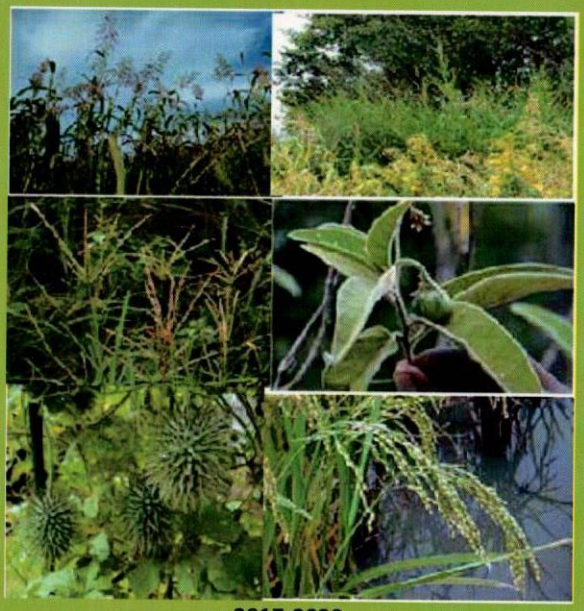
Republic of Zambia

Ministry of Agriculture

NATIONAL STRATEGIC ACTION PLAN FOR THE CONSERVATION AND SUSTAINABLE USE OF CROP WILD RELATIVES IN ZAMBIA



2017-2020

Ministry of Agriculture, 2016

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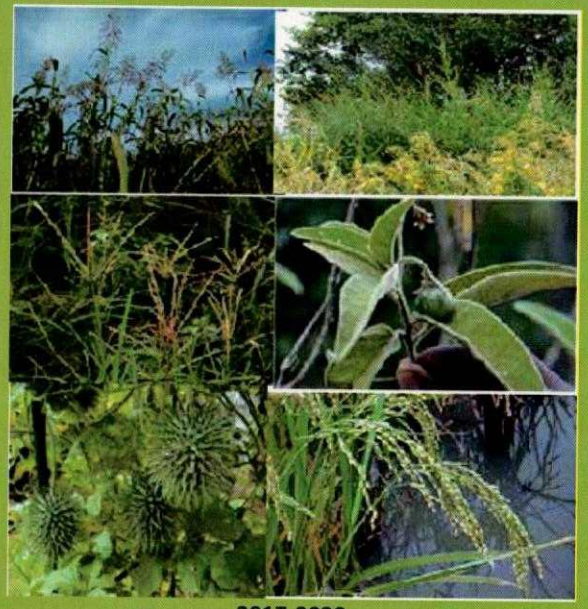

2017-2020

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FOREWORD

Crop wild relatives (CWR) are plant species that are related to cultivated crops and include crop progenitors closely related to cultivated crops. In Zambia, these species include but not limited to wild relatives of rice (*Oryza sativa* L), which are *Oryza barthii* A. Chev, *Oryza brachyantha* A. Chev. & Roehr and *Oryza longistaminata* A. Chev. & Roehr; cowpea, *Vigna unguiculata* L. (*Vigna unguiculata* (L.) Walp. var. *spontanea* (Schweinf.) Pasquet, *Vigna unguiculata* (L.) Walp. subsp. *dekindtiana* (Harms) Verdc.); and sorghum, *Sorghum bicolor* L. (*Sorghum verticilliflorum* (Steud.) Stapf, *Sorghum arundinaceum* (Desv.) Stapf). CWR constitute a potential source of basic genetic material for adapting crops to changing climatic conditions, improving crop productivity and developing the quality of the products. In the light of changing climate, genetic diversity represent a critical resource for crop variety improvement in our efforts towards food security for the ever growing population and dwindling natural resources.

CWR occur in wild habitats and often times they are not included in national conservation programmes despite being under threat of erosion. To minimize loss and maximize the availability of plant genetic resources for crop improvement efforts in the future, there is an urgent need to ensure appropriate conservation and management of PGRFA at global, regional, national and local levels. This need has been recognized by international conventions and agreements, including the Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA) to which Zambia is a Party.

Through the ACP-EU supported SADC CWR Project, Zambia has developed the National Strategic Action Plan (NSAP) for the conservation and sustainable use of nationally identified priority CWR. The NSAP outlines concrete strategic actions for the conservation and sustainable use of CWR, defines specific national collaborative partnerships and suggests the means of resources mobilization for its effective implementation and monitoring of its implementation.

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The SADC CWR project entitled *"In situ* Conservation and Use of Crop Wild Relatives in three countries of the SADC region" (funded by the European Union (EU) Secretariat of the African, Caribbean and Pacific (ACP) Group of States through its ACP-EU Co-operation Programme in Science and Technology (S&T II)), which aims to enhance scientific capacities within the partner countries of the SADC region (including Zambia) to conserve CWR and identify useful potential traits for use to adapt to climate change as well as to develop exemplar National Strategic Action Plans for the conservation and use of CWR in the face of the challenges of climate change is acknowledged for being the precursor initiative for this effort.

The national and regional institutions that were involved in the process leading to development of the NSAP, led by the Zambia Agriculture Research Institute (ZARI), are the University of Zambia (UNZA), Community Technology Development Trust (CTDT), Department of National Parks and Wildlife formerly Zambia Wildlife Authority (ZAWA), Biodiversity Community Network (BCN), The Department of Forestry, Zambia Environment Management Agency (ZEMA), SADC Plant Genetic Resources Centre (SPGRC). We would like to thank and recognise all the individuals from these and other institutions that contributed to the development of the NSAP.

We would like to thank the following persons for the provision of their valuable technical assistance, tools for enabling this work and for their advice throughout the process of NSAP development: Ehsan Dulloo, Imke Thormann and Hannes Gaisberger (from Bioversity International); Nigel Maxted, Joana Magos and Shelagh Kell (University of Birmingham).

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List of Acronyms

ACP	African, Caribbean and Pacific Group of States
AMCEN	African Ministerial Conference on Environment and Natural Resources
BCN	Biodiversity Community Network
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agriculture Research
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Centre
CSO	Central Statistics Office
CTDT	Community Technology Development Trust
CWR	Crop Wild Relative
CYMMIT	International Centre for Research in Maize and Wheat
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FR	Forest Reserve
GDP	Gross Domestic Product
GMA	Game Management Area
GPA	FAO Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture
GSPC	Global Strategic Plan for Conservation
GRZ	Government of the Republic of Zambia
ICRISAT	International Centre for Research in Semi-Arid Tropics
IITA	International Institute for Tropical Agriculture
IRRI	International Rice Research Institute
ITPGRFA	International Treaty for Plant Genetic Resources for Food and Agriculture
IUCN	International Union for the Conservation of Nature
MAFF	Ministry of Agriculture, Food and Fisheries
MLS	Multilateral System of plant genetic resources exchange
MTENR	Ministry of Tourism, Environment and Natural Resources
MU	Mulungushi University
NAIS	National Agricultural Information Services
NBSAP	National Biodiversity Strategy Action Plan
NEPAD	New Economic Plan for African Development
NP	National Park
NPGRC	National Plant Genetic Resources Centre
NSAP	National Strategic Action Plan
PA	Protected Area
PGRFA	Plant Genetic Resources for Food and Agriculture
SABONET	Southern Africa Botanical Network
SADC	Southern Africa Development Community of States
SNDP	Sixth National Development Plan
SPGRC	SADC Plant Genetic Resources Centre

UNZA	University of Zambia
ZANIS	Zambia National Information Services
ZARI	Zambia Agriculture Research Institute
ZAWA	Zambia Wildlife Authority
ZEMA	Zambia Environment Management Agency
ZNBC	Zambia National Broadcasting Corporation

Crop wild relatives (CWR) are wild species that are closely related to crops and are recognized as a vital component of agricultural biodiversity. They are genetically diverse, locally adapted and represent a potential source of genes and alleles for adapting crops to changing environmental conditions and human needs and is thus be an important resource for crop improvement. Most crop species have through natural processes receive genes from one or more CWR species conferring resistance to pests and diseases or tolerance to extreme climatic conditions.

There is a need for a National Strategic Action Plan (NSAP) in order to guarantee CWR conservation and sustainable use and to prevent diversity loss and to maximize availability for crop improvement.

This NSAP was prepared within the context of the SADC CWR project entitled "*In situ* Conservation and Use of Crop Wild Relatives in three countries of the SADC region" co-funded by European Union and implemented through the ACP-EU Co-operation Programme in Science and Technology (S&T II) by the ACP Group of States. Grant agreement no. FED/2013/330-210.

The NSAP was prepared in a participatory manner involving all stakeholders who participated in developing the initial checklist and inventory list of CWR and to prioritise them. Its goal is to conserve and sustainably utilize all priority CWR in the country. The preparation of the NSAP was led by The National Plant Genetic Resource Centre (NPGRC) which has the mandate of conserving plant genetic resources (PGR) (including CWR) in the country.

The NSAP derived significant input from the technical background document that was developed before formulation of the NSAP. The technical background document forms the scientific basis of the NSAP and outlines in detail the process through which the CWR lists were derived and prioritized. It therefore complements this NSAP document.

Zambia is signatory to various agreements that contribute to strengthening the conservation and use of PGR including CWR. These include the Convention on Biological Diversity (CBD) whose updated strategic plan for biodiversity conservation addresses CWRs and is specifically referred to in Target 13: "*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*".

Zambia has also endorsed FAO's Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (GPA) whose priority activities make special reference to CWR, highlighting the need to strengthen their conservation and sustainable use.

Out of 459 CWR from 59 national priority crops identified in Zambia, 30 were prioritised and plans for their conservation and use have been formulated in the NSAP. The best available option in the country for establishing active *in situ* conservation of CWR is to rely on existing protected areas (PA) and to develop CWR management plans that feed into the broader PA management plans. Out of the total of 30 priority CWRs, 21 are covered in the existing protected area network.

The key strategic actions required for conservation of CWR genetic resources are:

(i) Including CWR conservation in the NBSAP.
(ii) Making clearer and specific statements on CWRs in the various policy documents and development plans.
(iii) Integrating CWRs in natural resources management plans and conservation programmes.
(iv) Increasing financial resources to CWRs programmes.
(v) Including CWR' value in school curricula at all levels of learning.
(vi) Creation of functional and effective partnerships for conservation and sustainable use of CWR.
(vii) Developing national capacity for characterization and use of CWR in breeding in the country.

Further the NSAP has identified the concrete actions for the conservation and utilization of CWRs that need to be done and also identified the key stakeholders and the roles they will play in the implementation of the NSAP. Implementation of the NSAP will require resources and capacities that are spread out in different stakeholder organizations. Government will provide the core funding especially to cover personnel and basic infrastructure while other stakeholders will contribute in the form of specialist personnel and equipment cost. Major funding to carry out specialist activities for implementing the NSAP will also come from collaborative programmes from the SADC programme as well as various international on going initiatives. Various donors will also support specific aspects of CWR conservation and use guided by the NSAP.

Monitoring the implementation of the NSAP will be an integral component of the NSAP from the beginning of the implementation onwards. Monitoring will track changes in actual and potential uses of priority CWRs and changes in the user demand as a result of availability of more information and germplasm of CWR. Monitoring will also track if there is increase in the availability of CWR germplasm at national, regional and global levels and especially any increase of utilization at national level.

1 INTRODUCTION

Crop wild relatives (CWR) are wild species that are closely related to crops. They are recognized as an important component of agricultural biodiversity. In general, CWR are genetically diverse, locally adapted and represent a potential source of genes and alleles for adapting crops to changing environmental conditions and human needs and is thus an important resource for crop improvement.

Most crop species have through naturally processes received genes from one or more CWR species. CWRs harbor and confer genes for resistance to pests and diseases or for improved tolerance to extreme temperatures, drought and flooding. CWR are also components of natural and semi-natural ecosystems and they also play a role in environmental sustainability and ecosystem functioning. A decrease in the availability of CWR genes and alleles will also restrict the options of farmers and breeders and have a negative impact on future food security. Loss of populations of CWR can lead to a decline in the viability of plant communities, as well as a reduction in the evolutionary potential of the CWR species themselves, which can in turn eventually lead to species extinction and cause unforeseen changes in ecosystems.

CWR are increasingly used for crop development and improvement, offering unique potential and opportunity to enhancing food security and livelihoods of farmers. In Zambia these include wild relatives of asparagus (*Asparagus*), melon and cucumber (*Cucumis*), yams (*Dioscorea)*, millets (*Echinochloa, Eleusine, Pennisetum*), sweet potato (*Ipomoea)*, rice (*Oryza*), sesame (*Sesamum*), eggplant (*Solanum*), sorghum (*Sorghum*), cowpea and Bambara groundnuts (*Vigna*).

The world community at large has awakened to the important contributions that CWR have to make to global food and nutrition security, especially with the challenges of food production in the wake of climate change. In 2015, a notification[1] was jointly issued by the Secretariats of the Convention of Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the FAO Commission on Genetic Resources for Food and Agriculture, and Bioversity International, whereby countries were encouraged to *"review, develop or strengthen their national strategies for the in situ conservation of crop wild relatives through protected area networks and other area-based conservation measures and the development of integrated approaches that link their conservation to their sustainable use"*. Such actions have the potential to make significant

[1] https://www.cbd.int/doc/notifications/2015/ntf 2015 092 gspc en.pdf

contribution to the synergistic achievement of Aichi Biodiversity Targets 7, 11, 12 and 13, as well as to the Global Strategy for Plant Conservation Targets 5, 6, 7 and 9[2]. As per GSPC target 9, *70 per cent of the genetic diversity of crops including their wild relatives and other socio economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge*. Aichi target 13[3] stated *that 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*. The priority activity number 4 of the FAO Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (GPA) targets the promotion of *in situ* conservation of CWR and wild plants for food production.

There is a need for national CWR conservation and use planning in order to guarantee the conservation and sustainable use of CWR and to prevent diversity loss and to maximize their availability for crop improvement. CWR are increasingly suffering from genetic erosion thus a coordinated, systematic and integrated approach to CWR conservation is essential and should include both *in situ* and *ex situ* strategies. This can be best implemented via well articulated national conservation plans.

