

Valorization Potential Assessment: Mozambique

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Introduction

The main objective of this assessment is to support the valorization of genetic resources (GR) and to inform the development of national access and benefit sharing (ABS) frameworks. With a view to increasing the potential benefits arising from the utilization of GR, there is a need to bridge the gap between providers of GR and their potential users in foreign countries. For this purpose, the following key elements are examined:

Section one examines the key components of the national ABS regulatory framework in order to assess how the existing framework can contribute to an enabling environment for the valorization of Mozambique's GR.

In section two, an overview of Mozambican actors potentially using or involved in R&D on GR is presented. It seeks to answer the following questions: Which actors are valorizing and/ or utilizing GR in Mozambique? How are they connected to each other and to foreign users? Are they capable to meet the users R&D requirements? What are the gaps?

In section three, an overview of the economic potential of the species is drawn from the separate study 'Biodiversity in the Patent System: Mozambique'. The main question addressed in this study is: what can patent information teach us about the range of potential economic uses of African GR and traditional knowledge (TK)?

In section four, the link between patent documents, value chains and markets is presented. Examples were selected to illustrate different types of commercialization and to highlight the economic potential of the species. Analysis of the value or profits that have been derived from the commercialization of products based on these GR/species is beyond the scope of this assessment.

Finally, conclusions and recommendations are provided with a view to inform the development or revision of the national ABS framework and create an enabling environment for the valorization of GR. This approach seeks to answer the following questions: What are the practical steps to improve the valorisation of GR within the ABS framework? What kind of business, legislative and regulatory environment is favourable for this purpose?

1. National ABS framework

A national biotechnology strategy was adopted by the Ministry of Science and Technology in 2009. It has a ten-year framework with an initial operation plan of five years. It identifies key weaknesses related to the development of a biotechnology expertise in the country such as the lack of a critical mass of scientists, funding, supportive legislation, and a strong corporate culture with a committed leadership. Biodiversity is considered as a potential source of industrial and commercial material with the ambition to target intervention on the country's development challenges (food safety and quality, man, animals and plants health, industrial processing and the production of value-added competitive quality goods). The upcoming revision of the strategy should provide interesting lessons.

The following measures are relevant to ABS in Mozambique¹:

- The Constitution of the Republic of Mozambique
- Resolution No 2/94 of 24 August by which the Convention on Biological Diversity was ratified
- The Environmental Law (Lei do Ambiente N.º 20/97, of 1 October)
- Decree 19/2007 of 9 August 2007 passed the Regulation on Access to Genetic Resources, associated traditional knowledge and the fair and equitable sharing of benefits arising from their utilization (ABS Regulation).

MICOA (Ministerio para Coordenação da Acção Ambiental) was designated as the competent national authority for ABS by the ABS Regulation. In addition, the Regulation establishes an inter-institutional group for the management of genetic resources (Grupo Interinstitucional de Gestão de Recursos Genéticos) composed of representatives of relevant ministries (e.g. Science and Technology, Agriculture, Fisheries, Health, Education, Culture, Tourism, Mineral resources, Trade and Industry) and presided by the national competent authority.

Some elements of particular interest include the following²:

- Access to GR *in situ* is only permitted for national institutions, whether public or private, which carry out R&D activities in biology or related areas of activity. Access to GR can only be granted with the prior authorization of the resource provider. The same applies to TK, which can only be accessed with the prior authorization of the holders of such knowledge. Therefore, a foreign institution can only access GR or associated TK through partnership with a national institution.
- Access to GR held *ex situ* can be obtained through a Material Transfer Agreement. When there is an intention to commercialize a product or process based on a GR, an ABS contract will be required covering the utilization of the resources and the sharing of benefits.
- In principle, the samples accessed shall be conserved *ex situ* in Mozambique and can only be transferred to foreign institutions with the authorization of the competent national authority.
- The authorization to access GR *in situ* or to transfer material found *ex situ* to a foreign institution can only be granted by the competent national authority if a number of conditions are met, including: the consent of the local community, if the access takes place in a protected area, the consent of the relevant authority; the owner of the resource; the relevant fishing or marine authority for access to resources in marine areas within national jurisdiction; the relevant authority with respect to access to endemic resources or endangered species.

