s) of Expertise:	Ex situ crop conservation; indigenous agriculture in SW US and NW Mexico; database/web development for crop conservation; phylogenetics; entomology
Phone number	(US) 520-622-0830 x111
Email address	cschmidt@nativeseeds.org

iii Crowd-Sourcing Information from Growers

Native Seeds/SEARCH is, or has, employed methods to crowd-source crop data from the public. These efforts have come in a few principle forms. First, we solicit feedback from recipients of our seed donations (through our Native American Free Seed Program and Community Seed Grants). Second, through our now-defunct Gardener's Network program, we crowd-sourced characterization and evaluation data from participating growers across the U.S. Third, we are developing an online portal that will facilitate the same type of data-sourcing from the public in a more efficient manner. This will be done in both undirected (i.e., organically driven by the interest of individuals) and directed (i.e., crop evaluations facilitated by NS/S) fashions.

Native Seeds/SEARCH

Purpose

Farmers and gardeners make their own observations and submit them to NS/S through either paper or electronic means. NS/S staff organize, analyze, and share the results (in theory, anyway). The primary goal of this approach is to acquire information about the performance and characteristics of different crop varieties under different environmental and management contexts, and to understand the capacities of different communities to undertake seed-saving and seed exchange activities. Because these crowd-sourcing strategies can in theory continue indefinitely, they also become mechanisms for monitoring changes in crop adaptation or community capacity over time.

Target crop: These programs involve all crops and CWRs in the NS/S seed bank collection (over 100 species).

Metrics used

Quantitative and qualitative metrics

- Evaluative traits like yield, drought tolerance, disease and pest resistance, cold tolerance, etc.
- Standard suites of physical descriptors such as plant height; and phenological data.
- Indicators from the Free Seed and Community Seed Grant programs include qualitative values related to community capacity for seed security (success rate at saving seeds, number of other individuals provided with seeds, etc.).

In combination with geo-location and climatic data, these observations should provide valuable insights into crop adaptability and performance in different contexts and changes in them over time. Monitoring community capacity does not address crop diversity per se, but does inform our understanding of community-level processes that contribute or detract from seed security.

Additional metrics
An effort is being made to keep the metrics as simple as possible to encourage participation. Hence only the most important and broadly relevant questions are being asked.

Duration of the method application:
The Gardener's Network was active from about 2005–2007. The other listed activities have been ongoing for the past two years or are still in development.

Approximate costs:
The major expense in most of these efforts is the initial development of the information architecture to gather and organize the data, plus staff time to do the actual organizing, analyzing and sharing. As an incentive for participation in the Gardener's Network, participants were given provided with seeds free of charge.

Sponsors:
These programs have been funded by various granting agencies and are supplemented by the other revenue streams within the organization (private donors, distribution, etc.).

Application of the method:
The Free Seed and Community Seed Grant feedback is ongoing. The Gardener's Network was canceled after two seasons because the response rate was very low and made it difficult to justify the expense of the program. The new online incarnation of this program that is in development should address both problems by reducing overhead costs and making data submission easier for participants.

Replicability rate: 3 (high)
*Strength*s: Crowd-sourcing is built for scalability; once developed; the tools for obtaining data from the public can be potentially utilized very broadly by many people. They are also easily replicated and customized because they essentially involve responses to a short list of simple questions which can be adapted as needed.
Constrains: Efficient crowd-sourcing requires efficient means of communication, whether it's via physical mail, mobile phone or Internet. This is becoming less of a problem as mobile and Internet access become more ubiquitous, even in many developing nations. But it is still a hurdle to overcome.

Information on community involvement
For the Free Seed Program and Community Seed Grants, application forms state the questions and are a stated requirement of the program. The Gardener's Network was advertised via our website and newsletters, as will the new online system.

Activities conducted by the community

Community members agreed to accurately and honestly fill out responses to a set of questions we posed. For the seed donation programs these include questions such as "How will you/How did you save seeds from your activities?", "Did you share seeds from your harvest, and with whom?", and so on. For the Gardener's Network and the online system these include questions about crop performance and physical traits.