This NSAP was prepared in a participatorymanner involving all major stakeholders. In the initial stages of the project ZARI worked closely with Department of National Parks and Wildlife formerly Zambia Wildlife Authority (ZAWA), the University of Zambia (UNZA), Community Technology Development Trust (CTDT) and Biodiversity Community Network (BCN) to develop the initial checklist and inventory list of CWR in Zambia and there after to prioritise the CWR species according to set criteria (see section 6.1). Under the technical guidance from University of Birmingham and Bioversity International, diversity analysis of the priority CWR were carried out to determine the potential areas for *in situ* conservation of the priority CWR in Zambia. An initial stakeholder workshop was organised in October 2014 involving 12 participants to initiate the preparation of the NSAP. A roadmap was prepared that included the validation of the developed checklist by a wider national stakeholder participation. Key results of the diversity analysis was presented to participants indicating how the checklist was derived

[2] https://www.cbd.int/gspc/targets.shtml
[3] https://www.cbd.int/doc/strategic plan/2011 2020/Aichi Targets EN.pdf

by matching a crop priority list of 29 crop genera with the digitized 6,305 checklist of Zambian vascular plants. At this workshop a final list of priority crops was reached upon by consensus and this process generated 59 cultivated crop species belonging to 29 genera. This process is articulated in detail in the technical background document that complements the NSAP

Scope of the NSAP

While the development of the NSAP considers the full range of CWR that are found in Zambia as identified in Flora of Zambia which has 3,605 species of vascular plants (Phiri, 2005), this NBSAP however covers the identified list of priority wild relatives of priority crops which include cereal, food legumes, vegetable, root and tuber, oil, fibre, pasture and forage and green manure crops. This list of priority crops includes both those that are native to Zambia and those that are introduced. Some of the crops on the priority crop list such as maize (*Zea mays* L.), rice (*Oryza sativa* L.) and sorghum (*Sorghum bicolor* L.) for cereals, cowpea [*Vigna unguiculata* (L) Walp], and common bean (*Phaseolus vulgaris* L.) for food legumes, and cassava (*Manihot esculanta* L.) and sweet potato (*Ipomoea batatas*) are among the global food security crops as reflected in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) from FAO (2001) and among regional important crops as outlined in the Southern African Development Community Regional Agricultural Policy (SADC, 2013) and Southern African Development Community Agricultural Development Plans.

2 Goals and objectives of the National Strategic Action Plan

The goal of the NSAP is to conserve and sustainably utilize CWR in the country. The objectives are:

I. To establish a network of active *in situ* conservation sites to conserve the priority CWR in the country.

II. Formulation and implementation of complementary *ex situ* conservation of CWR; and

III. Promotion of the sustainable use of CWR in crop improvement.

The NSAP will establish better communication and coordination between various institutes and organizations engaged in *in situ* and *ex situ* conservation and land use management, at national, regional, and global levels.

3 Constitutional, legal and institutional framework

3.1 National policy framework

Agriculture remains the priority sector in achieving sustainable economic growth and reducing poverty in Zambia. This is because the country has immense natural resources such as land, water and arable land to support agricultural activities. In addition, over 80 percent of the rural population depends on

agriculture-related activities for their livelihood. The growth of this sector is, therefore, important for the attainment of the long term vision for Zambia which is to become "a prosperous middle income nation by 2030" (Vision 2030).

Agriculture and economic policies

Zambia is endowed with vast and diverse natural resources that form the basis for economic activity. These include land, wildlife, forest, minerals, natural heritage and wetlands. Effective and efficient management of these natural resources can significantly contribute to national development through foreign exchange earnings and employment creation. In addition, various natural resource products and ecosystem services are important sources of livelihood and energy.

The focus for the Revised Sixth National Development Plan (R-SNDP) is to reverse deforestation, wildlife depletion, heritage sites degradation, and land degradation, and to enhance collaboration among stakeholders in natural resources management in order to ensure sustainable exploitation of natural resources. SNDP does not however specifically refer to CWR.

The Second National Agricultural Policy (SNAP) was formulated in order to address the challenges and short comings identified during implementation of the National Agricultural Policy (NAP)2004 – 2015. The SNAP also addresses sustainable food security and nutrition contributing to profitability of agricultural enterprises, job creation, increased income generation, poverty reduction, as well as increased contribution of the agriculture sector to Gross Domestic Product (SNAP 2016). Although the SNAP does not specifically mentions the crop CWR, one of its objectives is to promote R&D in agriculture. Further, the Policy contains a policy measure aimed at promoting the cultivation and consumption of indigenous crop varieties.

National Plant Genetic Resources Programme

The National Plant Genetic Resource Centre (NPGRC) shoulders the responsibility of conserving locally available plant genetic resources for food and agriculture (including crop wild relatives) in the country. The NPGRC falls under the Zambia Agriculture Research Institute (ZARI) which is one of the departments under the Ministry of Agriculture. The mandate of the NPGRC includes both *in situ* and *ex situ* conservation. The latter includes field collections, characterization and evaluation, seed regeneration, multiplication and documentation of collected and stored germplasm. The *in situ* conservation of CWR and on farm management of crop genetic diversity involving the farming communities remain an important strategy complimentary to the *ex situ* conservation strategy under the national programme. The multisectoral National Plant Genetic Resources Committee (NPGRCom) provides policy guidance to the national PGR programme. Membership of the NPGRCom is drawn from

stakeholder institutions that include the Forestry Department, Department of Wild life (formerly ZAWA), the University of Zambia, National Institute of Scientific and Industrial Research, Mundawanga Botanic Gardens and local and international NGOs and farmer organizations. One of the major challenges to the contribution of PGRFA to food security is the inadequate appreciation, at all levels, of its value which has been leading to an increased erosion of the diversity of local PGRFA. At policy level, this lack of appreciation means PGRFA are not adequately integrated into the various sectoral policies and legal instruments.

3.2 Regional policy framework

Zambia participates in a number of PGRFA and crop networks that exist at sub-regional and regional levels. The country continues to participate in the regional PGR network under the AEGIS of the SADC Plant Genetic Resources Centre (SPGRC) which includes CWR in addition to cultivated PGR. The highest level collaboration on PGR related issues within the Africa region has been realized through the intergovernmental fora such as the African Ministerial Conference on Environment (AMCEN) and the relevant scientific committees of the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The NPGRC carries out these activities in close collaboration with the SPGRC and crop working groups within ZARI and continues to participate in the regional PGR network coordinated by SPGRC.

3.3 Global policy framework

Zambia is a party to agreements that contribute to strengthening the conservation and use of PGR including CWRs.

International Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was adopted by FAO's member countries in 2001 and came into force in 2004. Zambia ratified the Treaty in 2006. Its objectives are the conservation and sustainable use of PGRFA and the fair and equitable sharing of the benefits derived from their use. The Treaty refers to CWR in Article 5: *Conservation, Exploration, Collection, Characterization, Evaluation and Documentation of Plant Genetic Resources for Food and Agriculture*. Articles 5, 6 and 7 of the International Treaty contain clauses that mandate contracting parties not only to conserve and use PGRFA sustainably but also to develop policy instruments to underpin such activities.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was agreed in 1992 and entered into force in 1993 as a global and legally binding framework on biodiversity conservation and use. Zambia ratified the CBD in

1993. In 2010, the CBD adopted a revised and updated Strategic Plan for Biodiversity for the 2011-2020 period, including 20 targets known as the Aichi Biodiversity Targets. The maintenance of CWR is specifically referred to in Target 13: "*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*".

A Global Strategy for Plant Conservation (GSPC) with 16 global targets set for 2020 was also endorsed by CBD at its tenth Conference of parties in Nagoya, Japan. Target 9 refers to the conservation of CWR: "*70 per cent of the genetic diversity of crops including their wild relatives and other socio economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge*". The CBD requires that each party "*shall **develop national strategies, plans** or programmes for the conservation and sustainable use of biological diversity*", explicitly including its agrobiodiversity.

Nagoya Protocol on Access and Benefit Sharing

In 2010, the CBD adopted the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, a legal framework for the effective implementation of fair and equitable sharing of benefits arising out of the utilization of genetic resources.

Global Plan of Action for Plant Genetic Resources for Food and Agriculture

Zambia has also endorsed FAO's Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (GPA)) as adopted by FAO member countries in 2011. The second GPA is an agreed set of 18 priority activities that directly address the new developments, opportunities and challenges facing plant conservation and use in the 21st century. It provides a framework of action with these priority activities guiding action and progress at the community, national, regional and international levels, and is a supporting component to the ITPGRFA. Almost half of the priority activities of the second GPA make special reference to CWR, highlighting the need to strengthen their conservation and sustainable use *in situ*; improve documentation and assess gaps in the conservation of CWR in protected areas and *ex situ* collections; create a better understanding of the value and contributions of CWR; test and refine methodologies for location, establishment and management of CWR genetic reserves; assess genetic erosion and threats to all priority CWR populations; develop novel techniques to promote CWR utilization by breeders, farmers and other users; and develop CWR management strategies, well integrated into the existing conservation strategies.

Thus, the second GPA called for a development of a prioritized plan, particularly for those ecosystems in which high levels of diversity related to plant genetic resources for food and agriculture are found, and conduct national reviews to identify those management practices needed to protect the desired level of genetic diversity for CWR and wild plants for food production and to assist local communities in their efforts to identify, catalogue and manage CWR and wild foods. It also called for need to monitor the holdings, the distribution and diversity CWR and wild plants for food production, integrate and link data and information from *in situ* conservation programmes with that of *ex situ* programmes and encourage private and nongovernmental organizations to do likewise.

4 OVERVIEW OF NATIONAL AGRICULTURAL AND FLORISTIC DIVERSITY

4.1 Overview of national agriculture

Zambia lies in south-central Africa covering an area of 752,629 km^2 and lying on a plateau between altitudes 900 to 1,500 metres above sea level. Rainfall is the dominating factor influencing the climate pattern in the country. In general terms, the northern part of the country receives more annual rainfall than the south.

The contribution of the agricultural sector to the national economy has been variable over the past decade and is currently estimated to contribute 22% to the GDP. Food crop production is mainly in the hands of small-scale farmers who constitute more than 60% of the farming community, and is still largely based on traditional practices.

Zambia has vast agricultural potential. Yet despite a favourable climate, abundant arable land and a share of 40% of the water resources in the entire southern African region, that potential has not yet been fully realised. Of the 58% of land suitable for agricultural production, only 14% is currently under cultivation. The main crops being produced include maize, rice, sorghum and millets, sunflower, groundnut, soybean, wheat, cotton and tobacco. Others include beans, cassava and sweet potato. For these main crops the country is generally self sufficient and often has surplus for exports. These are also the crops that have active breeding programmes, that are in most cases implemented in collaboration with the CGIAR centres that often make available elite lines for use in the breeding programmes for maize (CYMMIT), sorghum and millet and groundnut (ICRISAT), and beans (CIAT). Maize is the main staple and the most supported in terms of subsidy and markets but despite bumper maize harvests experienced in recent years, agriculture makes up only 22% of GDP while employing roughly 85% of the population.

4.2 Overview of the national floristic diversity

As part of Flora Zambesiaca, there is an estimated 6,575 flowering plants and ferns in Zambia (http://zambiaflora.com/). The digitized checklist derived from the national checklist of Zambian vascular plants (Phiri, 2005) has a total of 6305 taxa. This is the list that has been used to derive the CWR of Zambia.

4.3 Overview of the protected area system in the country

The network of Zambia's statutory protected areas (Figure 1) is composed of over 63,580 km^2 in 20 National Parks (NPs), about 167,557 km^2 in 36 Game Management Areas (GMAs) and about 74,361 km^2 in 490 Forest Reserves (FRs). Although more than 18% of the country is within PAs, little is known and documented about the state of ecosystems in these PAS. Table 1 shows area coverage of different vegetation types in the PAs in Zambia.

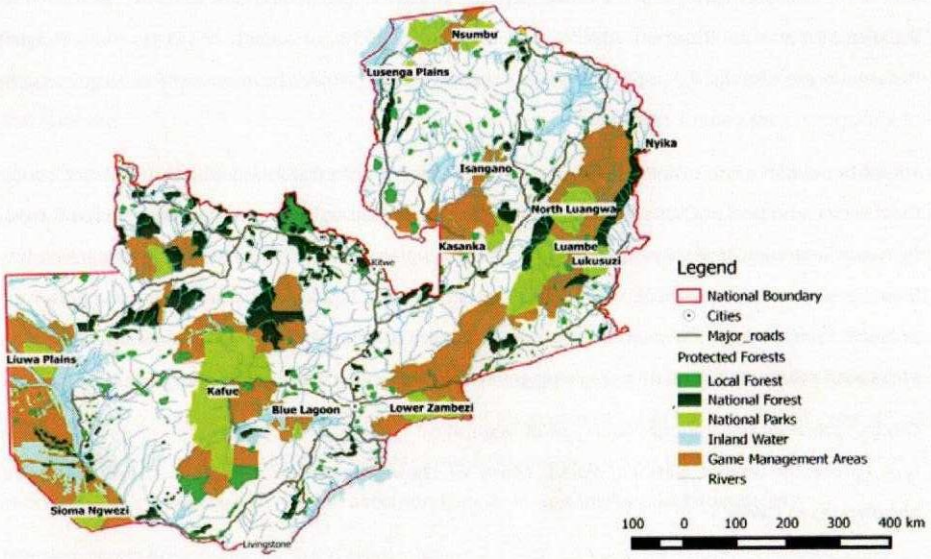

Figure 1 Protected areas in Zambia (*Source*: GRZ Forest Department, 2014)

Table 1 Approximate area coverage of vegetation types in national parks and forest reserves

Vegetation based ecosystem	Total area (square km)	Area (square km) in Protected Areas	
		National Parks	Forest Reserves
Forest	45690	9610 (21.0%)	6783 (9.5%)
Woodland	576587	43734 (7.6%)	47970 (8.3%)
Woodland/Grassland Transition	25698	3330 (13.0%)	921 (3.6%)
Grassland	93720	6854 (7.3%)	3633 (3.9%)

Aquatic	10905	52 (0.5%)	0 (0.0%)
Total	**752600**	**63580 (8.4%)**	**59307 (7.9%)**

There are two main categories of forest reserves in the country consisting of 306 Local Forests and 184 National Forests. The management objective in Local Forests is to meet the needs for forest products for present and future generations of local people. The objective for establishing National Forests is to protect and conserve major water catchments and their biodiversity. For these reasons, both Local and National Forests fall in the IUCN conservation area category VIII (Multiple use management area or Managed resource area). Regardless of the type of forest reserve, no permanent settlements are allowed in a forest reserve. Within each category of forest reserves, two functional sub□categories are recognized: production (107) and protection (383) forests. Licensed exploitation of forest products is allowed in production forests while protection forests are intended for the protection of water catchments, biodiversity and cultural values. In addition to forest reserves, there are also 59 Botanical Reserves which are located either within or outside forest reserves. Botanical Reserves were established to preserve relic vegetation types and/or promote the *in-situ* conservation of important plant genetic resources.

