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(UNEP/CBD/COP/11/INF/20)

CLUSTER REPORT ON RESOURCE REQUIREMENTS FOR THE AICHI BIODIVERSITY TARGETS

TARGET 13: GENETIC DIVERSITY

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Resource requirements for Aichi Target 13 – Genetic Diversity

Report to the CBD High Level Panel

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Contents

1 INTRODUCTION

This Target cluster relates to the conservation of genetic diversity. Target 13 is the only Target within the cluster.

Target 13 – Genetic Diversity

By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species is maintained and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Target 13 falls under Aichi Biodiversity Targets Strategic Goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. The Strategic Goal also includes:

- Target 11 on conserving and managing biodiversity and ecosystem services for terrestrial and inland waters; and
- Target 12 on preventing the extinction of threatened species and improving and maintaining their conservation status.

This paper addresses resource requirements to meet the objectives of Target 13, considering potential overlaps with activities that may be required under other, related Aichi Targets.

1.1 Introduction to the Target

1.1.1 Genetic diversity definition

IUCN defines genetic diversity under Target 13 as 'the genetic material contained in traditional varieties, modern cultivars and breeds grown [or developed] and maintained by farmers and livestock keepers, as well as their wild relatives and other wild plant and animal species that can be used as food, and as feed for domestic animals, or as medicines, fibre, clothing, shelter, wood, timber and energy, and are of cultural value to humans.'

1.1.2 Interpretation

Genetic diversity is fundamental to global food security. The technical rationale for Target 13 under the Convention on Biological Diversity (CBD) is that genetic diversity is in decline for three different categories of species (CBD 2012):

- ***Cultivated plants and farmed and domesticated animals -*** Species which have been selected or developed by humans for their produce and/or certain traits.
- ***Wild relatives*** - Species which are closely related to current plant varieties[1] and that survive in the wild. They are potential sources of genetic material which could be used to develop new breeds or varieties.
- ***Other socio-economically as well as culturally valuable species*** - Species which are not necessarily important for agriculture but which are particularly important for socio-economic or cultural reasons and are therefore crucial to human wellbeing. They include species used in traditional medicines, non-timber forest products and local land races (for plants) and species farmed or hunted (for animals).

What genetic diversity remains should be maintained and efforts are required to minimise genetic erosion. *Ex-situ* collections are one opportunity to do so. These are already well-developed for many species and across many parts of the world for cultivated plants. *Ex situ* conservation facilities still have some gaps and needs, however, particularly for animal

[1] and potentially animal breeds, although their likely introduction for domestic breeding is thought to be limited.

genetic resources, for certain plant reproductive behaviours (e.g. recalcitrant seed and vegetatively propagated species) and for plant and animal resources in Africa. They may be enhanced through new accessions and focus on wild relatives, land races and socio-economically and culturally valuable species.

Progress is particularly important for *in situ* conservation to enable on-going adaptation in their natural habitat or traditional production system. For animal genetic resources, *in situ* conservation is the primary objective.. This can be facilitated both through on-farm cultivation and through conservation of rare breeds, wild relatives and land races inside and outside protected areas.[2]

1.1.3 Challenges and limitations to estimating resource needs under Target 13

Target 13 is broad and ambitious. The objectives set out under this Target are also imprecise, which makes identifying the particular activities that may be conducted to meet the Target difficult. A major gap in this study is a complete assessment of the baseline situation and identifying specific conservation needs and priorities. Activities that have been identified for this study through literature review and expert consultation are those for which little research exists. There are significant knowledge gaps concerning the extent of work undertaken that already meets Target 13 objectives and what more remains to be done. The approaches that experts currently believe are required to meet Target 13 objectives, such as developing economic incentives for conservation by farmers, are little understood, and the most suitable and effective means of doing so are not widely agreed upon.

As a result of these combined issues, there is very little information available on the resource requirements needed to meet Target 13. Estimates of resource requirements needed based on assessment of key activities and using available evidence has been made for this study, but should be viewed as very preliminary results. More research is required to more accurately describe the activities needed, the existing gaps and the resource requirements. This assessment, therefore, is ambitious in its remit, but limited in terms of what the results can provide. It is only a first step; much more research and analysis is required to make this assessment more robust.

1.2 Links to other Targets

Target 13 is linked to many other Aichi Targets. Target 13 focuses on genetic diversity for food and agriculture; activities addressing conservation of genetic diversity more generally are out of scope for this assessment and will be covered by resource needs assessments for other Targets, for example, Target 19 on improving the science base, knowledge and technologies related to biodiversity and Target 16 on access and benefit sharing for genetic resources under the Nagoya Protocol.

Generally, where there are overlapping activities, resource needs are assumed to be assessed in relation to the Target to which the activity most directly refers. For example, awareness-raising activities are an important component of activities that will need to be undertaken to meet Target 13. But since awareness-raising resource needs as such are assessed under Target 1, they are not considered as separate activities under Target 13 (though they may constitute one component of a larger programme or project).

The Global Environment Facility GEF-6 assessment of Target 13 observes that there are also links between Target 13 and:

- Target 5 to reduce the loss of natural habitats;
- Target 6 to sustainably manage and harvest aquatic animals and plants;
- Target 7 to sustainably manage areas under agriculture, aquaculture and forestry;
- Target 11 to conserve and manage biodiversity and ecosystem services for terrestrial and inland waters; and

[2] http://www.cbd.int/sp/targets/rationale/target-13/ d

- Target 12 to prevent the extinction of threatened species and improve and maintain their conservation status.