¹ <http://absmocambique.net/legislacao/>

² For further information, see : Lago, A.; Silvestri, L. y Lapeña, I. 2012. *Acceso a los Recursos Genéticos y Conocimientos Tradicionales (ABS) en Mozambique. Manual para Instituciones de Investigación*. Cátedra UNESCO de Territorio y Medio Ambiente. Universidad Rey Juan Carlos, Madrid, España.

- When access to GR is for research purposes, there is an obligation for the institution receiving a sample of the GR to facilitate the transfer of technology associated with these resources on the basis of mutually agreed terms between the national and foreign institutions involved. When access is for commercial purposes, a contract regarding the utilization of the resources and the sharing of benefits is mandatory. Although the Regulation includes a list of possible benefits to be shared, these are to be determined on a case-by-case basis.
- It is worth noting that the importance of non-monetary benefits is recognised and can contribute to national development. Non-monetary benefits may include: the transfer of technology relevant to conservation or sustainable use of resources, participation in scientific research, the development of human capacity, exchange of information, and support to the establishment of infrastructure for research and development activities.
- The Regulation also refers to a list of issues which need to be addressed in the ABS contract, including, among others: the contracting parties, the purpose of utilization of the resources accessed, the sharing of benefits, intellectual property rights, and penalties for situations of non-compliance.
- In addition, the ABS contract must be registered with the competent national authority. If the resource is only accessed for research purposes the ABS agreement does not need to be registered with the competent national authority.

In light of the above, it can be concluded that the ABS framework establishes clear rules and procedures for ABS that should contribute to legal certainty and contribute to the valorization of GR and the development of national capacities for the utilization of GR. However, the available information is insufficient in order to determine whether the implementation of these measures can provide an enabling environment for the valorization of GR in Mozambique or whether improvements are still needed.

2. Overview of Mozambican actors potentially using or involved in R&D on GR

This analysis is based on publicly available information that could be identified through internet research. Limited information was found on Mozambican actors. Actors involved in the valorization of biodiversity generally have a limited public profile as they are often a technical intermediary in long and complex R&D processes. Finally, actors that do not have an internet website could not be identified and are therefore not taken into account in the assessment. While some potential leads are identified, only partial conclusions can be drawn.

2.1 Methodology

The methodology used to identify the actors that are potentially using or involved in R&D on GR was based on the following steps:

- The characteristic of the country's economy was first examined to identify the key players that could be involved in the utilization of GR (e.g. biodiversity conservation, main actors of the principal economic sectors)

- An internet search based on key words was carried out. The key words used are presented in annex one.
- When possible, interviews were realised with individuals having a good knowledge of the actors related to the utilisation of GR, R&D and the valorisation of biodiversity in the country³.
- Specific internet research for each actor was carried out to identify: area(s) of R&D, maintenance of collections (e.g. genes), potential uses of GR and any collaborations with foreign actors (as a basis for potential exchanges of genetic material). For the last two categories, a basic Yes / No / Unclear categorisation was used
- Based on the facts compiled, 29 institutions stood out as potentially relevant for ABS as their activities are related to the utilisation of GR.

While a total of 65 actors were identified (listed in the annex two⁴), the most 29 relevant actors are examined in this report (and listed in annex three). They are categorised as follow:

- **Actors providing GR:** they are officially designated under national legislation as institutions with mandate to provide GR
- **Actors which may utilize GR in the context of their broader activity:** it is unclear if they specifically use GR, but it is a possibility in consideration of their mission statement, activities and area of expertise. Based on very limited information available, it is not possible to formally confirm this. There are two sub-categories: public researcher institutions and other institutions (e.g. NGOs, private sector)
- **Actors of the support environment:** they do not directly use GR but they contribute to a conducive valorization environment by providing financial, technical and organizational support to potential providers, users and other actors.