The national parks and other protected areas, however, were established with little specific concern for the conservation of CWRs. Management plans for protected areas are not usually broad enough to conserve genetic diversity for these species to complement other conservation approaches. It will thus be necessary to include CWR conservation in new and revised management plans for all protected areas where CWRs occur. It is also necessary to complement the conservation in protected areas with measures aimed at conserving genetic diversity which lies outside such areas.

Table 2 presents the national coverage of vegetation types and the percentage of each vegetation type, protected within National Parks. Many of these vegetation types are known to harbour populations of CWRs.

Table 2 Summary of vegetation types and their distribution in Zambia

Vegetation Type	National Coverage (%)	Occurring in National Parks, (%)
Dry Evergreen Forest	5.0%	**4.6%**
Kalahari Woodland	13.2%	**5.6%**
Miombo Woodland	47.2%	**6%**
Grassland	20.6%	**7.7%**
Munga Woodland	5.6%	**7.7%**
Terminataria Vegetation	2.0%	**13%**

Dry Deciduous Forest	1.4%	**15%**
Mopane Woodland	3.4%	**28%**
Moist Evergreen Forest	**0.1%**	**45%**

Source: REMNPAS, 2010.

5 CONSERVATION STATUS AND NEEDS OF CWR DIVERSITY

5.1 National CWR diversity

In Zambia there are 107 different crops that are cultivated in the country (MAFF, 1995; NPGRC, CSO) and a total of 3671 wild relatives of these crops have been identified (ref to Tech background document). Most of these species are wide spread in terms of their distribution while others are confined to few areas. Of the priority CWRs, *Oryza barthii, O. punctata O. brachyantha, Vigna haumaniana, V. multinervis* and *Cucumis zeyheri* all have restricted distribution while *Oryza longistaminata* and *Eleusine indica* are widespread. In addition, there are many CWR of globally important crops which are located within the territory of Zambia. Examples are *Oryza, Lactuca* and *Solanum* spp.

In preparation of this NSAP, 59 crops were prioritized based on a set of criteria related to national socio-economic importance, food security and industrial use, occurrence of wild relatives in the country and local cultural and use value of the crop and included cereals, food legumes, vegetables, root and tuber, oil, fibre, pasture and forage and green manure crops. This reduced the list from 107 to a more manageable list of 59. From this crop list 464 CWR species were then derived.This partial list of CWR was further prioritized using four criteria; geographical distribution of CWR, utilization potential for crop improvement, Red List status and economic value of the associated crop species, resulting in a set of 30 priority CWR. For additional information on how the CWR checklist and the list of priority CWR were created see the accompanying technical background document.

The generated priority list included wild relatives of rice, cowpea, sorghum, cucurbits, kenaf and sesame. However, the extent to which these CWRs have been used in crop improvement programmes in the country is limited.

Priority CWRs that have received relatively more prominence in terms of collection and conservation in Zambia are those that are related to cowpea (*Vigna unguiculata*), rice (*Oryza sativa*), finger millet (*Eleusine coracana*), pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*). This has mostly been due to the fact that past collection missions where conducted by the CGIAR targeting their mandate crops. That is IRRI for wild rice, ICRISAT for wild sorghum and millet and IITA for wild cowpeas. In addition there are many more CWRs of crops that are not cultivated in Zambia or little

cultivated. These include pasture grass and legumes, medicinal and spices as well as plants for aesthetic purposes. Most are wide spread in terms of their distribution while others are confined to few areas.

On the basis of the nationally prioritized 29 genera consisting of 59 cultivated crops , out of 6305 flora, 459 taxa are CWR (Appendix 1). The summary of the list of priority CWR genera and number of taxa generated for each genus and the associated common crop is provided in Table 3. Out of the total CWR generated and according to Phiri (2005), 27 CWR taxa including mainly *Crotalaria* spp. were endemic to Zambia representing about 6% of the total CWR taxa. A total of 139 CWR taxa, representing 30% of the CWR taxa, have a distribution restricted to the southern Africa and are native to Zambia.

Table 3 List of priority CWR genera, associated crops and number of CWR taxa for each genus

CWR genus	Common crop	Number of CWR
Amaranthus	Amaranths	8
Chloris	Rhodes grass	2
Cleome	Cats wiskers	5
Corchorus	Jute mallow	9
Crotalaria	Sunnhemp	159
Cucumis	Melon, Cucumber,West Indian Gherkin	9
Dioscorea	Yam	16
Eleusine	Finger millet	2
Hibiscus	False Roselle, Kenaf	34
Ipomoea	Sweet potato	67
Lactuca	Lettuce	12
Lagenaria	Bitter gourd	3
Momordica	Momordica	8
Mucuna	Velvet beans	5
Oryza	Rice	5
Pennisetum	Pearl millet	10
Plectranthus	Livingstone Potato	29
Sesamum	Sesame	6
Sesbania	Sesbania	11
Solanum	African eggplant, Eggplant, Potato	14
Sorghastrum	Sorghum	6
Sorghum	Sorghum	4
Vigna	Cowpea, Bambara groundnuts	35
Total		**459**

Of the generated 30 prioritized CWR 9 taxa belong to genus *Vigna*, 5 each belong to genera *Dioscorea* and *Cucumis*, 4 taxa belong to genus *Oryza*, 2 CWR taxa each belong to genera *Sorghum* and *Solanum* and a single CWR taxon each belong to genera *Ipomoea* and *Pennisetum*. On the overall, most of the generated priority CWR taxa, 75%, were classified as primary or secondary relatives of the selected crop based on the level of affinity measured in terms of crossability between the CWR and crop species as defined by the genepool concept of Harlan and de Wet outlined in the technical background document.

The diversity analysis done on priority CWR described in the technical background document showed that the cells in Northwestern and Copperbelt Provinces had the highest species richness (Figure 2). The cells in Eastern, Luapula and Western Provinces had the lowest species richness.

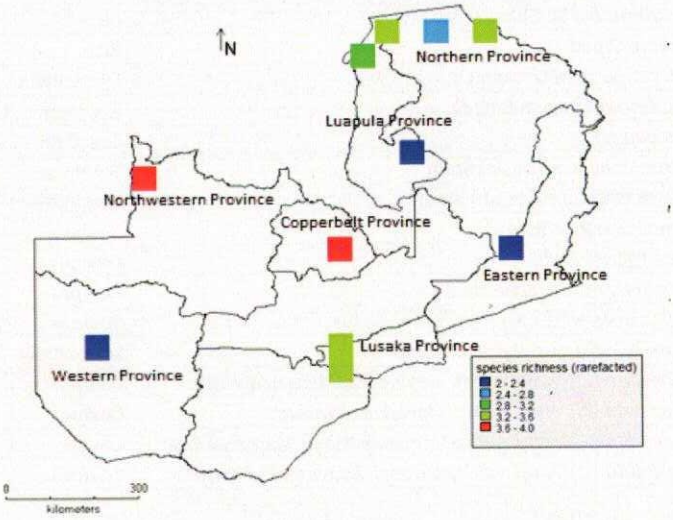

Figure 2. Number of occurrences and rarefaction accounting for sampling bias

Table 4 shows the 30 priority CWR and the crops that they are related to. The NSAP outlines the strategic plans and specific actions directed at conserving these CWR and to promote their use in crop improvement programmes. These are listed in alphabetical order and do not reflect any priority within this priority list.

Table 4 List of priority CWRs with associated crops

CWR	Related crops
Cucumis africanus L.f.	Cucumber
Cucumis ficifolius A. Rich	Cucumber
Cucumis humifructus Stent	Cucumber
Cucumis myriocarpus Naudin	Cucumber
Cucumis zeyheri Sond.	Cucumber
Dioscorea bulbifera L.	Yam
Dioscorea dumetorum (Kunth) Pax	Yam
Dioscorea praehensilis Benth.	Yam
Dioscorea schimperiana Hochst. ex Kunth	Yam
Eleusine coracana (L.) Gaertn. subsp. *africana*	Finger millet
Eleusine indica (L.) Gaertn.	Finger millet
Ipomoea richardsiae Verdc	Sweet potato
Oryza barthii A. Chev.	Rice
Oryza brachyantha Chev. & Roehr.	Rice
Oryza longistaminata A. Chev. & Roehr.	Rice
Oryza punctata Steud	Rice
Pennisetum purpureum Schumach.	Pearl millet
Solanum aureitomentosum Bitter	Egg plant
Solanum incanum L.	Egg plant
Sorghum arundinaceum (Desv.) Stapf	Sorghum
Sorghum verticilliflorum (Steud.) Stapf	Sorghum
Vigna haumaniana R. Wilczek	Cowpea
Vigna juncea Milne-Redh	Cowpea
Vigna multinervis Hutch. & Dalziel	Cowpea
Vigna phoenix Brummitt	Cowpea
Vigna radiata (L.) Wilczek. var. *sublobata*	Mung bean
Vigna unguiculata (L.) Walp. subsp. *dekindtiana* (Harms) Verdc.	Cowpea
Vigna unguiculata (L.) Walp. subsp. *pawekiae* Pasquet	Cowpea
Vigna unguiculata (L.) Walp. subsp. *tenuis* (E.Mey.) Marechal et al.	Cowpea
Vigna unguiculata (L.) Walp. var. *spontanea* (Schweinf.) Pasquet	Cowpea

Table 4 List of priority CWRs with associated crops

CWR	Related crops
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Cucumis humifructus Stent	Cucumber
Cucumis myriocarpus Naudin	Cucumber
Cucumis zeyheri Sond.	Cucumber
Dioscorea bulbifera L.	Yam
Dioscorea dumetorum (Kunth) Pax	Yam
Dioscorea praehensilis Benth.	Yam
Dioscorea schimperiana Hochst. ex Kunth	Yam
Eleusine coracana (L.) Gaertn. subsp. *africana*	Finger millet
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Oryza punctata Steud	Rice
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Solanum aureitomentosum Bitter	Egg plant
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Sorghum arundinaceum (Desv.) Stapf	Sorghum
Sorghum verticilliflorum (Steud.) Stapf	Sorghum
Vigna haumaniana R. Wilczek	Cowpea
Vigna juncea Milne-Redh	Cowpea
Vigna multinervis Hutch. & Dalziel	Cowpea
Vigna phoenix Brummitt	Cowpea
Vigna radiata (L.) Wilczek. var. *sublobata*	Mung bean
Vigna unguiculata (L.) Walp. subsp. *dekindtiana* (Harms) Verdc.	Cowpea
Vigna unguiculata (L.) Walp. subsp. *pawekiae* Pasquet	Cowpea
Vigna unguiculata (L.) Walp. subsp. *tenuis* (E.Mey.) Marechal et al.	Cowpea
Vigna unguiculata (L.) Walp. var. *spontanea* (Schweinf.) Pasquet	Cowpea

Box 1 Occurence of wild sorghum adjacent to cultivated sorghum fields

The cultivation of sorghum among small scale farmers is still largely based on local varieties, although there are a number of improved varieties available, whose cultivation is being adopted by some farmers. A wild form occurs in the sorghum growing areas, probably *Sorghum verticilliform.* A lot of interactions between the cultivated and wild forms are suspected to occur as the wild types frequently occur as weeds in the crops. *Sorghum verticilliform* is said to cross freely with the cultivated species. This situation may also be the case for other indigenous crops like pearl and finger millets as well as cowpeas. Hence the priority CWR list is composed mostly of those species related to indigenous species.

Oryza longistaminata is widely distributed across the country while *O. barthii* and *O. punctata* have restricted distribution in the South Luangwa National Park and *O. brachyantha* in the northern part of the country (Figure 3).

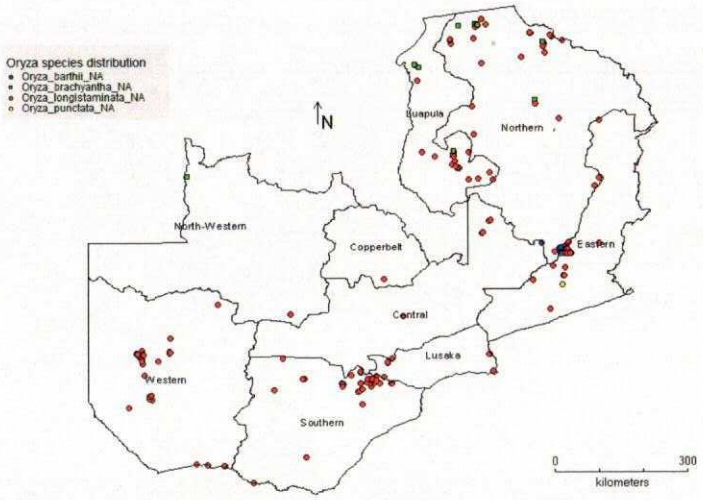

Figure 3 National distribution of priority *Oryza* species

For wild relatives of cowpeas, *Vigna juncea* is widely distributed across the whole country while *V. haumaniana* and *V. multinervis* are restricted to South Luangwa and *V. unguiculata* subsp. *dekindtiana* is in the northern and northwestern part of the country (Figure 4).

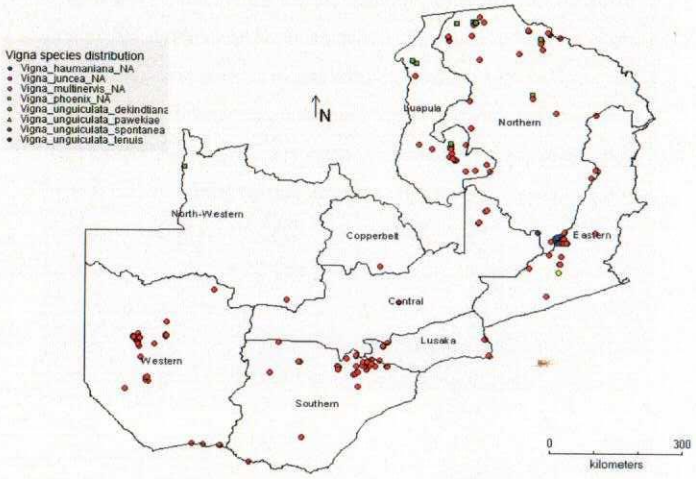

Figure 4 National distribution of priority *Vigna* species

The wild relatives of fingermillet, *Eleusine coracana* subsp. *africana* and *E. indica* are found in the northern half of the country (Figure 5).