The GEF-6 assessment proposes that efforts may be focused to ensure greater synergies between *in situ* and *ex situ* conservation efforts. This could include targeted national level programmes that aim to improve conservation of wild relatives of plants and domesticated animals, and for culturally significant species.[3] The present study has taken a similar approach, identifying activities that fall outside the remit of other Targets such that Target 13 objectives would not be otherwise met through activities undertaken to meet those Targets. Specific activities identified as being within and outside the scope of this study are discussed in greater detail in section 3.1.

[3] GEF-6 Assessment of Target 13 (*draft*) (2012)

2 ACTIONS

As discussed in Chapter 1, Target 13 sets broad, ambitious and imprecise objectives for conserving and maintaining genetic diversity. A wide range of activities may be employed to help meet the Target and these will be required at multiple scales—including national, regional and global levels. This chapter identifies a set of activities that can help to meet Target 13 through review of UN Food and Agriculture Organisation (FAO), CBD and GEF actions plans, needs assessments and programmes of work. The list of activities has been refined through consultation with experts from these and other organisations to comprise a set of more general key activities required.

2.1 Potential activities to meet Target 13 and overlaps with other Targets

A list of potential activities to meet Target 13, the level at which activities may be undertaken and potential overlaps with other targets is provided in Table 2.1. The list of potential activities to meet Target 13 has been developed by drawing on:

- FAO Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture;
- The GEF-6 needs assessment;
- CBD Programmes of Work, and
- CBD Decisions X/17 (Consolidated update of the Global Strategy for Plant Conservation 2011-2020), X/34 on agricultural biodiversity and X/38 (Develop Capacity-building Strategy for the Global Taxonomy Initiative).

2.2 Priority activity types to meet Target 13 and rationale for selection

Three priority activities were chosen for this resource assessment, through consultation with experts, additional literature review and by considering overlaps with other Targets and opportunities to specifically address resource requirements for activities that would not be covered by the other Targets. The three activities are:

- *Ex situ* maintenance and expansion of existing collections;
- Develop approaches to create economic incentives for *in situ* conservation by farmers;
- Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species

These include plant and animal genetic resources as illustrated in the matrix of priority activities set out in Figure 2.1.

2.2.1 *Ex situ* maintenance and expansion of existing collections

Ex situ conservation is the most common approach to conserving plant genetic resources. More than 1,750 genebanks and 2,500 botanical gardens hold a variety of accessions around the world (FAO 2010a). Collections held by the CGIAR centres are amongst the largest in the world, although national government genebanks together conserve 6.6 of the estimated 7.4 million accessions held in genebanks worldwide (Ibid). Approximately 25 to 30 per cent of the accessions are thought to be distinct and the rest are duplicates held in the same or different centres.

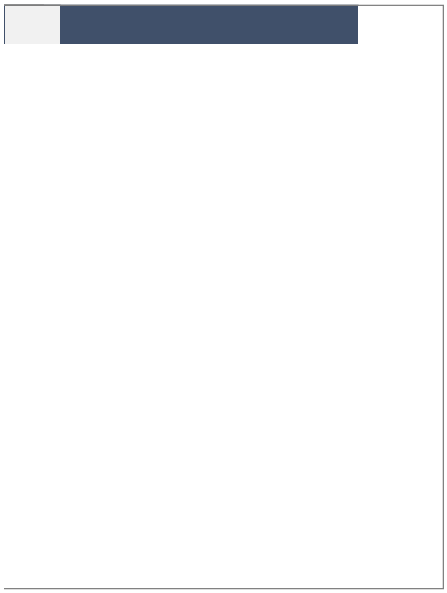
Crop wild relatives are species that are taxonomically related to domesticated crops. They are important as a source of genes for crop improvement. New techniques are making crop wild relatives more important for agricultural breeding work (i.e. inter-specific hybridization, the identification of desirable alleles and the direct gene transfer) (CGIAR 2010). The FAO Second State of the World Report observes that there continues to be a declining trend in international collecting activity since the first Report, but also increases in national collecting and a greater focus on crop wild relatives.

It more expensive to conserve *ex situ* animal genetic resources; for this and other reasons, animal breeds do not have the same *ex situ* coverage as plant materials. Developing greater *ex situ* resources for animal genetic resources will be important for meeting Target 13, but there are still a number of constraints (FAO 2012a):

- Further knowledge is required regarding livestock breed characteristics (e.g. geographical distribution and population size);
- There are few conservation programmes or structured breeding programmes for threatened breeds; and
- Government policies do not often consider or may discourage maintenance of animal genetic diversity.

FAO (2007) report that information required to assess the current state of animal genetic diversity *ex situ* (*in vitro*) conservation is not available.

Figure 2.1 Matrix of priority activities required to meet Target 13



2.2.2 Develop approaches to create economic incentives for *in situ* conservation by farmers

Farmers are conservation agents for most indigenous crop varieties in developing countries (Wale 2011). Farmers gain private benefit from growing traditional varieties and retain seed stock to ensure food security. They are thereby *de facto* conservation agents because they do not undertake these activities for conservation purposes and they are not paid for this 'service'. Equally, farmers generally maintain these varieties only to the extent that they generate private benefits (e.g. supporting the household and livelihoods). There are varieties that are not of private interest to farmers and therefore require additional support to ensure their conservation. Biodiversity conservation efforts are still required in this context.