2.2 Main results: the most relevant actors related to GR

The following examines the actors that seem of particular relevance to the utilization and valorization of GR. However, due to the limited information available, it was not possible to examine the specific areas of research, projects and the technical capabilities of these actors. Although all these actors are involved in activities related to the valorization of biological resources (BR), it is unclear if and how they utilize GR.

In order to develop the human and institutional capacities of higher education and research institutions in terms of ABS in Mozambique, a project entitled '**Acesso aos recursos geneticos e conhecimentos tradicionais (ABS) em Moçambique**⁵ (**ABS Moçambique**) was implemented in 2012. The project was funded by the Spanish Agency for International Cooperation and Development (AECID). National partners included: the **Biotechnology Centre of the Eduardo Mondlane University**⁶ (Centro de Biotecnologia da Universidade Eduardo Mondlane), the **Research Institute for Water**⁷

³ In the case of Mozambique, M. A. Lago (Dir. UNESCO Chair for the Environment at Universidad Rey Juan Carlos, Spain) was interviewed.

⁴ Considering the limited information available, further analysis may indicate that they should be integrated into the core actors concerned by ABS and the economic valorisation of GR.

⁵ <http://absmocambique.net/>

⁶ <http://www.cb.uem.mz/pt/>

⁷ www.mct.gov.mz/portal/page?_pageid=617,3783527&_dad=portal&_schema=PORTAL

(Instituto de Investigação em Águas), the **Centre for Research and Development in Ethnobotany**⁸ (Centro de Investigação e Desenvolvimento em Etnobotânica), and the **Institute for Marine Biotechnology**⁹ (Instituto de Biotecnologia Marinha).

Under this project, a series of workshops was carried out and a pedagogical manual¹⁰ to sensitize research institutions on ABS was produced.

2.2.1 Actor providing GR

No institutions are designated as official provider of GR.

2.2.2 Actors which may utilize GR in the context of their broader activity

Public Research Institutions

In total, five public research centres, one botanical garden and one NGO were identified. There is very limited information available on these actors.

The Botanical Garden of the National Institute of Agronomic Research (INIA) houses the National Gene Bank with approximately 62,000 herbarium specimens, of which 90% are indigenous to Mozambique.

National partners involved in the ABS Mozambique project mentioned above as well as two other public actors are identified as potential users of GR. The first four actors are particularly relevant to ABS.

- The establishment of the **Institute of Marine Biotechnology**¹¹ (Instituto de Biotecnologia Marinha) is an important development for the biotechnology sector in the country. It was funded by the Government of Spain and established in 2013¹². Its purpose is to provide the country with a modern center able to carry out activities related to marine biotechnology. The project includes a database of marine organisms intended for taxonomic and biotechnology activities in order to develop basic science as well as commercial initiatives.
- **Biotechnology Center of the Eduardo Mondlane University**¹³ (Centro de Biotecnologia da Universidade Eduardo Mondlane). This center was created in 2009. It focuses on theoretical and experimental biotechnology. In February 2012, the Centre launched the first Master in Biotechnology in the country. It has a botanical garden with an approximate number of herbarium specimens of 62,000. Approximately 90% of plants in the collection are indigenous to Mozambique. The Garden contains a building housing the National Gene Bank.

⁸

<http://www.mct.gov.mz/pls/portal/docs/PAGE/PORTALCIENCIATECNOLOGIA/PUBLICACOES/REV.INOV.TECN.NR.12%20-%20JUNHO%202010%20-%20CIDE.PDF>

⁹ <http://www.cpdciencia.com/vistas/01.aspx?id=93>

¹⁰ Lago, A.; 2012. <http://absmocambique.files.wordpress.com/2013/01/libro-final-es.pdf>
<http://absmocambique.files.wordpress.com/2013/01/libro-final-es.pdf>

¹¹ http://absmocambique.files.wordpress.com/2012/12/apresentac3a7c3a3o- laboratorio-de-biotecnologia_maputo_novembro_2012.pdf