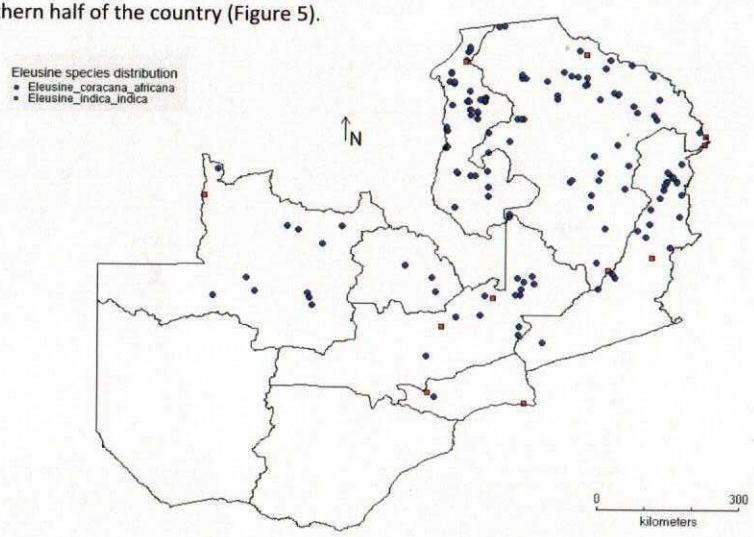

Figure 5 National distribution of priority *Eleusine* species

The distribution of wild yam, *Dioscorea bulbifera* and *D. dumetorum* is restricted to the Northern, Central, Lusaka, Southern and parts of Eastern Zambia (Figure 6).

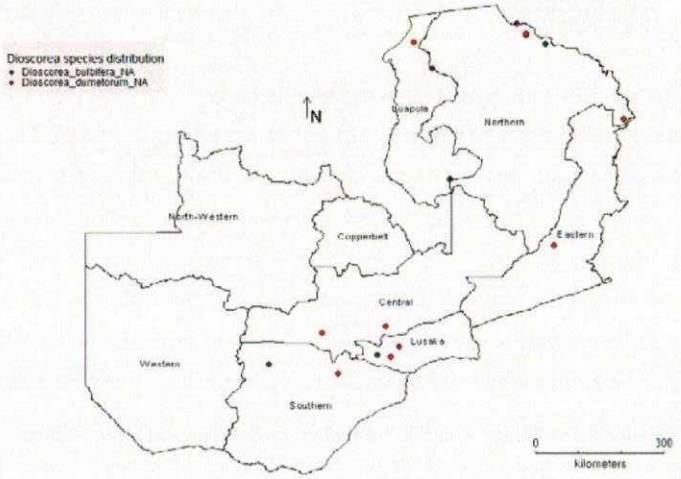

Figure 6 National distribution of priority *Dioscorea* species

Figure 7 shows the distribution of the rest of the priority CWRs. *Pennisetum purpureum* is found in the northern region of the country while *Sorghum bicolor* subsp. *verticiflorum* is in the southern. *Solanum incanum* is evenly distributed between the Southern and Central regions of the country whereas *S. aureitomentosum* is in the northern part. The distribution of *Cucumis zeyheri* is restricted to the southern part.

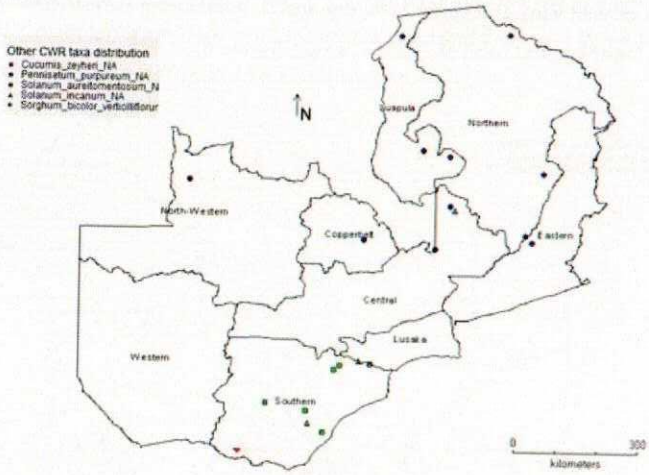

Figure 7 National distribution of *Cucumis, Pennisetum, Solunum* and *Sorghum* priority species

5.2 Threat assessment

Like other wild plant species, CWR are increasingly subject to a wide range of threats, some of which are anthropogenic, i.e. are linked to human activities. Overall, some of the key factors threatening the existence and diversity of CWR include:

(i) Unsustainable use of natural resources, including over-exploitation and excessive use or extraction of wild plants for timber, fuel, feed etc.

(ii) Habitat conversion for agricultural production, industrial development or urban expansion, Habitat destruction, degradation, homogenisation and fragmentation,

(iii) Climate change,

(iv) Changes in agricultural practices and land use,

(v) Introduction of exotic species (other plants, animals, or microbes) that compete with, hybridise with, cause physical or biological damage to, or kill native species,

(vi) Natural calamities, such as, floods, landslides, and soil erosion.

5.3 Current status of *in situ* conservation of CWR

In situ conservation involves the location, designation, active management and monitoring of target plant populations within their natural habitats or where they have developed their distinctive

characteristics[4]. *In situ* conservation of wild plant populations often takes place in formally designated or informal Protected Areas (PA), and the conservation can target either the populations themselves or the full ecosystems in which they occur.

The institutions responsible for conducting inventories and surveys of PGR include the NPGRC, Department of Biological Resources of the University of Zambia, Zambia Forestry Division and Zambia Wildlife Authority. Nonetheless, there has been no systematic and coordinated inventories and surveys especially that each institute works within its mandates, needs and priorities.

In situ conservation of wild plant genetic resources for food and agriculture has never been undertaken in the national parks and national forest reserves. The management plans for these areas have not specifically targeted conservation of plant genetic resources. However, the country formulated the National Biodiversity Strategy and Action Plan (NBSAP) for implementing the Convention on Biological Diversity. The first NBSAP, adopted in 1999, was formulated to ensure that biodiversity activities meet national interests as well as priority actions required for achieving the objectives of the conservation in the years to come but even the NBSAP only mentions CWRs in passing, with no specific plans directly formulated for their conservation. Following formulation of the NBSAP, an assessment of status of biodiversity was undertaken. The assessment amongst other things identified major problem areas that included the fact that wild relatives of crops were insufficiently surveyed and conserved.

Out of the total of 30 priority CWR, 21 are covered by the protected area network. Priority CWR species covered in the protected areas is shown in Table 5. However, these CWRs may not necessarily be under active *in situ* conservation and therefore their actual status on site may not be known. Table 6 provides more detail about the number of populations of priority CWR, those that are in PAs as well as the percentage of these populations.

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[4] *Maxted N, Ford-Lloyd BV and Hawkes JG (1997) Plant Genetic Conservation: The In Situ Approach. Chapman & Hall, London.*

Table 5 Number of different priority CWRs in protected areas

Protected area	Target CWRs
Mosi Oa Tunya National Park	*Cucumis zeyheri*
Copperbelt Forest Reserve	*Vigna phoenix*
Kafue National Park	*Eleusine indica* subsp. *indica, Oryza barthii, O. longistaminata, Pennisetum purpureum, Sorghum bicolor* subsp. *verticiflorum, Vigna unguiculata* subsp. *dekindtiana, V. unguiculata* subsp. *spontanea*
Nsumbu National Park	*Dioscorea bulbufera, D. dumetorum, Eleusine coracana* subsp. *africana, Oryza longistaminata, Solanum aureitomentosum, Vigna haumaniana, V. juncea, V. unguiculata* subsp. *dekindtiana, V. unguiculata* subsp. *pawekiae,*
South Luangwa National Park	*Oryza punctata*
Miengwe Forest Reserve	*Vigna unguiculata* subsp. *tenius*
Kasanka National Park	*Oryza longistaminata, Solanum incanum*
West Lunga National Park	*Eleusine indica* subsp. *indica, Oryza longistaminata, Vigna juncea, V. multinervis*

Table 6 Number of populations of each priority CWR covered by existing protected areas

Priority CWR taxa	Number of populations	Populations covered in protected areas	% of populations covered in protected areas
Cucumis zeyheri	1	0	0
Dioscorea bulbufera	4	2	50
Dioscorea dumetorum	13	3	23
Eleusine coracana subsp. *africana*	145	34	23
Eleusine indica subsp. *indica*	11	4	36
Oryza barthii	17	17	100
Oryza brachyantha	18	8	44
Oryza longistaminata	201	102	51
Oryza punctata	1	0	0
Pennisetum purpureum	8	4	50
Solanum aureitomentosum	4	1	25
Solanum incanum	4	1	25
Sorghum bicolor subsp. *verticiflorum*	5	1	20
Vigna haumaniana	6	2	33
Vigna juncea	31	6	19
Vigna multinervis	6	3	50
Vigna phoenix	1	0	0
Vigna unguiculata subsp. *dekindtiana*	95	30	32
Vigna unguiculata subsp. *pawekiae*	2	1	50
Vigna unguiculata subsp. *spontanea*	3	1	33
Vigna unguiculata subsp. *tenius*	14	2	14

5.4 *In situ* conservation needs

Challenges affecting the conservation of CWRs include the following:

(i) Inadequate capacity in manpower and financial resources,

(ii) Inadequate information on what the occurrence, conservation status and genetic characteristics of CWR,

(iii) Inadequate awareness about CWRs and therefore limited appreciation about their value and importance.

Initial data to help determine areas of need for in situ conservation was derived from the diversity and complementarity analysis in the technical background document. The species richness analysis of data of all priority CWR taxa revealed six possible areas as the richest in number of species (Figure 8). Comparatively, four of these locations numbered 1-4 located in Northern, Eastern, Lusaka and Copperbelt seemed to areas of highest species richness.

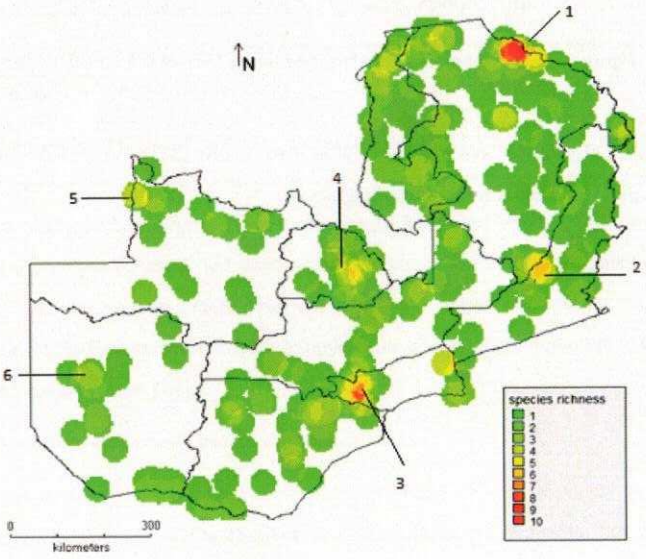

Figure 8. Indication of levels of species richness for priority CWRs Red areas are possible areas of the highest number of CWR species.

Complementarity analysis at 10 x 10 km has established a total number of 13 cells in the PAs as shown in (Figure 9).

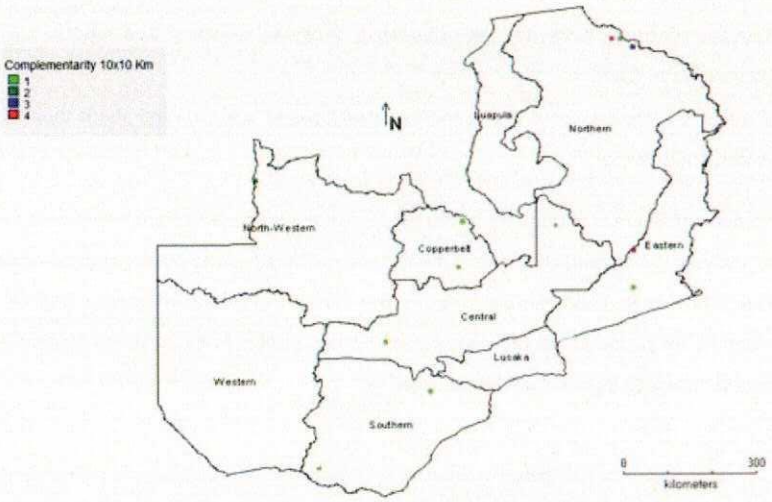

Figure 9. Complementarity sites for the priority CWR at cell level 10 x 10 km

Out of the total of 31 priority CWR taxa generated, twenty one (21) of these CWR taxa are covered in the protected area network of the country (Figure 10).

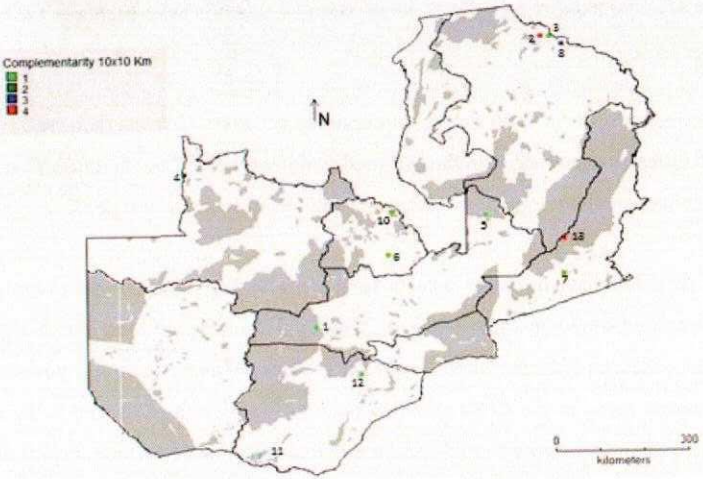

Figure 10. Complementarity of the Priority CWRs in the protected area network

From the complementarity analysis as indicated in Figure 10, national protected areas were genetic reserves are feasible include Nsumbu National Park in Mbala, South Luangwa National Park, Kasanka National Park and Mosi-Oa-Tunya National Park.

However, there are proposed sites outside protected areas that could be recommended for establishment of genetic reserve for conservation of priority CWR taxa. These include sites in Northwestern part of the country at the source of Zambezi River and Mbala district of the Northern Province. The three priority CWR taxa that do not occur within any of the existing protected areas are *Cucumis zeyheri*, *Vigna unguiculata* subsp. *pawekiae* and *Vigna unguiculata* subsp. *spontanea*. It will be necessary to undertake field surveys targeting the indicated sites to ascertain the feasility of setting up these proposed conservation sites.

5.5 Current status of *ex situ* conservation of CWR

Ex situ conservation involves the location, sampling, transfer and storage of plants away from where they grow naturally[5]. A range of *ex situ* conservation techniques are available, but seed storage in genebanks predominates as the most practical *ex situ* conservation technique for many plant species.