2.2.3 Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species

Aichi Target 13 specifically refers to conservation of plants and animals which are socio-economically and culturally valuable. The GEF 6 Needs Assessment (2012), for example, refers to the black buck deer in North West India. Their decline due to biotic pressures is a loss for both local and global communities. Few resources go directly to address this priority. The GEF identifies this issue as a key requirement for meeting Target 13 (GEF 6 needs assessment).

Table 2.1 Specific activities proposed to meet Aichi Target 13

Activity type	Activity description	Required activity level			Potential overlaps
		National	Regional	Global	
***In situ* conservation**	Explore and inventory national resources	✓			19
	In-situ conservation of agro-biodiversity species including wild relatives of domesticated plants and livestock on farm	✓	✓		5,6,7
	Support farmers' *in situ* conservation of traditional and local plant varieties, animal breeds, and efforts to conserve crop wild relatives	✓	✓		5,6,7
***Ex situ* conservation**	Establish, maintain and expand *ex situ* collections, especially *ex situ* conservation of endangered animal species, and land races and wild relatives for plants	✓	✓	✓	12, 19
Interface (*in situ* and *ex situ*)	Identify extreme focus zones for conservation and implement conservation programmes	✓	✓		5
	Conservation of culturally valuable plant species and animal breeds	✓			12
	Promote on-going and planned activities for *in situ* and *ex situ* agricultural biodiversity conservation—particularly for the variability of genetic resources for food and agriculture, including plant wild relatives in the countries of origin	✓	✓	✓	5,7
	Assess and develop strategies aimed at minimizing threat of genetic erosion on domesticated biodiversity (crops, animal) and wild relatives, paying particular attention to the centres of origin of genetic resources for plants and domestication centres for animals or biodiversity hotspots for both plants and animals	✓	✓	✓	7
Economic development/ incentives	Promote sustainable use of economically valuable local wild plants and animals, as an income generating activity for local inhabitants	✓			6,7,16
	Establish incentives for marketing products from rare and threatened plant species and animal breeds	✓			6,7,12
Institutional and human capacity-building	Strengthen biodiversity-friendly patent, breeding and seed laws and regulation	✓	✓	✓	19
	Work with agriculture industry on biodiversity-friendly regulations and guidelines	✓			19
	Strengthen farmers' rights in national, regional and global guidelines and regulations	✓	✓	✓	19
	Develop material transfer agreements for conserved germplasm and capacity building/ training for those handling agreements	✓			12

3 METHOD OF ASSESSMENT

3.1 Scope of the assessment

Chapter 2 sets out three main activities that need to be undertaken in order to meet the objectives of Aichi Target 13 on genetic diversity. These include:

- *Ex situ* maintenance of existing collections for plant and animal genetic resources, and building these collections over the Target period;
- Developing approaches to create economic incentives for *in situ* conservation of genetic diversity by farmers; and
- Capacity-building in developing countries to protect and enhance *in situ* and *ex situ* conservation activities, focusing on socio-economically and culturally valuable species.

There are three other activities that are critically important for meeting the Target, but which have not been assessed in this study:

- Investing in new technologies for *ex situ* collection and maintenance activities;
- *In situ* conservation activities for farmed and domesticated animals and for crop wild relatives and landraces *inside protected areas*; and
- Awareness-raising activities specific to conservation of genetic diversity for the public, governments and the non-profit and business sectors.

Each of these activities significantly overlaps with the objectives and activities required under other Aichi Targets and are difficult to assess in the specific context of Target 13:

- Target 19 on improving the science base and technologies related to biodiversity overlaps with investments in new technologies for conserving plant and animal genetic diversity.
- Target 11 on conservation activities related to terrestrial and marine protected areas overlaps with *in situ* conservation of plant and animal genetic diversity *inside protected areas*.
- Target 1 on awareness-raising activities overlaps with awareness-raising activities specific to conservation of plant and animal genetic diversity.

Nevertheless, these activities will need to be prioritised under the other Targets specifically as they relate to conservation of genetic diversity; otherwise, these objectives may not be met. Coordination will be required to ensure that projects and programmes undertaken to meet these Targets highlights the objectives related to Target 13 as well.

3.2 Approach to the assessment

This assessment is based on existing estimates of resource requirements to undertake the three activities. In particular:

- *Ex situ* maintenance and expansion of collections for plant genetic diversity resource requirements are drawn from a funding proposal for financial support to the CGIAR genebanks in 2011 (CGIAR Proposal to the Funding Council 2011). The proposal estimates the current operating costs for all of the Consultative Group genebanks worldwide and expected one-time and recurring funding needs for these centers to 2013. The CGIAR genebanks represent some of the most comprehensive and complete collections of plant genetic resources for important crops in the world, and operate as a service to international researchers and farmers. As such, effective maintenance and expansion of these collections may be viewed as an underestimated proxy for the overall need to maintain and expand *ex situ* collections (which includes hundreds of large and small private and public genebanks such as the Millennium Seed Bank at Kew Gardens in the UK and PhilRice for rice germplasm in the Philippines. Information on the resource requirements needed to maintain all of these genebanks is not available).