Focus on particular social group:

The Free Seed Program is exclusively geared toward indigenous gardeners and farmers, primarily in our region of focus but also beyond. Community Seed Grants are involve donations of seeds to schools, NGOs, or community institutions, again primarily in our region but not exclusively so. The Gardener's Network and online system are open to anyone but will by their nature only capture a self-selected demographic of interested growers. With appropriate incentive mechanisms we should be able to expand our reach to a larger community.

Data access and dissemination

Data are stored in custom databases, and will be shared publicly through our online system once its development is completed.

Additional comments:

N.A.

Key references to the methods:

N.A.

Contact for further information	
First name, Last name	Chris Schmidt
Affiliation	Native Seeds/SEARCH
List Area(s) of Expertise:	Ex situ crop conservation; indigenous agriculture in SW US and NW Mexico; database/web development for crop conservation; phylogenetics; entomology
Phone number	(US) 520-622-0830 x111
Email address	cschmidt@nativeseeds.org

2. Monitoring Experiences and Strategies

2.1. Varietal/Species Level

2.1.1. Crops

i Strategy to maintain potato landrace diversity in the communities

Carlos Venegas; Miguel Altieri; Bárbara Gomez; Jorge Negrón.

Center for Education and Technology (CET)

Purpose and activities

Field activities were carried out by professional team members mainly from CET, such as agronomists, agro-ecologists , agricultural technicians, anthropologists and commercial engineers. The features of the work include the Following areas:

- Collection of varieties.
- Maintenance of a germplasm bank with more than 200 varieties.
- Cultivation, maintenance and reproduction of varieties.
- Distribution and exchange of seed varieties in different rural communities.
- Development of participatory research.
- Development of farmer groups working on botanical seed reproduction.
- Participatory variety selection identifying varieties with resistance to water stress ; *P. infestans* and frost tolerance.
- Conducting workshops to train women farmers in seed management.
- Support seed exchange among custodian farmers through traditional seed fairs.
- Linking the gastronomic sector and custodian farmers.
- promoting the potato diversity center of Chiloe as Globally Important Agricultural Heritage Site (GIAHS) and inform about the conservation status,.
- •Certification of production of native varieties of potatoes under the brand Sipam

Target crop: *Solanum tuberosum tuberosum*

Contact for further information	
First name, Last name	Bárbara Gómez Montenegro
Affiliation	CET
List Area(s) of Expertise:	Agronomist
Phone number	+56-9-62305949
Email address	Cetchiloe.pro@gmail.com

ii Inventory of Agrobiodiversity by Ecological Zones

Agronomists and agricultural technicians, who worked on an agrobiodiversity inventory of Mollepata and Anta districts in Peru.

CADEP J.M.A.

Purpose

Agricultural technicians collaborated with local custodian farmers to establish a participatory landrace inventory, to document the genetic diversity and local knowledge of potato landraces, considering threatening factors for agrobiodiversity. Target crop: Potato, corn, beans, quinoa, Tarwi (lupine) and native fruits.

Metrics used

Quantitative metrics

- Morphologic descriptors for plant parts that are considered by local farmers to distinguish their varieties.

These metrics have been chosen because they are familiar for most of the technicians and farmers.

Additional metrics

Time to maturity, resistance to pests and diseases and, recently, indicators for climate change.

Duration of the method application:

Four years

Approximate costs:

N.A.

Sponsors:

N.A.

Application of the method:

N.A.

Replicability rate: 2 (medium)

Strengths: The descriptors that were used for characterization were frequently applied by custodian farmers in target locations.

Constrains: Descriptors are very site-specific and depend on local language and tradition.

Information on community involvement

CADEP has long-term experience with the target community. Custodian farmers have been visited during the harvest, in order to accumulate all varieties of each crop. In community assemblies the varieties were identified and information on use and properties collected by interviewing local women.

Activities conducted by the community

The community members participated in the harvest, in the selection of varieties with agricultural technicians and in the determination of its uses, and at the community level, participation was in determining the names of the varieties and then, the commitment to conserve and distribute conservation work at the family level.

Focus on particular social group:

Particularly women.

Data access and dissemination

The data are present in project reports.

Additional comments:

N.A.

Key references to the methods:

Internal project reports from CADEP

Contact for further information	
First name, Last name	Domingo Begazo Olivera
Affiliation	Team Coordinator in Cotabambas
List Area(s) of Expertise:	Agronomy and crop species and Biodiversity
Phone number	984112983
Email address	dbegazo@cadep.org.pe