[5] See footnote 1

Other means of maintaining samples of plant species *ex situ* are as living plants or explants *in vitro* or cryopreserved.

The NPGRC is responsible for most *ex situ* conservation activities. Currently it is holding about 7,300 accessions of different crop species in form of seed samples in sealed aluminium foil bags, maintained as an active collection under long term storage conditions of temperature -20°C .

The priority CWRs that have not been collected and conserved *ex situ* in the gene bank as revealed in the gap analysis and shown in Table 7 include *Dioscorea dumetorum, Dioscorea bulbifera, Cucumis zeyheri, Oryza punctata, Solanum aureitomentosum, Vigna unguiculata* subsp. *pawekiae* and *Vigna phoenix*. However, some of the CWRs with less than five accessions conserved in the genebank are underrepresented and therefore should also be targeted for collection. These include *Eleusine indica subsp. Indica, Solanum incanum, Sorghum bicolor* subsp. *Verticilliflorum, Vigna haumaniana and Vigna unguiculata* subsp. *spontanea.*

Table 7 *Ex situ* collections of priority CWRs in national and international genebanks

Taxon	Common name	Accessions in National Genebank	Accessions in National & International Genebank
Cucumis zeyheri	Cucumber	0	0
Dioscorea bulbifera	Yam	0	0
Dioscorea dumetorum	Yam	0	0
Eleusine coracana subsp. *africana*	Finger millet	0	137
Eleusine indica subsp. *indica*	Finger millet	3	3
Oryza barthii	Rice	1	13
Oryza brachyantha	Rice	1	8
Oryza longistaminata	Rice	56	112
Oryza punctata	Rice	0	0
Pennisetum purpureum	Pearl millet	0	5
Solanum aureitomentosum	Eggplant	0	0
Solanum incanum	Eggplant	0	1
Sorghum bicolor subsp. *verticilliflorum*	Sorghum	0	2
Vigna haumaniana	Cowpea	0	3
Vigna juncea	Cowpea	0	13
Vigna multinervis	Cowpea	0	6
Vigna phoenix	Cowpea	0	0
Vigna radiata	Mung bean	1	1
Vigna unguiculata subsp. *dekindtiana*	Cowpea	20	86

Other means of maintaining samples of plant species *ex situ* are as living plants or explants *in vitro* or cryopreserved.

The NPGRC is responsible for most *ex situ* conservation activities. Currently it is holding about 7,300 accessions of different crop species in form of seed samples in sealed aluminium foil bags, maintained as an active collection under long term storage conditions of temperature -20°C .

The priority CWRs that have not been collected and conserved *ex situ* in the gene bank as revealed in the gap analysis and shown in Table 7 include *Dioscorea dumetorum, Dioscorea bulbifera, Cucumis zeyheri, Oryza punctata, Solanum aureitomentosum, Vigna unguiculata* subsp. *pawekiae* and *Vigna phoenix*. However, some of the CWRs with less than five accessions conserved in the genebank are underrepresented and therefore should also be targeted for collection. These include *Eleusine indica subsp. Indica, Solanum incanum, Sorghum bicolor* subsp. *Verticilliflorum, Vigna haumaniana and Vigna unguiculata* subsp. *spontanea.*

Table 7 *Ex situ* collections of priority CWRs in national and international genebanks

Taxon	Common name	Accessions in National Genebank	Accessions in National & International Genebank
Cucumis zeyheri	Cucumber	0	0
Dioscorea bulbifera	Yam	0	0
Dioscorea dumetorum	Yam	0	0
Eleusine coracana subsp. *africana*	Finger millet	0	137
Eleusine indica subsp. *indica*	Finger millet	3	3
Oryza barthii	Rice	1	13
Oryza brachyantha	Rice	1	8
Oryza longistaminata	Rice	56	112
Oryza punctata	Rice	0	0
Pennisetum purpureum	Pearl millet	0	5
Solanum aureitomentosum	Eggplant	0	0
Solanum incanum	Eggplant	0	1
Sorghum bicolor subsp. *verticilliflorum*	Sorghum	0	2
Vigna haumaniana	Cowpea	0	3
Vigna juncea	Cowpea	0	13
Vigna multinervis	Cowpea	0	6
Vigna phoenix	Cowpea	0	0
Vigna radiata	Mung bean	1	1
Vigna unguiculata subsp. *dekindtiana*	Cowpea	20	86

Other means of maintaining samples of plant species *ex situ* are as living plants or explants *in vitro* or cryopreserved.

The NPGRC is responsible for most *ex situ* conservation activities. Currently it is holding about 7,300 accessions of different crop species in form of seed samples in sealed aluminium foil bags, maintained as an active collection under long term storage conditions of temperature -20°C .

The priority CWRs that have not been collected and conserved *ex situ* in the gene bank as revealed in the gap analysis and shown in Table 7 include *Dioscorea dumetorum, Dioscorea bulbifera, Cucumis zeyheri, Oryza punctata, Solanum aureitomentosum, Vigna unguiculata* subsp. *pawekiae* and *Vigna phoenix*. However, some of the CWRs with less than five accessions conserved in the genebank are underrepresented and therefore should also be targeted for collection. These include *Eleusine indica subsp. Indica, Solanum incanum, Sorghum bicolor* subsp. *Verticilliflorum, Vigna haumaniana and Vigna unguiculata* subsp. *spontanea.*

Table 7 *Ex situ* collections of priority CWRs in national and international genebanks

Taxon	Common name	Accessions in National Genebank	Accessions in National & International Genebank
Cucumis zeyheri	Cucumber	0	0
Dioscorea bulbifera	Yam	0	0
Dioscorea dumetorum	Yam	0	0
Eleusine coracana subsp. *africana*	Finger millet	0	137
Eleusine indica subsp. *indica*	Finger millet	3	3
Oryza barthii	Rice	1	13
Oryza brachyantha	Rice	1	8
Oryza longistaminata	Rice	56	112
Oryza punctata	Rice	0	0
Pennisetum purpureum	Pearl millet	0	5
Solanum aureitomentosum	Eggplant	0	0
Solanum incanum	Eggplant	0	1
Sorghum bicolor subsp. *verticilliflorum*	Sorghum	0	2
Vigna haumaniana	Cowpea	0	3
Vigna juncea	Cowpea	0	13
Vigna multinervis	Cowpea	0	6
Vigna phoenix	Cowpea	0	0
Vigna radiata	Mung bean	1	1
Vigna unguiculata subsp. *dekindtiana*	Cowpea	20	86

Taxon	Common name	Accessions in National Genebank	Accessions in National & International Genebank
Vigna unguiculata subsp *pawekiae*	Cowpea	0	0
Vigna unguiculata subsp. *spontanea*	Cowpea	0	3
Vigna unguiculata subsp. *tenuis*	Cowpea	0	5
Grand Total		**82**	**398**

5.6 *Ex situ* conservation needs

According to the gap analysis of the *ex situ* collection, there is an urgent requirement to consider germplasm collection of populations of a number of priority CWR taxa. These CWR taxa include *Dioscorea dumetorum, Dioscorea bulbifera, Vigna unguiculata* subsp. *spontanea, Eleusine indica* subsp. *indica, Sorghum bicolor* subsp. *verticiflorum, Vigna haumaniana* and *Solanum incanum*. One of the compelling reason is that even if some of these priority CWR taxa may have been collected and conserved *ex situ*, they have fewer number of populations in the ex situ collection. This is apparent for CWR taxa such as *Vigna unguiculata* subsp. *spontanea, Eleusine indica* subsp. *indica, Sorghum bicolor* subsp. *verticiflorum, Vigna unguiculata* subsp. *tenius, Pennisetum purpureum* and *Solanum incanum*.

6 CWR UTLIZATION POTENTIAL

6.1 Actual and potential uses of priority CWR

Using CWR in breeding is a long and laborious process that is typically much more difficult than breeding with cultivated crop varieties. Many plant breeders avoid the use of CWR for this reason. The first step towards using CWR in breeding is *pre-breeding*, consisting of activities that aim to identify desirable traits (e.g., disease resistance) and introgress them into breeding lines and adapted varieties.

Challenges regarding the use of CWRs identified by stakeholders during the stakeholder workshop held on 6 August 2015 on the preparation of the NSAP included:

(i) Slow process of conventional breeding especially when it involves CWRs;

(ii) Lack of information on desirable traits related to lack of characterization data.

Consequently there is currently no breeding programme in the country that utilizes any of the priority CWRs. The capacity for breeding is inadequate to low numbers of qualified breeders, who in most cases are mostly utilizing elite lines from the CGIAR centres to develop crop varieties, as well as inadequate access to modern technological tools that facilitate easy crossibility between CWRs and crop species.

6.2 Current users' demands

At international level there has been a steady increase in the use of CWR in variety development. While there continues to be a strong emphasis on using pest and disease resistance genes, a wider range of characteristics are being introduced than in the past. Those crops whose wild relatives have traditionally been used as sources of useful traits (e.g., wheat, tomato) continue to be most likely to include new genes from their wild relatives. CWR are continually gaining in importance and prevalence, but their contributions to the development of new cultivars remain less than might have been expected given improved procedures for intercrossing species from different gene pools, advances in molecular methods for managing backcrossing programes, increased numbers of wild species accessions in gene banks, and the substantial literature on beneficial traits associated with wild relatives[6]).

Over the next decades, the world is expected to experience climate change that will likely bring about more extreme weather such as higher average temperatures and more variable rainfall. This will impact most food crops in tangible ways and in many cases agricultural yields are predicted to fall significantly.

Adapting agriculture to climate change is therefore an urgent challenge of our time. A critical step to prepare for a changing climate is to ensure that the crops feeding humanity are more resilient to the vagaries of the weather, by developing new crop varieties that can be productive in changing climatic conditions. For agriculture to meet this challenge, plant breeders will need genetic diversity. The greatest source of untapped diversity, especially for the adaptive characteristics needed to confront the challenges of a changing climate, are the wild relatives of our domesticated food crops. These crop wild relatives are however threatened in their natural environment; most of them are also missing in crop collections and therefore not yet available for use[7].

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[6] Hajjar and Hodjkin (2007) http://link.springer.com/article/10.1007%2Fs10681_007_9363_0

[7] https://www.croptrust.org/what_we_do/supporting_the_global_system/crop_wild_relatives/

Most plant breeding programmes in Zambia involve selections and crosses from elite lines provided through collaborations with the CGIAR centres. Therefore any current use of CWR germplasm in breeding in Zambia is indirectly through use of this elite germplasm whose development may have included use of CWR. However there is a recognized need for CWR germplasm now especially due to climate change when there is increased need for adaptive germplasm. The changing patterns of pests and diseases due to climate change also means that useful germplasm may only be available in CWR.

6.3 Access and benefit sharing

Germplasm introductions from external sources outside the country continue to be a major feature of the crop development and improvement programmes for all crops in the country with the exception of Bambara groundnuts which has wholly depended on local germplasm. The major sources of introduced germplasm are the International Agriculture Research Centres, such as ICRISAT, CIMMYT, CIAT, CIP and IRRI. Therefore the country has benefited by having this access to germplasm for crop improvement. On the other hand the country has also made available to the international community information about the germplasm that can be accessed from Zambia. Consequently Zambia has notified the Secretary of the ITPGRFA on the inclusion of a total of 4,340 accessions of Annex 1 crops onto the MLS of the Treaty.

7 STRATEGIC ACTIONS FOR CONSERVATION AND SUSTAINABLE USE OF CWR

The key strategic actions required for conservation of CWR genetic resources are outlined below and the baseline, target and indicators in Table 8:

(i) Government take decision to include conservation of CWRs in the National Biodiversity and Strategic Action Plan.

(ii) Ensuring the inclusion of clearer and more specific policy statements on CWRs in the various policy documents and development plans.

(iii) Take steps to integrate CWRs in management plans and conservation programmes.

(iv) Increase the allocation of financial and other necessary resources to CWRs programmes.

(v) Inclusion of CWRs in school curricula at all levels of learning.

(vi) Creation of functional and effective partnerships for systematic and coordinated conservation and sustainable use of CWR.

(vii) Develop national capacity for CWR characterization and breeding in the national agriculture research system.

Table 8 Strategic actions required for conservation and use of CWRs

Strategic actions (what?)	Baseline (current status?)	Targets	Time Line*	Indicators (how to measure progress)	Management responsibilities (who?)**
Government take decision to include the conservation of CWR in their National Biodiversity and Strategic Action Plan	*Current NBSAP does not include conservation of CWR*	*Country reports the status of CWR conservation in the next NBSAP to the CBD*	*2017-2018*	*Number of NBSAP meetings/committees in which issues relating to CWR has been mentioned*	*Relevant departments of the Ministries of Environment, Natural Resources and Agriculture in collaboration with the National Environmental Agency to lead implementation*
Increase awareness and importance of CWR among policy makers and researchers.	*Little understanding of the CWR among Policy makers and researchers*	*Policy briefs and awareness campaign meeting, proposed specific policy statements for inclusion in the national policy*	*2017-2019*	*Number of policy briefs and meetings. Number of policy briefs on CWR*	*ZARI*
Integration of CWRs in management plans for protected areas and conservation programmes	*Current plans do not specify CWR*	*Develop CWR management plans and include them in national conservation programmes*	*2017-2019*	*Number of CWR management plans developed Number of PAs whose mgt plans include CWR conservation*	*ZARI with agriculture and environment ministries*
Allocate more resources to CWRs programmes	*No resources specifically for CWR*	*Introduce budget line on CWR in agriculture and environment budgets*	*2017-2019*	*Number of program budgets with CWR line items. Amounts of resources allocated*	*ZARI with agriculture and environment ministries*
Include CWRs in school curricula at all levels of learning	*Current school curricula has no CWR Agriculture colleges and UNZA have no CWR in curricula*	*CWR in primary, secondary and tertiary school curricula*	*2017-2019*	*Number of primary, secondary and tertiary school curricula*	*Ministry of agric, Ministry of education, UNZA School of Agric, UNZA biology Dept*

Create functional and effective partnerships	*Current partnerships on CWR are weak*	*Partnerships between government and other stakeholders formed*	*2017-2019*	*Number of meetings of stakeholders. Report of stakeholder meetings. Stakeholder work programs on CWR*	*ZARI and CWR stakeholders*
Develop national capacity for CWR characterization and breeding in the national agriculture research system	*There is limited capacity due to very low numbers of plant breeders in the country*	*Increased numbers of trained and specialised breeders*	*2017-2019*	*Number of trained breeders joining NARS. Number of breeders working on CWRs*	*UNZA School of Agriculture. UNZA Dept of Biology. Ministry of Agriculture. ZARI*

* Timeline in which each concrete action is to be carried out. ** It should include lead agency(ies) responsible for implementation

8 CONCRETE ACTIONS FOR CONSERVATION AND SUSTAINABLE USE OF CWR

Table 9 summarizes the concrete actions for the conservation and utilization of CWRs.