- Creating economic incentives for *in situ* conservation of genetic diversity by farmers is an inherently difficult task due to lack of existing research on this subject and wide range of potential incentives that may be required according to different national contexts and the relative importance of the materials conserved (amongst other issues). As such, this paper draws on a concept paper (Dinerstein et al 2010) to develop a 'wildlife premium market' for conservation and recovery of endangered species and habitats—a market which could be applied to on-farm conservation of plant and animal genetic diversity as well.
- Capacity-building resource requirements in developing countries to protect and enhance *in situ* and *ex situ* conservation activities, focusing on socio-economically and culturally valuable species, have been based on the GEF-6 needs assessment, which estimates the cost of conducting a single project in a country to conserve culturally valuable species where the focus is on capacity-building. The present study calculates two scenarios for project funding based on per project GEF-6 resource estimates: an ambitious scenario that provides for at least one project per developing country (based on the World Bank definition) for a total of 144 projects and a modest scenario that provides for 50 projects in developing countries where the needs for such investment are assessed to be the greatest and where the return on investment may be highest.

This includes one-time investment needs and annual, recurring costs as follows:

- *Ex situ* maintenance and expansion of collections for plant and animal genetic diversity includes up-front investment needs to optimise and regenerate materials in existing collections and recurring resource requirements to maintain the materials in storage;
- Developing approaches to create economic incentives for *in situ* conservation of genetic diversity by farmers includes investments needs to develop a fund for payments to farmers for conservation efforts; and
- Capacity-building in developing countries to protect and enhance *in situ* and *ex situ* conservation activities includes investment needs to implement projects.

3.3 *Ex situ* maintenance and expansion of existing collections

The CGIAR Proposal to the Funding Council (2011) calculates the annualised resource requirements of an accession maintained in a collection by establishing two different resource types:

- One-off investment needs incurred once for an accession such as acquisition (entry of a new accession into a collection), characterization (once an accession has been adequately characterized, the exercise does not have to be repeated) and introduction into *in vitro* cryopreservation, as well as overall collection optimization to eliminate backlogs in regeneration or bring a collection into long-term storage.
- Recurring resource requirements for annual activities (such as maintaining the material in medium- and long-term storage) or that occur at regular and predictable intervals (e.g. regeneration, which may occur once every 15 – 50 years), which are annualized by accounting for the number of accessions involved in a given year.

Centres that maintain collections of the same crops are compared to assess factors that may lead to differential costs across centres; these were rationalized in the estimate as far as possible.

The funding proposal developed a common list of essential activities to maintain and distribute existing collections in order to ensure comparability between Centres and crops. The list includes:

- Acquisition: bringing new material into the collection – at an annual rate of 1% per year of the 2010 total accessions (i.e. not compounded), plus new acquisitions through regeneration;
- Characterization: essential passport and characterization data were included, primarily those used for accession identification purposes. Molecular characterization was largely

excluded except for clonal crops for which the identification and elimination of unwanted duplicates are important;

- Safety duplication, including the cost of preparing material to be sent to the Svalbard Global Seed Vault;
- Preservation of vegetatively-propagated crops: *in vitro* conservation,x cryopreservation, field genebanks, collections of lyophilized leaves and true seed, as appropriate;
- Medium and long-term seed storage;
- Regeneration activities;
- Germination testing, seed processing and germplasm health testing (including disease cleaning);
- Distribution, including compliance with international agreements and regulations;
- Information management for genebank operations and for making information about the collections widely available electronically; and
- General management, including professional staff costs.

A number of important activities for effective genebank operation are not included in the funding proposal assessment since they do not directly relate to the maintenance and distribution of existing material. These include collecting new material, duplicate identification, evaluation, pre-breeding, research on conservation methods, networking, providing international leadership, training and public awareness.

The consultants who undertook the CGIAR study noted that determining resource requirements for these operations is much harder to cost in a standardized way and have far greater elasticity than the operations that are covered. As noted in section 3.1, awareness-raising is considered to be covered in the present study by the Target 1 assessment. New collecting activity costs are indicated based on information provided by Kew Gardens on their own acquisition costs (see section 4.3.1.1), but these should be considered as an indicative, rather than directly comparable assessment of the resources required for this activity.

3.4 Develop approaches to create economic incentives for *in situ* conservation by farmers

Determining the resource requirements to conserve genetic diversity has been a priority since the early 1990's, but most studies focus on *ex situ* conservation or aggregate the costs of all conservation activities (e.g. Jarret and Florkowski 1990, Burstin et al 1997, Epperson et al 1997, Virchow 1999, Parday et al 1999, Dyer Leal 2002, Koo et al 2004, Zander et al 2009; cited in Wale 2011). Very little research has been undertaken to determine the resources required for *in situ* activities, and particularly for on-farm conservation (notable exceptions include Zander et al 2009 and Wale 2011).

At the same time, there is an acknowledged absence of market mechanisms to finance conservation activities for important species and habitats. Economic incentives are thought to be the most viable means of ensuring adequate on-farm conservation of genetic diversity, but research in this area is even more limited. At present, there is a voluntary market for carbon emissions that values forests which is earmarked for a few countries. There are no comparable markets related to biodiversity that can reduce the opportunity costs of conservation for developing countries and local communities (Dinerstein et al 2010).

The resource assessment for this activity used in the present study is drawn from a concept paper on developing a premium market for endangered species and habitats linked to carbon payments under UN-REDD[4] and REDD+ (Dinerstein et al 2011). The wildlife

[4] United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries; REDD+ goes beyond deforestation and forest degradation to include

premium concept can also be applied to other global biodiversity conservation priorities such as the *in situ* genetic diversity conservation needs described here.

The concept paper assumes that a large voluntary fund is available at a minimum to provide a source for 'wildlife premium payments'. Such a market cannot exist without accurate measurements of the resources being traded, and monitoring, reporting and verification procedures provided through a transparent system. The paper describes the steps required to do so including monitoring, reporting and verification procedures to ensure the market is credible and science-based.