Table 9 Concrete actions for conservation and utilization of CWRs

Concrete action (what?)	Baseline (current status)	Target	Timeline *	Indicator (how to meaure progress?)	Management responsibilities (who?)**
***In situ* conservation actions**					
To review management plans for protected areas for the conservation of CWR	*Management Plans of protected areas in the country do not include any CWR*	*Management plans for Nsumbu, South Luangwa and Kasanka NPs are reviewed and provisions for conservation of CWR are included, by 2020*	*2017-2020*	*Number of management plans reviewed.*	*Protected Area Agencies*
Compile lists of CWRs in all protected areas under ZAWA and forest reserves under Forestry Department	*The CWR lists are not consolidated and are incomplete*	*Consolidated CWR lists are compiled for national parks by 2020 and forestry by 2018*	*2017-2020*	*Number of protected areas with complete lists of CWRs*	*Protected Area Agencies and ZARI*
Verifications and ground proofing of hotspots	*Hotspots not verified on ground*	*At least 5 actual and potential hotspots are verified by ground proofing by 2020*	*2017-2020*	*Number of hotspots verified*	*ZARI with Protected Area Agencies*
Compile occurrence data including herbaria and other sources for CWRs that have data gaps needed to identify hotspots	*Incomplete occurrence data*	*Occurrence data compiled and used to identify more hotspots*	*2017-2020*	*Complete data and diversity analysis done*	*ZARI with Protected Area Agencies*
Develop management plans for the hotspots	*No management plans exist for hotspots*	*Management plans developed for at least 2 hotspots by 2020*	*2017-2020*	*Number of management plans developed*	*ZARI with Protected Area Agencies*
Expand the Potected Area network to include CWR rich areas as identified by the complementarity analysis	*Some of the priority CWRs occur outside protected areas*	*Develop proposals for establishing at least 2 protected areas where priority CWRs occur*	*2017-2020*	*Number of new sites designated as protected areas*	*Universities, ZARI and Protected Area Agencies*
Initiate with farmers conservation of priority CWR populations around cultivated	*No farmer led conservation programmes exist for CWR populations adjacent to cultivated fields*	*Identify potential sites and CWR populations around farmer fields*	*2017-2020*	*Number of target sites for farmer led conservation*	*ZARI and NGOs*

Concrete action (what?)	Baseline (current status)	Target	Timeline *	Indicator (how to meaure progress?)	Management responsibilities (who?)**
cropssuch as rice, sorghum and millets					
Development of monitoring tools and programmes for priority CWRs	*No monitoring programme in place*	*Monitoring and evaluation tools developed by 2020*	*2017-2020*	*Monitoring tools Number of monitoring activities*	*ZARI and Protected Area Agencies*
Monitor CWR populations in PAs and identified hotspots outside PAs	*No monitoring is done*	*Initiate monitoring in Nsumbu, South Luagwa and Kasanka by 2020*	*2017-2020*	*Lists and conservation status of CWR*	*ZARI and Protected Area Agencies*
***Ex situ* conservation actions**					
To fill gaps of CWR representations in* ex situ *collections	*CWR diversity (genetic and species) are not well represented in the national genebank*	*At least 70% of genetic diversity of prioirty CWRs are conserved in the national genebank and SPGRC by 2020*	*2017-2020*	*Number of new accessions of priority CWR in genebanks*	*National Genebank authority in collaboration with Protected Areas and forestry authorities*
Develop five year collection strategy plans for CWRs	*There are no collection strategy plans for CWRs*	*Collection strategy plan developed by 2018*	*2017-2020*	*Strategy plan for CWR collection*	*ZARI*
Integrate CWRs in crop germplasm collection activities	*CWRs have lagged behind cultivated crops in collections*	*All crop germplasm collection missions include CWRs by 2017*	*2017-2020*	*Number of CWR accessions in collections*	*ZARI*
Utilization of CWR diversity					
Identification of potential breeding materials through characterization and evaluation of CWR diversity	*No chacterization and evaluation have been done on CWRs*	*At least 10% of CWRs in the collection are characterized by 2020*	*2017-2020*	*Number of CWR accessions characterised*	*University and ZARI*
Use predictive characterization of priority CWRs to identify populations or accessions potentiall containing useful trait diversity	*No predictive characterization data available to identify useful traits*	*Priority populations or accessions that are predicted to contain useful traits identified in at least 5 species by 2020*	*2017-2020*	*Number of accessions and populations with predictive characterization data*	*ZARI and University*
Public awareness					

Concrete action (what?)	Baseline (current status)	Target	Timeline *	Indicator (how to meaure progress?)	Management responsibilities (who?)**
Develop awareness programmes through the media and also directly with communities.	*Currently no awareness programmes exist for CWRs*	*At least one newspaper article every year, one TV documentary by 2020, at least one meeting with communities in each target area by 2020, one annual workshop*	*2017-2020*	*Number of radio and TV progrmmes and newspaper articles. Number of meetings and workshops with farmers and stakeholders*	*ZARI*
Capacity building					
Initiate manpower training based on a needs assessment done in the SADC project including MSc and PhD research on CWR	*Limited trained manpower*	*Training programs designed in all the identified needs*	*2017-2020*	*Number of trained personnel in CWRs conservation and use*	*ZARI and University*
Train protected area staff on CWR identification and conservation	*Limited knowledge on CWR by protected area staff*	*Staff in all protected areas with CWRs are trained*	*2017-2020*	*Number of trained personnel in protected areas*	*ZARI, University and Protected Area Agencies*
Improve genebank and herbarium facilities in the country	*Limited herbarium and genebank space and facilities*	*Genebank with facilities to handle CWRs by 2020 Herbaria with adequate space and facilities for processing and storing specimens*	*2017-2020*	*Number and types of equipment procured for genebanks and herbaria*	*ZARI, University, Protected Area Agencies*

* Timeline where each concrete action is to be carried out. ** It should include lead agency(ies) to champion implementation.

9 COLLABORATIVE PARTNERSHIP FOR IMPLEMENTING NSAP

The Ministry of Agriculture will be responsible for leading the implementation and monitoring of th NSAP through ZARI. The focal point at ZARI will be the national genebank which has the nationa mandate for the conservation of all PGR in the country. Implementation of the NSAP including it management and coordination will be led by the national genebank under the guidance of the nationa plant genetic resources committee. All major stakeholders in the conservation and sustainabl utilization of CWR genetic resources will be represented on this committee.

Local communities should participate in identifying CWRs that have both a direct use at communit level and potential in crop improvement through breeding. They will participate in identifyin populations of CWRs and provide first hand information about the changes occurring in a particula area. This information will contribute to decision making with regards to choices of *in situ* and *ex sit* conservation activities. The local knowledge of history of CWRs, pouplations and use will be importa in carrying out monitoring and evaluation.

The local communities will also play a major role in guarding against the destruction of conservatio areas and of specific CWR populations if they are involved as key stakeholders in the conservation an use of these resources. Therefore they will be part of the process of developing management pla and will develop the initial landuse maps at community level.

Table 10 Stakeholders involved in CWRs programmes and their roles

Stakeholder	Roles
Policy makers	Provide policy support on the CWR and influence resource allocation towards the conservation and utilization of CWR
Department of National Parks and Wildlife (formerly, ZAWA)	To compile lists of species of CWR in protected areas and identify hotspots
Forestry Department	To compile lists of species of CWR in forest reserves and identify hotspots
Media (NAIS, ZNBC, ZANIS, Private media)	Information dissemination
Universities (UNZA, MU, CBU)	Manpower training and data analysis
ZARI	Overall coordination and maintaining the momentum

Stakeholder	Roles
Extension Services (Department of Agrculture)	Linkages with communities
NGOs (CTDT, BCN)	Awareness creation and popularization
Donors	Resource provision
Local communities and farmer associations	Integrating programmes with their livelihoods
Traditional leadership	Internalizing and legitimizing programmes in the communities

The specific focal units and persons for all stakeholders will be identified in order to strengthen and guarantee stakeholders play their roles. Specific media will also be targeted for specific roles.

Creation of public awareness on the value of CWRs and the need for their conservation and sustainable use will be preceded by increasing awareness even at technical level targeting personnel at public and private research institutions including universities and the government extension system by involving them in planning meetings and other forums addressing CWRs. This will result in expanding the base from which public awareness can be better achieved. Awareness will also be targeted at the communities themselves who may not have the full information about these resources which often constitute parts of their livelihoods directly and indirectly. Policy makers will also be targeted so that policy statements can then be used for wider dissemination of information to the wider public. Awareness creation will also be targeted at NGOs and other stakeholders before reaching the general public.

There is currently an increase in the interest and efforts to integrate CWRs in mainstream crop development by initiating conservation and utilization programmes at regional and international levels. The NSAP should buy into these efforts. The development of the NSAP is itself part of the SADC CWR programme which is also part of the global programme covering the ACP group of countries. The Crop Trust with its international security genebank (Svalbard Global Seed Vault) has recently increased focus on CWRs and the NSAP would benefit by linking with the CWR programme of the Crop Trust. The NSAP should lead to an increase of *ex situ* collections of CWRs from Zambia to the Global seed Vault. The '*In situ* conservation and use of crop wild relatives in three ACP countries of the SADC region' projecct, whose initiative has led to the development of this NSAP will be a major source of information, expertise and guidance throughout the implementation of the NSAP.

10 Resource mobilization

Implementation of the NSAP will require reources and capacities that are spread out in different stakeholder organizations. While the secretariat for the implementation of the NSAP will be the national genebank within ZARI under the Ministry of Agriculture, actual implementation of specific activities will be by stakeholders falling under different line Ministries including that of Environment and Natural Resources. Therefore while the core funding will be administered through ZARI, other resources for specific activities will come directly from other stakeholders. For this arrangement to function effectively, the membership to the steering committee should be appointed by Permanent Secretaries in the different Ministries and at Chief Executive levels for non government stakeholders. This team should be responsible for approving the CWR budget with authority from their respective institutions and departments. This committee will also draw the core implementation team composed of staff from the different stakeholders.

Government will provide the core funding especially to cover personnel and basic infrastructure while other stakeholders will contribute in the form of specialist personnel and equipment cost. Major funding to carry out specialist activities for implementing the NSAP will also come from collaborative programmes from the SADC programme as well as various international ongoing initiatives in conservation and sustainable use of CWR genetic resources. Various donors will also support specific aspects of CWR conservation and use based on well articulated proposals guided by the NSAP.

11 Monitoring the National Strategic Action Plan

Monitoring the implementation of the NSAP will be an integral component of the NSAP from the beginning of the implementation onwards. The proposed monitoring plan for the NSAP is intended to keep track of the implementation arrangement and the strategic actions that have been developed. Ample consideration should be given to implementing conservation plans for priority CWR taxa occurring both within protected area conservation and outside of protected areas. It is necessary that for threatened CWR taxa, a regular monitoring schedule will be required to monitor population level and assess the need for rescue collection missions targeting those species.

Monitoring will track changes in actual and potential uses of priority CWRs and changes in the user demand as a result of availability of more information and germplasm of CWR. Monitoring will also track if there is increase in the availability of CWR germplasm at national, regional and global levels and especially any increase of utilization at national level. Increase in genebank requests for information and germplasm will be another feature to monitor.

A major factor to monitor is any change in the number of active *in situ* conservation sites both in and outside protected areas. Table 11 outlines how the different implementation activities, the methodology, the timelines, the responsible entities, the resources and the expected outputs will be monitored.

Table 11 Monitoring plan of the NSAP

Activity	How	When	By who	Resources	Output
Establishment of national committee	Letters of invitation by PS Agriculture	June 2017	ZARI	MAL	Broad stakeholder committee on CWR
Approval of first annual work plan and budget	Draft work plan and budget presented to committee by ZARI	December 2017	National committee	ZARI	Approved annual work plan and budget
Review management plans for PAs for the conservation of CWR	Engagement of consultants	March 2018	ZARI and PA Agencies	PA Agencies	Revised PA management plans
Compile lists of CWRs in all protected areas	Establish task group	June 2018	National committee	Donor funds	Complete lists of CWRs
Verify and ground proof hotspots of CWR	Engagement of consultants	December 2018	National committee	Donor funds	Hotspots verified and confirmed
Develop management plans for the hotspots	Engagement of consultants	December 2018	National committee	Donor funds	Management plans for hotspots
Expand PA network to include CWR rich areas outside PAs	Gazeting new areas for protection	2020	PA Agencies	Ministry of Environment	New protected areas created
Development of monitoring tools for priority CWRs	Engagement of expert	March 2018	National committee	ZARI	Monitoring tools for priority CWR
Fill gaps of CWR in *ex situ* collections	Carrying out collection missions	August 2019	ZARI	ZARI and donors	*Ex situ* samples secured in gene banks
Develop five year collection strategy plans	Draft developed by NPGRC	June 2018	ZARI	ZARI	Collection strategy document
Integrate CWRs in crop germplasm collections	Include CWR in crop collecting missions	June 2018	ZARI	ZARI	Collection strategy that is integrated with CWR
Identification of potential breeding materials	Carry out characterization of CWR	December 2019	ZARI and UNZA	Donor funds	Characterization and evaluation data for CWR
Use predictive characterization of priority CWRs to identify useful traits	Carry out predictive characterization	December 2018	ZARI and UNZA	Donor funds	Predictive characterization data for priority CWR
Develop awareness programmes	Workshops, media	March 2017	ZARI	ZARI and donors	Awareness program in place
Manpower training based on a needs assessment.	Training workshops, scholarships	December 2017	ZARI	ZARI and donors	Trained personnel

Improve genebank and herbarium facilities in the country	Expand infrastructure and equipment	December 2020	National committee	Government and donors	Improved gene bank and herbarium facilitie