A premium market for *in situ* conservation could be developed based on established lists of the most important centres of genetic diversity, where *in situ* conservation priorities are likely to be greatest, such as the eight Vavilov Centers of diversity for domesticated plants where large numbers of crop wild relatives and landraces can be found.

3.5 Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species

Capacity-building is cited by experts as an essential need to ensure that genetic diversity is maintained for plant and animal genetic resources. Capacity-building is also one of the most challenging tasks amongst conservation efforts in developing countries and mechanisms for developing and sustaining institutional and human capacity are poorly understood and highly context-dependent. The capacity required to meet Target 13 objectives, furthermore, cannot be readily measured. Instead of attempting to assess the existing and incremental capacity required to meet the Target, this study builds on the GEF-6 needs assessment by proposing that a large number of projects are undertaken in developing countries to gather additional information and develop approaches for capacity-building in each. The focus of these activities is on socio-economically and culturally valuable species—an area of conservation activity for genetic diversity that requires further basic investigation / information gathering and model projects in order to build up our understanding of these species and develop approaches for their conservation.

The GEF-6 needs assessment estimates the cost of conducting a single project in a country to conserve culturally valuable species where the focus is on capacity-building. The present study has assessed the resources required to implement projects of this type under two scenarios: an ambitious scenario that provides for at least one project per developing country (based on the World Bank definition) for a total of 144 projects and a modest scenario that provides for 50 projects in developing countries where the needs for such investment are assessed to be the greatest and where the return on investment may be highest.

3.6 Difference between the approach adopted here and the GEF needs assessment

3.6.1 The GEF needs assessment approach for Target 13

The GEF 6 needs assessment for Target 13 focuses on creating greater synergies between *in situ* and *ex situ* conservation efforts. It prioritises two activities to meet this Target objective:

- Conservation of agro-biodiversity species including wild relatives of domesticated plants and livestock on farm; and
- Conservation of culturally valuable species.

A unit cost of $5 million is assumed based on estimates available from similar projects executed in Africa and Asia. This cost covers the period 2014-2018.

conservation, sustainable management of forests and enhancement of forest carbon stocks; see: http://www.un-redd.org/.

The GEF 6 assessment is based on conducting a small number of pilot studies that could serve as models for large scale national level efforts. The assessment thus proposes three ambition levels for funding over the GEF funding period for each of the two activities: Scenario 1 assumes 3 projects of each type, Scenario 2 assumes 6 projects of each type and Scenario 3 assumes 9 projects of each type will be undertaken.

3.6.2 Use of the GEF 6 needs assessment approach for this study

The present study focuses on one of the two activities proposed under the GEF 6 assessment: conservation of culturally valuable species. On-farm conservation is, by contrast, assessed through the development of economic incentives using a premium market to provide farmers with payments for conservation activities (see section 3.4) since project-based activities are widely thought to be inadequate on their own to meet the Target objectives, and particularly for sustaining long-term conservation activities.

This study uses the unit cost estimate of $5 million per project, assuming that the annual cost is approximately $1 million per year (GEF 6 funding period is 2014-2018), and thus $8 million per project in total over the Aichi Target period (2013 - 2020). A much larger number of projects are expected to be required, since the GEF assessment looks at developing only a small number of pilot projects, but the current study is required to assess the global needs to meet Target 13.

4 ASSESSMENT OF RESOURCE NEEDS

4.1 *Ex situ* maintenance and expansion of existing collections of plant genetic resources

4.1.1 Investment needs

There are two main investment needs to maintain existing collections of plant genetic resources:

- 'Optimising' collections in order to bring material from medium-term to long-term storage and to cryopreserve materials that are currently held only *in vitro*, but for which sufficiently robust cryopreservation protocols are available; and
- 'Regenerating' collections and bringing these new materials into the collections.

The estimates provided in the CGIAR Funding Proposal total approximately $11.5 million for 'optimising' activities and $6 million for 'regeneration' activities, for a total of approximately $18 million in investment needs across all 10 genebanks in the system. This represents a conservative estimate and is likely to be incomplete. The estimated investment needs by genebank are detailed in Table 4.2.

4.1.2 Recurring resource requirements

Table 4.1 summarises the annual, recurring resource requirements needed for maintenance and distribution activities of each of the CGIAR genebanks. These range between approximately $350,000 per year to more than $3 million per year. The total cost of these core genebank functions across all 10 CGIAR genebanks in 2011 is $15 million. These resources will be required every year over the project period to continue the conservation of *ex situ* plant genetic diversity in these genebanks.

Table 4.1 Summary of CGIAR genebank maintenance & distribution activity requirements for 2011

	Maintenance & distribution
Center	US$
AfricaRice	342,515
Bioversity	970,932
CIAT	2,394,585
CIMMYT	1,165,430
CIP	3,231,248
ICARDA	1,299,908
ICRISAT	2,464,419
IITA	1,130,621
ILRI	840,763
IRRI	1,393,625
Sub-total	15,234,045

CGIAR 2011

The CGIAR Funding Proposal provides an assessment of costs in a given year. But the resource requirements will not remain constant over the Aichi Target period. For example, the collections are expected to grow in size. The Funding Proposal observes that some collections may increase by as much as 7.5 per cent between now and 2015. Equally, some collections may decrease in size where duplicate accessions are removed.