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APPENDICES

1. CWR partial checklist

CWR	Crop related to
Amaranthus dubius Mart.ex Thell	Amaranthus
Amaranthus graecizans L. subsp. *syvestris*	Amaranthus
Amaranthus hybridus L. subsp. *cruentus*	Amaranthus
Amaranthus hybridus L. subsp. *hybridus*	Amaranthus
Amaranthus lividus L. subsp. *polygonoides*	Amaranthus
Amaranthus spinosus L.	Amaranthus
Amaranthus thunberg Moq.	Amaranthus
Amaranthus viridis L.	Amaranthus
Chloris pycnothrix Trin.	Rhodes grass
Chloris virgata Sw.	Rhodes grass
Cleome hirta (Klotzsch) Oliv.	Cats whisker
Cleome macrophylla Klotzsch) Briq. subsp. *macrophylla* var. *macrophylla*	Cats whisker
Cleome monophylla L.	Cats whisker
Cleome rubella Burch.	Cats whisker
Cleome rutidospermum DC.	Cats whisker
Corchorus aestuans L.	Jute mallow
Corchorus asplenifolius Burch.	Jute mallow
Corchorus fascicularis Lam.	Jute mallow
Corchorus olitorius L.	Jute mallow
Corchorus pseudocapsularis Schweinf.	Jute mallow
Corchorus saxatilis Wild	Jute mallow
Corchorus schimperi Cufod.	Jute mallow
Corchorus tridens L.	Jute mallow
Corchorus trilocularis L.	Jute mallow
Crotalaria abbreviata Baker f.	Sunnhemp
Crotalaria abscondita Welw. ex Baker	Sunnhemp
Crotalaria aculeata De Wild.	Sunnhemp
Crotalaria adamsonii Baker f.	Sunnhemp
Crotalaria adenocarpoides Taub.	Sunnhemp
Crotalaria alemanniana Torre	Sunnhemp
Crotalaria alexandri Baker f.	Sunnhemp
Crotalaria amoena Welw. ex Baker	Sunnhemp
Crotalaria anisophylla (Hiern) Welw. ex Baker	Sunnhemp

CWR	Crop related to
Crotalaria annua Milne-Redh.	Sunnhemp
Crotalaria anthyllopsis Welw. ex Baker	Sunnhemp
Crotalaria arcuata Polhill	Sunnhemp
Crotalaria argenteotomentosa R.Wilczek	Sunnhemp
Crotalaria argyrolobioides Baker	Sunnhemp
Crotalaria axillaris Aiton	Sunnhemp
Crotalaria axilliflora Baker f.	Sunnhemp
Crotalaria axillifloroides Baker f. ex R.Wilczek	Sunnhemp
Crotalaria barkae Schweinf.	Sunnhemp
Crotalaria barnabassii Dinter ex Baker f.	Sunnhemp
Crotalaria basipeta R.Wilczek	Sunnhemp
Crotalaria baumii Harms	Sunnhemp
Crotalaria becquetii Baker f. ex R.Wilczek	Sunnhemp
Crotalaria bemba R.Wilczek	Sunnhemp
Crotalaria bequaertii Baker f.	Sunnhemp
Crotalaria blanda Polhill	Sunnhemp
Crotalaria bongensis Baker f.	Sunnhemp
Crotalaria bredoi R.Wilczek	Sunnhemp
Crotalaria brevidens Benth.	Sunnhemp
Crotalaria calycina Schrank	Sunnhemp
Crotalaria campestris Polhill	Sunnhemp
Crotalaria carsonii Baker f.	Sunnhemp
Crotalaria caudata Welw. ex Baker	Sunnhemp
Crotalaria cephalotes Steud. ex A.Rich.	Sunnhemp
Crotalaria chirindae Baker f.	Sunnhemp
Crotalaria chrysochloa Baker f. ex Harms	Sunnhemp
Crotalaria chrysotricha Polhill	Sunnhemp
Crotalaria cistoides Welw. ex Baker	Sunnhemp
Crotalaria cleomifolia Welw. ex Baker	Sunnhemp
Crotalaria comosa Baker	Sunnhemp
Crotalaria confertiflora Polhill	Sunnhemp
Crotalaria cornetii Taub. & Dewèvre	Sunnhemp
Crotalaria crebra Polhill	Sunnhemp
Crotalaria criniramea Baker f. ex Polhill	Sunnhemp
Crotalaria cuspidata Taub.	Sunnhemp
Crotalaria cylindrocarpa DC.	Sunnhemp
Crotalaria cylindrostachys Welw. ex Baker	Sunnhemp
Crotalaria debilis Polhill	Sunnhemp
Crotalaria decora Polhill	Sunnhemp
Crotalaria densicephala Welw. ex Baker	Sunnhemp
Crotalaria deserticola Taub. ex Baker f.	Sunnhemp

CWR	Crop related to
Crotalaria distans Benth.	Sunnhemp
Crotalaria duboisii R.Wilczek	Sunnhemp
Crotalaria egregia Polhill	Sunnhemp
Crotalaria elisabethae Baker f.	Sunnhemp
Crotalaria ephemera Polhill	Sunnhemp
Crotalaria eurycalyx Polhill	Sunnhemp
Crotalaria filicaulis Welw. ex Baker	Sunnhemp
Crotalaria flavicarinata Baker f.	Sunnhemp
Crotalaria florida Welw. ex Baker	Sunnhemp
Crotalaria friesii I.Verd.	Sunnhemp
Crotalaria gamwelliae Baker f.	Sunnhemp
Crotalaria germainii R.Wilczek	Sunnhemp
Crotalaria glauca Willd.	Sunnhemp
Crotalaria glaucifolia Baker	Sunnhemp
Crotalaria goetzei Harms	Sunnhemp
Crotalaria goreensis Guill. & Perr.	Sunnhemp
Crotalaria graminicola Taub. ex Baker	Sunnhemp
Crotalaria grandistipulata Harms	Sunnhemp
Crotalaria huillensis Taub.	Sunnhemp
Crotalaria incana L.	Sunnhemp
Crotalaria involutifolia Polhill	Sunnhemp
Crotalaria ionoptera Polhill	Sunnhemp
Crotalaria johnstonii Baker f.	Sunnhemp
Crotalaria juncea L.	Sunnhemp
Crotalaria kambolensis Baker f.	Sunnhemp
Crotalaria kapiriensis De Wild.	Sunnhemp
Crotalaria kerkvoordei R.Wilczek	Sunnhemp
Crotalaria kipandensis Baker f.	Sunnhemp
Crotalaria kipilaensis R.Wilczek	Sunnhemp
Crotalaria kuiririensis Baker f.	Sunnhemp
Crotalaria kwengeensis R.Wilczek	Sunnhemp
Crotalaria laburnifolia L.	Sunnhemp
Crotalaria lachnocarpoides Engl.	Sunnhemp
Crotalaria lachnophora Hochst. ex A.Rich.	Sunnhemp
Crotalaria lanceolata E. Mey.	Sunnhemp
Crotalaria lasiocarpa Polhill	Sunnhemp
Crotalaria laxiflora Baker	Sunnhemp
Crotalaria lepidissima Baker f.	Sunnhemp
Crotalaria leptoclada Harms	Sunnhemp
Crotalaria limosa Polhill	Sunnhemp
Crotalaria lukafuensis De Wild.	Sunnhemp

CWR	Crop related to
Crotalaria microcarpa Hochst. ex Benth.	Sunnhemp
Crotalaria microthamnus Robyns ex R.Wilczek	Sunnhemp
Crotalaria minutissima Baker f.	Sunnhemp
Crotalaria miranda Milne-Redh.	Sunnhemp
Crotalaria modesta Polhill	Sunnhemp
Crotalaria morumbensis Baker f.	Sunnhemp
Crotalaria natalitia Meisn.	Sunnhemp
Crotalaria nigricans Baker	Sunnhemp
Crotalaria nuda Polhill	Sunnhemp
Crotalaria nudiflora Polhill	Sunnhemp
Crotalaria nyikensis Baker	Sunnhemp
Crotalaria occidentalis Hepper	Sunnhemp
Crotalaria ochroleuca G. Don.	Sunnhemp
Crotalaria ononoides Benth.	Sunnhemp
Crotalaria onusta Polhill	Sunnhemp
Crotalaria orthoclada Welw. ex Baker	Sunnhemp
Crotalaria pallida Aiton	Sunnhemp
Crotalaria pallidicaulis Harms	Sunnhemp
Crotalaria parvula Welw. ex Baker	Sunnhemp
Crotalaria passerinoides Taub.	Sunnhemp
Crotalaria peregrina Polhill	Sunnhemp
Crotalaria pisicarpa Welw. ex Baker	Sunnhemp
Crotalaria platysepala Harv.	Sunnhemp
Crotalaria podocarpa DC.	Sunnhemp
Crotalaria polysperma Kotschy ex Schweinf.	Sunnhemp
Crotalaria polytricha Polhill	Sunnhemp
Crotalaria praetexta Polhill	Sunnhemp
Crotalaria prittwitzii Baker f.	Sunnhemp
Crotalaria prolongata Baker	Sunnhemp
Crotalaria pseudodiloloensis R.Wilczek	Sunnhemp
Crotalaria pseudotenuirama Torre	Sunnhemp
Crotalaria pygmaea Polhill	Sunnhemp
Crotalaria quangensis Taub.	Sunnhemp
Crotalaria quarrei Baker f.	Sunnhemp
Crotalaria recta Steud. ex A.Rich.	Sunnhemp
Crotalaria reptans Taub.	Sunnhemp
Crotalaria rhodesiae Baker f.	Sunnhemp
Crotalaria ringoetii Baker f.	Sunnhemp
Crotalaria rogersii Baker f.	Sunnhemp
Crotalaria senegalensis (Pers.) Bacle ex DC.	Sunnhemp
Crotalaria sertulifera Taub.	Sunnhemp

CWR	Crop related to
Crotalaria shirensis (Baker f.) Milne-Redh.	Sunnhemp
Crotalaria simoma Polhill	Sunnhemp
Crotalaria sparsifolia Baker	Sunnhemp
Crotalaria spartea Baker	Sunnhemp
Crotalaria sphaerocarpa Perr. ex DC.	Sunnhemp
Crotalaria spinosa Hochst. ex Benth.	Sunnhemp
Crotalaria stenoptera Welw. ex Baker	Sunnhemp
Crotalaria steudneri Schweinf.	Sunnhemp
Crotalaria streptorryncha Milne-Redh.	Sunnhemp
Crotalaria subcaespitosa Polhill	Sunnhemp
Crotalaria subcapitata De Wild.	Sunnhemp
Crotalaria subtilis Polhill	Sunnhemp
Crotalaria sylvicola Baker	Sunnhemp
Crotalaria tabularis Baker f.	Sunnhemp
Crotalaria tenuipedicellata Baker f.	Sunnhemp
Crotalaria tenuirama Welw. ex Baker	Sunnhemp
Crotalaria teretifolia Milne-Redh.	Sunnhemp
Crotalaria trinervia Polhill	Sunnhemp
Crotalaria tristis Polhill	Sunnhemp
Crotalaria ulbrichiana Harms	Sunnhemp
Crotalaria umbellifera R.E.Fr.	Sunnhemp
Crotalaria unicaulis Bullock	Sunnhemp
Crotalaria valida Baker	Sunnhemp
Crotalaria vandenbrandtii R.Wilczek	Sunnhemp
Crotalaria vanmeelii R.Wilczek	Sunnhemp
Crotalaria variegata Welw. ex Baker	Sunnhemp
Crotalaria virgulata Klotzsch	Sunnhemp
Cucumis africanus L.f.	Cucumber
Cucumis anguria L.	Cucumber
Cucumis ficifolius A. Rich	Cucumber
Cucumis hirsutus Sond.	Cucumber
Cucumis humifructus Stent	Cucumber
Cucumis metuliferus E.Mey. ex Naudin	Cucumber
Cucumis myriocarpus Naud. subsp. *myriocarpus*	Cucumber
Cucumis sacleuxii Paill. & Bois	Cucumber
Cucumis zeyheri Sond.	Cucumber
Dioscorea asteriscus Burkill	Yam
Dioscorea baya De Wild.	Yam
Dioscorea bulbifera L.	Yam
Dioscorea cochleari apiculata De Wild	Yam
Dioscorea dumetorum (Kunth) Pax	Yam

CWR	Crop related to
Dioscorea hirtiflora Benth.	Yam
Dioscorea hylophila Harms ex Engl.	Yam
Dioscorea liebrechtsiana De Wild. & T.Durand	Yam
Dioscorea mundii Baker	Yam
Dioscorea odoratissima Pax	Yam
Dioscorea praehensilis Benth.	Yam
Dioscorea preussii Pax	Yam
Dioscorea quartiniana A.Rich.	Yam
Dioscorea sansibarensis Pax	Yam
Dioscorea schimperiana Hochst. ex Kunth	Yam
Dioscorea sylvatica Eckl.	Yam
Eleusine coracana (L.) Gaertn. subsp. *africana*	Finger millet
Eleusine indica (L.) Gaertn.	Finger millet
Hibiscus acetosella Welw. ex Hiern	Kenaf, Roselle
Hibiscus allenii Sprang & Hutch.	Kenaf, Roselle
Hibiscus articulatus Hoschst. ex A. Rich	Kenaf, Roselle
Hibiscus caesius Garcke	Kenaf, Roselle
Hibiscus cannabinus L.	Kenaf, Roselle
Hibiscus debeerstii De Wild	Kenaf, Roselle
Hibiscus diversifolius Jacq. subsp. *rivularis*	Kenaf, Roselle
Hibiscus dongolensis Caill. ex Delile	Kenaf, Roselle
Hibiscus hiernianus Exell & Mendonca	Kenaf, Roselle
Hibiscus lobatus (Murr.) Kuntze	Kenaf, Roselle
Hibiscus ludwigii Eckl. & Zeyh.	Kenaf, Roselle
Hibiscus mastersianus Hiern	Kenaf, Roselle
Hibiscus mechowii Garcke	Kenaf, Roselle
Hibiscus meeusei Exell	Kenaf, Roselle
Hibiscus micranthus L f.	Kenaf, Roselle
Hibiscus migeodii Exell	Kenaf, Roselle
Hibiscus nigricaulis Baker f.	Kenaf, Roselle
Hibiscus noldeae Baker f.	Kenaf, Roselle
Hibiscus nyikensis Sprague	Kenaf, Roselle
Hibiscus ovalifolius (Forssk.) Vahl	Kenaf, Roselle
Hibiscus panduriformis Burm f.	Kenaf, Roselle
Hibiscus physaloides Guill. & Perr.	Kenaf, Roselle
Hibiscus platycalyx Mast.	Kenaf, Roselle
Hibiscus praeteritus R.A. Dyer	Kenaf, Roselle
Hibiscus rhabdotospermus Garcke	Kenaf, Roselle
Hibiscus rhodanthus Gürke apud Schinz	Kenaf, Roselle
Hibiscus richardsiae Exell	Kenaf, Roselle
Hibiscus rostellatus Guill. & Perr.	Kenaf, Roselle