Table 4.2 CGIAR genebanks – one-time costs

	Optimising the collection		Introducing accessions from Regeneration Project		
Center	Activity	Cost (USD)	Activity	Cost (USD)	Center total (USD)
AfricaRice	Processing 8000 accessions from medium to long-term storage	494,399			494,339
Bioversity	Cryobanking / safety duplicating 464 accessions	728,944			728,944
CIAT	Regenerating 16191 bean accessions Cryobanking 1000 cassava accessions Regenerating 9259 forage accessions	5,907,393	Bean and cassava introductions	354,644	6,262,037
CIMMYT			Maize and wheat introductions	2,369,177	2,369,177
CIP	Cryobanking 750 potato & 750 SP accessions; safety duplication 300 m maize accessions	2,364,595	Potato and sweet potato introductions	1,655,678	4,020,273
ICARDA			Barley, faba bean, grasspea, and lentil introductions	164,245	164,245
ICRISAT			Pearl millet, small millet, and sorghum introductions	475,678	475,678
IITA	Health testing 13303 cowpea accessions; safety duplication 300 m maize accessions	735,626	Bambara groundnut, cowpea, maize, and yam introductions	494,649	1,230,275
ILRI	Processing 4000 forage accessions into long term storage	1,170,158			1,170,158
IRRI			Rice introductions	469,620	469,620
Total		11,401,055		5,983, 691	17,384,746

CGIAR 2011

The collections are also expected to acquire proportionally more accessions of wild relatives, and these are generally more difficult and expensive to maintain than cultivated accessions. It might be possible to reduce the cost of clonal collections through a greater use of cryopreservation, true seed and other technologies but in many cases this will require further research and a considerable up-front expenditure. The costs of molecular characterization are expected to fall but additional indexing and cleaning may be required to eliminate virus and other disease (CGIAR Funding Proposal 2011).

The Proposal predicts that the total size of all the CGIAR collections will reach more than 750,000 accessions by 2015, and require annual funding of $16 million to maintain at that size.

4.2 Develop approaches to create economic incentives for *in situ* conservation by farmers

There are no studies that can provide an estimate of the level of investment required to set up a market for *in situ* conservation. Nevertheless, in their concept paper for a wildlife premium market, Dinerstein et al (2011) suggest an indicative figure of $135 million for the World Bank to operationalize the Prototype Carbon Fund in 2000. Today, the World Bank's Forest Carbon Partnership Facility, which evolved out of this Fund, is involved in assisting developing countries to prepare for REDD+ projects, establishing large-scale systems of incentives to reduce emission from deforestation and forest degradation and provides a financing source for sustainable use of forest resources (Dinerstein et al 2011: 5).

This amount ($135 million) is likely to be the minimum amount required to set up a similar fund for *in situ* on-farm conservation of genetic diversity. No further information is available regarding potential recurring costs for such a fund over the Target period.

4.3 Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species

The GEF 6 needs assessment cites unit cost estimates for conservation of threatened species under reasonably robust conservation project conditions both by unit habitat area and by unit cost per species. Unit costs for conservation of threatened species range from $0.33 million to $15 million per unit (i.e. per individual animal) conserved in New Zealand (Cullen et al 2005). Unit costs based on habitat size range from $10 per hectare (Boo 1990) to $18 per hectare for a project in India to develop tiger reserves (Damodaran 2009, cited in GEF-6 2012). The GEF 6 assessment uses the estimate from Damondaran (2009) as it is the most recent figure to provide a benchmark.

A strong national commitment to conservation activities is assumed, such that the baseline conditions for conservation are already strong. The assessment uses a conservative habitat-based unit cost of $5 million to conduct additional activities to meet agro-biodiversity targets under national action plans over the GEF 6 funding period 2014-2018. The modal project size is 3,000 sq km, or $1,666/sq km at a unit project cost of $5 million.

4.3.1 Data gaps and shortcomings

4.3.1.1 Ex-situ plant genetic diversity

The CGIAR funding proposal does not include the resources required to conduct collecting activities for the expansion of their *ex situ* collections. In addition to maintenance and preservation needs, there will also be investment needs to conduct collecting activities, process and store the accession and to conduct research, management and capacity-building activities in the country of collection.

While estimates of these resource requirements are not available for the CGIAR centers, the Millennium Seed Bank at Kew Gardens has determined the average cost of storing a seed

collection in the Millennium seed bank within the first 10 years of the Millenium Seed Bank Project. Within this time period the project reached 50 countries.

The total cost per species (two collections, one in the Millennium Seed Bank and another in the country of origin) is estimated to be approximately $3,000 per species, of which:

- 20% ($600) is spent on collection;
- 10% ($300) is spent on processing and storage; and
- 70% is spent on research, management and building capacity (training and creating facilities etc) ($2,100).

4.3.1.2 *Ex situ animal genetic diversity*

The assessment of resource requirements related to conservation of *ex situ* collections for maintaining genetic diversity is limited due to the lack of information available on the resources required to conserve animal genetic resources. The estimate for *ex situ* resource requirements is therefore a considerable underestimate of the resources required as it is missing this essential component. Further research is required to understand the potential resource requirements to maintain *ex situ* animal genetic resources over the Aichi Target period.

5 Overview of results

This section provides an overview of the resource assessment results for three activities to meet the objectives of Target 13. The results are broken down by investment needs and recurrent resource requirements.

5.1 Investment needs

Investment needs are the most significant resource requirement for meeting Target 13. Each activity requires upfront investment over the first three years of the Aichi Target period (2013-2015).