CWR	Crop related to
Hibiscus schinzii Gürke	Kenaf, Roselle
Hibiscus shirensis Sprague & Hutch	Kenaf, Roselle
Hibiscus sidiformis Baill.	Kenaf, Roselle
Hibiscus surettensis L	Kenaf, Roselle
Hibiscus trionum L.	Kenaf, Roselle
Hibiscus vitifolius L.	Kenaf, Roselle
Ipomoea aquatica Forssk.	Sweet potato
Ipomoea asarifolia (Desr.) Roem. & Schult.	Sweet potato
Ipomoea barteri Baker	Sweet potato
Ipomoea blepharophylla Hallier f.	Sweet potato
Ipomoea bolusiana Schinz	Sweet potato
Ipomoea cairica (L.) Sweet	Sweet potato
Ipomoea chloroneura Hallier f.	Sweet potato
Ipomoea chrysoch Hallier f.	Sweet potato
Ipomoea chrysochaetia Hallier f.	Sweet potato
Ipomoea coptica (L.) Roth ex Roem. & Schult. Var. *coptica*	Sweet potato
Ipomoea coscinosperma Hochst. ex Choisy	Sweet potato
Ipomoea crassipes Hook.	Sweet potato
Ipomoea crepidiformis Hallier f. var. *microcephala*	Sweet potato
Ipomoea crepidiformis Hallier f. var *minor*	Sweet potato
Ipomoea decora Hochst. ex Choisy	Sweet potato
Ipomoea dichroa Hochst. ex Choisy	Sweet potato
Ipomoea eriocarpa R.Br.	Sweet potato
Ipomoea fanshawei Verdc.	Sweet potato
Ipomoea fulvicaulis (Hochst. ex Choisy) Boiss. ex Hallier f. var. *fuvicaulis*	Sweet potato
Ipomoea fulvicaulis (Hochst. ex Choisy) Boiss. ex Hallier f. var. *heterocalyx*	Sweet potato
Ipomoea fulvicaulis (Hochst. ex Choisy) Boiss. ex Hallier f. var. *asperifolia*	Sweet potato
Ipomoea hederifolia L.	Sweet potato
Ipomoea heterotricha Didr.	Sweet potato
Ipomoea hochsteteri House	Sweet potato
Ipomoea holubii Baker	Sweet potato
Ipomoea humidicola Verdc.	Sweet potato
Ipomoea involucrata P.Beauv. subsp. var. *involucrata*	Sweet potato
Ipomoea kituiensis Vatke	Sweet potato
Ipomoea lapathifolia Hallier f. var. *lapathifolia*	Sweet potato
Ipomoea leucanthemum (Klotzsch) Hallier f.	Sweet potato
Ipomoea linosepala Hallier f.	Sweet potato
Ipomoea linosepala Hallier f. subsp. *alpina*	Sweet potato
Ipomoea mauritiana Jacq.	Sweet potato
Ipomoea milnei Verdc.	Sweet potato
Ipomoea obscura (L.) Ker Gawl.	Sweet potato

CWR	Crop related to
Ipomoea ochracea (Lindl.) Sweet	Sweet potato
Ipomoea oenotherae (vatke) Hallier f.	Sweet potato
Ipomoea papilio Hallier f.	Sweet potato
Ipomoea parasitica (Kunth) G.Don	Sweet potato
Ipomoea pes caprae (L.) Sweet subsp. *brasiliensis*	Sweet potato
Ipomoea pes caprae (L.) Sweet	Sweet potato
Ipomoea pes tigridis L. var. *pes tigridis*	Sweet potato
Ipomoea pes tigridis L. var. *strigosa*	Sweet potato
Ipomoea pileata Roxb.	Sweet potato
Ipomoea plebeia R.Br. subsp. *Africana*	Sweet potato
Ipomoea polymorpha Roem. & Schult	Sweet potato
Ipomoea primatosyphon Welw.	Sweet potato
Ipomoea protea Britten & Rendle	Sweet potato
Ipomoea purpurea (L.) Roth	Sweet potato
Ipomoea recta De Wild.	Sweet potato
Ipomoea richardsiae Verdc	Sweet potato
Ipomoea rubens Choisy	Sweet potato
Ipomoea shirambensis Baker	Sweet potato
Ipomoea shupangensis Baker	Sweet potato
Ipomoea sinensis (Desr.) Choisy subsp. *blepharosepala*	Sweet potato
Ipomoea sinensis (Desr.) Choisy subsp. *sinensis*	Sweet potato
Ipomoea stenosiphon Hallier f.	Sweet potato
Ipomoea tenuipes Verdc.	Sweet potato
Ipomoea tenuirostris Steud. & Chosy subsp. *tenuirostris*	Sweet potato
Ipomoea tuberculata Ker Gawl. var. *odontosepala*	Sweet potato
Ipomoea turbinata Lag.	Sweet potato
Ipomoea venosa (Desr.) Roem. & Schult subsp. *stellaris*	Sweet potato
Ipomoea venosa (Desr.) Roem. & Schult subsp. *venosa*	Sweet potato
Ipomoea verbascoidea Choisy	Sweet potato
Ipomoea vernalis R.E.Fr.	Sweet potato
Ipomoea welwitschii Vatke ex Hallier f.	Sweet potato
Ipomoea wightii (Wall.) Choisy subsp. var. *wightii*	Sweet potato
Lactuca calophylla C.Jeffrey	Lettuce
Lactuca homblei De Wild.	Lettuce
Lactuca imbricata Hiern	Lettuce
Lactuca inermis Forssk.	Lettuce
Lactuca lasiorhiza (O.Hoffm.) C.Jeffrey	Lettuce
Lactuca longispicata De Wild.	Lettuce
Lactuca mwinilungensis G.V.Pope	Lettuce
Lactuca praecox R.E.Fr.	Lettuce
Lactuca schulzeana Büttner	Lettuce

CWR	Crop related to
Lactuca schweinfurthii Oliv. & Hiern	Lettuce
Lactuca setosa Stebbins ex C.Jeffrey	Lettuce
Lactuca zambeziaca C.Jeffrey	Lettuce
Lagenaria breviflora (Berth.) Roberty	Gourd
Lagenaria siceraria (Molina) Standl.	Gourd
Lagenaria sphaerica (Sond.) Naudin	Gourd
Momordica balsamina L	Momordica
Momordica boivinii Baill.	Momordica
Momordica cardiospermoides Klotzsch	Momordica
Momordica charantia L	Momordica
Momordica corymbifera Hook f.	Momordica
Momordica foetida Schumach.	Momordica
Momordica kirkii (Hook.f.) C.Jeffrey	Momordica
Momordica peteri Zimmermann	Momordica
Mucuna coriacea Baker	Velvet bean
Mucuna deeringiana (Bort) Merr.	Velvet bean
Mucuna glabrialata (Hauman) Verdc.	Velvet bean
Mucuna poggei Taub.	Velvet bean
Mucuna stans Welw. ex Baker	Velvet bean
Oryza barthii A. Chev.	Rice
Oryza brachyantha Chev. & Roehr.	Rice
Oryza longistaminata A. Chev. & Roehr.	Rice
Oryza punctata Steud	Rice
Oryza schweinfurthiana Prodoehl	Rice
Pennisetum macrourum Trin.	Pearl millet
Pennisetum pedicillatum Trin.	Pearl millet
Pennisetum polystachion (L.) Schult. subsp. *atrichum*	Pearl millet
Pennisetum polystachion (L.) Schult. subsp. *polystachion*	Pearl millet
Pennisetum purpureum Schumach.	Pearl millet
Pennisetum setaceum (Forssk.) Chiov.	Pearl millet
Pennisetum thunbergii Kunth	Pearl millet
Pennisetum trachyphyllum Pilg.	Pearl millet
Pennisetum typhodes (Burm f.) Stapf & C.E.Hubb.	Pearl millet
Pennisetum unisetum (Nees) Benth.	Pearl millet
Plectranthus acaulis Brummitt & Seyani	Livingstone potato
Plectranthus alboviolaceus Gürke	Livingstone potato
Plectranthus betonicaefolius Baker	Livingstone potato
Plectranthus buchananii Baker	Livingstone potato
Plectranthus candelabriformis Launert	Livingstone potato
Plectranthus caninus Roth	Livingstone potato
Plectranthus comosus Sims	Livingstone potato

CWR	Crop related to
Plectranthus cylindraceus Hochst. ex Benth	Livingstone potato
Plectranthus equisetiformis (E.A.Bruce) Launert	Livingstone potato
Plectranthus esculentus N.E.Br.	Livingstone potato
Plectranthus flaccidus (Vatke) Gürke	Livingstone potato
Plectranthus goetzei Gürke	Livingstone potato
Plectranthus gracillimus (T.C.E Fr.) Hutch. & Dandy	Livingstone potato
Plectranthus hjalmarii (T.C.E Fr.) Hutch. & Dandy	Livingstone potato
Plectranthus kapatensis (R.E.Fr.) J.K. Morton	Livingstone potato
Plectranthus laxiflorus Benth.	Livingstone potato
Plectranthus luteus Gürke	Livingstone potato
Plectranthus masukensis Baker	Livingstone potato
Plectranthus mirabilis (Briq.) Launert	Livingstone potato
Plectranthus modestus Baker	Livingstone potato
Plectranthus neochilus Schltr	Livingstone potato
Plectranthus nyikensis Baker	Livingstone potato
Plectranthus primulinus Baker	Livingstone potato
Plectranthus stenophyllus Baker	Livingstone potato
Plectranthus tetensis (Baker) Agnew	Livingstone potato
Plectranthus tetragonus Gürke	Livingstone potato
Plectranthus thyrsoideus (Baker) B. Mathew	Livingstone potato
Plectranthus viphyensis Brummitt & Seyani	Livingstone potato
Plectranthus zebrarum Brummitt & Seyani	Livingstone potato
Sesamum alatum Thonn.	Sesame
Sesamum angolense Welw.	Sesame
Sesamum angustifolium (Oliv.) Engl.	Sesame
Sesamum calycinum Welw. subsp. *baumii*	Sesame
Sesamum calycinum Welw. subsp. *calycinum*	Sesame
Sesbania bispinosa (Jacq.) W.Wight	Sesbania
Sesbania cinerascens Welw. ex Baker	Sesbania
Sesbania coerulescens Harms	Sesbania
Sesbania goetzei Harms	Sesbania
Sesbania greenwayii J.B. Gillett	Sesbania
Sesbania macrantha Welw. ex E. Phillips & Hutch.	Sesbania
Sesbania microphylla Harms ex E. Phillips & Hutch.	Sesbania
Sesbania mossambicensis Klotzsch	Sesbania
Sesbania rogersii E. Phillips & Hutch	Sesbania
Sesbania sesban (L.) Merr.	Sesbania
Sesbania tetraptera Hochst. ex Baker	Sesbania
Solanum aculeatissimum Jacq.	Eggplant, potato
Solanum anguivi Lam.	Eggplant, potato
Solanum aureitomentosum Bitter	Eggplant, potato

CWR	Crop related to
Solanum dasyphyllum Schumach.	Eggplant, potato
Solanum goetzei Dammer	Eggplant, potato
Solanum incanum L.	Eggplant, potato
Solanum lagascae Roem. & Schult.	Eggplant, potato
Solanum macrocarpon L.	Eggplant, potato
Solanum nigrum L.	Eggplant, potato
Solanum richardii Dunal	Eggplant, potato
Solanum rothii C.H. Wright	Eggplant, potato
Solanum taitense Vatke	Eggplant, potato
Solanum terminale Forssk.	Eggplant, potato
Solanum tettense Klotzsch var. *renschii*	Eggplant, potato
Sorghastrum friesii (Pilg.) Pilg.	Sorghum
Sorghastrum fuscescens (Pilg.) Clayton	Sorghum
Sorghastrum incompletum (J. Presl) Nash var. *bipennatum*	Sorghum
Sorghastrum nudipes Nash	Sorghum
Sorghastrum pogonostachyum (Stapf) Clayton	Sorghum
Sorghastrum stipoides (Kunth) Nash	Sorghum
Sorghum arundinaceum (Desv.) Stapf	Sorghum
Sorghum bicolor (L.) Moench subsp. *verticiflorum*	Sorghum
Sorghum purpureosericeum (Hochst. ex A. Rich.) Asch. & Schweinf.	Sorghum
Sorghum versicolor Andersson	Sorghum
Vigna antunesii Harms	Cowpea
Vigna comosa Baker	Cowpea
Vigna fischeri Harms	Cowpea
Vigna frutescens A. Rich.	Cowpea
Vigna gracilis (Guill. & Perr.) Hook.f	Cowpea
Vigna haumaniana R. Wilczek	Cowpea
Vigna heterophylla A. Rich.	Cowpea
Vigna juncea Milne-Redh	Cowpea
Vigna kirkii (Baker) J.B. Gillett	Cowpea
Vigna longissima Hutch.	Cowpea
Vigna luteola (Jacq.) Benth	Cowpea
Vigna macrorhyncha (Harms) Milne-Redh	Cowpea
Vigna monophylla Taub.	Cowpea
Vigna multinervis Hutch. & Dalziel	Cowpea
Vigna nuda N.E.Br.	Cowpea
Vigna oblongifolia A. Rich. var. *oblingifolia*	Cowpea
Vigna oblongifolia A. Rich. var. *Parvifolia*	Cowpea
Vigna parkeri Baker	Cowpea
Vigna parkeri Baker subsp. *maranguensis*	Cowpea
Vigna phoenix Brummitt	Cowpea

CWR	Crop related to
Vigna platyloba Hierm	Cowpea
Vigna procera Welw. ex Hiern	Cowpea
Vigna pygmaea R.E.Fr.	Cowpea
Vigna racemosa (G.Don) Hutch	Cowpea
Vigna radiata (L.) Wilczek var. *sublobata*	Cowpea
Vigna radicans Welw. ex Baker	Cowpea
Vigna reticulata Hook. f.	Mung bean
Vigna richardsiae Verdc.	Cowpea
Vigna triphylla (R. Wilczek) Verdc.	Cowpea
Vigna unguiculata (L.) Walp. var. *spontanea*	Cowpea
Vigna unguiculata (L.) Walp. subsp. *dekindtiana*	Cowpea
Vigna unguiculata (L.) Walp. subsp. *pawekiae*	Cowpea
Vigna unguiculata (L.) Walp. subsp. *tenuis*	Cowpea
Vigna vexillata (L.) A. Rich.	Cowpea
Vigna wittei Baker f.	Cowpea

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