- *Ex situ* maintenance and expansion of existing collections requires $18 million from 2013-2015 to optimise and regenerate the CGIAR genebank collections.
- A minimum of $135 million will be required to set up a market fund for *in situ* on-farm conservation activities by farmers (based on setting up a similar market for a carbon fund). This will likely cover initial setup requirements and seed a pilot programme of payments for conservation activities.
- Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species will require between $553 million (50 projects) and $1.2 billion (144 projects). For the present study, two scenarios are assessed:
  - **Scenario 1** assumes modest resource investment over the Aichi period, which will target projects in countries where conservation needs and the return on investment may be greatest. Under this scenario, 50 projects will be undertaken in developing countries. The average cost per year is $1 million, or $8 million per project over the Aichi Target period (2013-2020). Fifty projects at $8 million per project will require a $400 million investment.
  - **Scenario 2** assumes more ambitious resource investment over the Aichi Target period, with the opportunity to conduct at least one capacity-building project for socio-economically and culturally valuable species over the project period (or more than one where the needs are determined to be greatest and where some countries do not require any projects). There are 144 developing countries according to the current World Bank definition; 144 projects at $8 million per project will require a $1.2 billion investment.

5.2 Recurrent expenditures

Recurrent expenditures have been calculated for *ex situ* maintenance and expansion of existing CGIAR genebank collections based on estimates provided in the CGIAR funding proposal (2011). Recurrent expenditures are expected to be between $15 and $17 million per year, depending on the rate of growth of the collections and any cost savings achieved through development of new techniques and other measures such as eliminating duplicates.

Two recurring resource requirement scenarios are used in this assessment:

- **Scenario 1** is a modest estimate, using the $15 million per year budget set out in the CGIAR funding proposal for a total of $120 million over the Aichi Target period (2013-2020).
- **Scenario 2** is a more ambitious estimate, assuming that the collections grow as predicted and require an additional $0.5 mil per year over the Target period, for an average of approximately $17 million per year needed to maintain the collections for a total of $134 million over the Target period (2013-2020).

Recurrent expenditures were not established for the other two activities: developing economic incentives for on-farm conservation and capacity-building activities in developing countries. Recurrent expenditures for on-farm conservation activities will be, required, for example, but the number of participants, types of activities to be funded and other issues are unknown. Estimates for recurrent resource requirements for these activities cannot be

determined as they are tentative and poorly understood. Further research will be required to make these estimates.

5.3 Additional resource needs

This resource assessment is based on limited information regarding the needs for meeting Target 13. It draws on expert views regarding the key activities needed to meet the Target and a small number of sources that attempt to assess the unit costs for approaches that could be used to undertake these activities (particularly for *in situ* activities). As a result of these limitations, the resource requirements presented in this study represent a significant underestimate of existing investment and additional resource needs required to meet Target 13 objectives.

A complete assessment of the current global investment levels for activities that already meet Target 13 objectives is not possible given the limited time and resources available for the study. A strong baseline for *ex situ* plant genetic resources conservation is thought to exist. The most recent State of the World Report on PGRFA observes that there are approximately 1750 crop genebanks worldwide that, together, conserve about 7.4 million accessions (samples). The author is not aware of any published information on the resources required to maintain all of these genebanks. The costs of maintaining the CGIAR genebanks and expanding their collections was considered to be a suitable proxy since these genebanks conserve all of the major crop groups, including a significant number of crop wild relatives and landraces and act as a resource for biodiversity conservation efforts worldwide. Moreover, *ex situ* resource requirement for conserving animal genetic diversity was not included in this assessment due to lack of information.

Current investment for *in situ* conservation activities is even harder to determine. The resource needs provided in this study reflect only the additional minimum levels of additional resources required to undertake activities in this area during the Aichi Target period.

5.4 Cost profile

The profile of resources required to meet Target 13 objectives will not remain static. There are many factors that may affect the cost profile of the different activities over time. Examples of these likely changes are highlighted below.

- ***Ex-situ* maintenance and expansion of existing collections**: resources required to maintain individual accessions of plant genetic resources are most affected by the period between regeneration of materials because these activities have high labour costs associated with them (CGIAR 2011). Where the period can be extended between regeneration, *ex situ* resource requirements are likely to decrease. Similarly, vegetatively-propagated crops require higher resources per accession than seed crops due to labour requirements for their *in vitro* conservation (Ibid). Using new methods such as cryopreservation may help to reduce costs over time, but these methods still require development of protocols to ensure that the results are robust. Genebank operational costs have also increased due to international requirements for phytosanitary permits, material transfer agreement management and GMO presence declarations as well as additional safety backups, including at the Svalbard Global Seed Vault (SGSV).
- **Develop approaches to create economic incentives for *in situ* conservation by farmers**: as agriculture becomes more productive and commercialised, economic incentives are likely to increase in order to maintain their attractiveness to farmers. The resources required for these activities are therefore likely to increase over time (Wale 2011).
- **Capacity-building activities in developing countries, particularly through conservation of socio-economically and culturally valuable species**: effective capacity-building should reduce resource requirements over time for conservation activities in general, and decrease the need to carry out capacity-building projects since institutional and human capacity will not only be created, but maintained.

Table 1.1 Estimated resource needs - breakdown

Activity	Investment needs (total period, 2013 – 2015)		Recurrent annual expenditure		Recurrent total (total period, to 2020)	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Ex-situ maintenance of plant genetic resources	(CGIAR Centres) $18 mil		(CGIAR Centres) $15 mil	(CGIAR Centres) $17 mil	(CGIAR Centres) $120 mil	(CGIAR Centres) £134 mil
Create economic incentives for *in situ* conservation	(market initiative) $135 m					
Capacity-building in developing countries	(GEF-6 project cost, 50 projects) $400 mil	(GEF-6 project cost, 144 projects) $1.2 bil				
Total	$553 mil	$1.4 bil	$15 mil	$17 mil	$120 mil	$134 mil

Table 1.2 Total resource needs

Activity	Total for the whole period (2013 – 2020)		Average annual (for period 2013 – 2020)	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2
Ex-situ maintenance of plant genetic resources	(CGIAR Centres) $138 mil	(CGIAR Centres) $152 mil	(CGIAR Centres) $17 mil	(CGIAR Centres) $19 mil
Create economic incentives for *in situ* conservation	(market initiative) $135 million		(market initiative) $17 mil	
Capacity-building in developing countries	(GEF-6 project cost, 50 projects) $400 mil	(GEF-6 project cost, 144 projects) $1.2 bil	(GEF-6 project cost, 50 projects) $50 mil	(GEF-6 project cost, 144 projects) $150 mil
Total	$673 mil	$1.5 bil	$84 mil	$186 mil

6 DISCUSSION

6.1 Confidence in the estimates produced

The confidence levels associated with the different estimates and activities vary. There are also varying gaps in the evidence. These are summarised in Table 6.1 below. Overall, confidence in the estimates produced is low. Further research is required to assess the baseline situation for plant and animal genetic resources globally. Additionally, animal genetic resources are not sufficiently considered in the present study. Alternative approaches for developing economic incentives for *in situ* conservation should be investigated.

Table 6.1 Confidence levels and gaps associated with estimated expenditure of the different activities

Activity	Confidence levels associated with estimated expenditure	Gaps in the evidence and further research needs
Ex-situ maintenance and expansion of existing collections	**MEDIUM** CGIAR centres have some of the largest and most comprehensive collections of plant genetic resources in the world; estimates available on resources required to maintain these and develop the collections further.	Information lacking on resources required to maintain national genebanks and botanical garden collections for plant genetic resources No information on current extent of *ex situ* conservation for animal genetic resources or resources required to meet Target 13.
Develop approaches to create economic incentives for *in situ* conservation	**LOW**	Little information on current extent of *in situ* conservation approaches or resources required to maintain these for plant or animal genetic resources.
Capacity-building in developing countries	**LOW**	Uncertainty regarding best approach to capacity-building in developing countries, compounded by uncertainty regarding current extent of *in situ* conservation and additional resources required.

6.2 Benefits of delivering the Target

Genetic diversity is an international public good and the benefits of conservation extend well beyond national boundaries (Perrings 1995 cited in Wale 2011). Plant and animal genetic resources are essential for sustainable agricultural production.

Plant and animal genetic resources for food and agriculture provide the biological basis for agricultural production and world food security. Plant genetic resources are critical raw material for farmers and for plant breeders (FAO 2010b). The genetic diversity in these resources allows crops and varieties to adapt to ever-changing conditions and to overcome the constraints caused by pests, diseases and abiotic stresses. Specifically:

- Genetic resources conserved *ex situ*, particularly in genebanks that distribute materials like those maintained under the CGIAR umbrella, are the basis for breeding programmes and provide breeders, researchers and farmers worldwide with materials to use in agricultural development.
- Developing approaches to create economic incentives for *in situ* conservation by farmers helps to maintain indigenous crop varieties, evolutionary processes and farmers'

indigenous knowledge. *In situ* conservation is also a participatory approach to conservation and provides a link between conservation and the use of the varieties and farmers' livelihoods. On-farm conservation in particular is a good conservation strategy for harmonising policy objectives with farmers needs and interests (Wale 2011).

- A market mechanism for *in situ* on-farm conservation activities can help to reduce or even halt the loss of genetic diversity and improve livelihoods for the rural poor who maintain genetic diversity on-farm (and in the larger community) (Dinerstein et al 2011).

6.3 Links to other policy areas

Managing a portfolio of crop varieties is important in light of increasing global stress factors (global warming, land degradation, desertification and agro-ecological imbalance) (Wale 2011). There is a strong relationship between poverty and a high degree of genetic diversity for livestock and crop plants (Blench 2005). A high level of genetic diversity helps to ensure that rural households have access to the materials required and manage risk in order to maintain their livelihoods in uncertain environments.

6.4 Funding opportunities / Sources of funding

There are some funding opportunities that may specifically be harnessed for *ex situ* conservation of plant genetic resources, including the Global Crop Diversity Trust and the CGIAR Fund:

- The Global Crop Diversity Trust utilises donations from national governments, civil society, the private sector, farmers' organisations and individuals. The Trust was created in 2004 and aims to ensure the long-term conservation of plant genetic resources for food and agriculture for food security and sustainable agriculture. The Trust is co-sponsored by FAO and the International Plant Genetic Resources Institute (IPGRI). The Global Crop Diversity Trust was created to help fund important collections in perpetuity, including those of the CGIAR Centres (http://www.croptrust.org).
- The CGIAR Fund was designed to unite donors in order to harmonise their contributions to agricultural research for development and improve the quantity and quality of funding to the CGIAR centres (http://www.cgiarfund.org/history).

ANNEXES

Annex 1 References

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