¹² http://absmocambique.files.wordpress.com/2012/12/apresentac3a7c3a3o- laboratorio-de-biotecnologia_maputo_novembro_2012.pdf

¹³ http://www.cb.uem.mz/pt/docs/cbuem/INTRODUCTION_TO_THE_CENTER_OF_BIOTECHNOLOGY.pdf

- **The Research Institute for Water** (Instituto de Investigação em Águas) focuses on research and training in water, including access to aquatic genetic resources.
- The **Center for Research and Development of Ethnobotany** (Centro de Investigação e Desenvolvimento em Etnobotânica) focuses on the protection and valorisation of TK as well as the valorisation of products based on medicinal plants. The center has entered into international collaborations for research on GR.

Finally, the **Tunduru Botanical Garden**¹⁴ has various plant collections (number of taxa: 230) and the **Institute for Agriculture Research**¹⁵ (Instituto de Investigação Agrária de Moçambique), which houses the Centre of Micropropagation, can be considered as potential providers of GR. However, no further information is available in this respect.

At the international level, there is a collaboration between **Mozambican institutions** (University Eduardo Mondlane, Institute of Agricultural Research of Mozambique, Centre for Research and Development in Ethnobotany) and **Portuguese ones** (Institute of Tropical Scientific Research - IICT and Center Sintra Live Science - HCMC) that co-organised the event "Our Plants Our Lives"¹⁶. It included activities in the following areas: *'From the flora to the laboratory, Molecule of life, The allure of seed'*. Although no further information with respect to activities related to the utilization of GR could be found on the internet, these may be worth further exploring:

At the regional level, the **Southern African Development Community (SADC) Plant Genetic Resources**¹⁷ Center works in coordination with plant genetics centers in each of the Member States of the SADC. It conserves and preserves the genetic diversity and viability of Southern African plant stock.

The **Gilé National Reserve** conducted an inventory of the reserve natural resource in 2008, with financing from the French Development Agency¹⁸. No further information was found. Very limited information was available for the **University Eduardo Mondlane**¹⁹ on research related to BR²⁰.

Although the Nagoya Protocol does not cover human GR, it is interesting to note that **the National Health Institute**²¹ (El Instituto Nacional de Saude) has a Laboratory of Molecular Biology with a plan to expand its capacity for the molecular diagnosis of genetic diseases, as well as improved knowledge about epidemiologic diseases. Also the Institute for Health Sciences (**Instituto Superior de Ciências da Saúde**) has a laboratory capable of conducting biotechnology activities²².

The Agricultural Research Center of Mapupulo²³ carries out research for the strengthening of agricultural products, including those leading to improved production and crop protection. **ICRISAT-Mozambique**²⁴, is an NGO that conducts agricultural research for development. It has a program on biotechnology and a gene bank on millet. However, for these actors related to agronomy, it is unclear

¹⁴ www.cbd.int/doc/world/mz/mz-ex-bg-en.do

¹⁵ www.iam.gov.mz

¹⁶ <http://www.idcplp.net/?idc=2&idi=5974>

¹⁷ www.sadc.int/sadc-secretariat/services-centres/spgrc/

¹⁸ <http://www.afd.fr/lang/en/home/pays/afrique/geo-afr/mozambique/projets-mz/environnement-mz/reserve-gile>

¹⁹ http://biologia.uem.mz/index.php?option=com_content&view=article&id=6&Itemid=6

²⁰ http://biologia.uem.mz/index.php?option=com_content&view=article&id=6&Itemid=6

²¹ www.ins.gov.mz

²² Lago, A.; 2012. <http://absmocambique.files.wordpress.com/2013/01/libro-final-es.pdf>

²³ www.flickr.com/photos/e4a-2030/5109540793/in/photostream/

²⁴ www.icrisat.org/icrisat-globalpresence.htm

if these R&D activities are covered by Multilateral System (MLS) of the FAO of the International Treaty on Plant Genetic Resources (ITPGRFA) or by the Nagoya Protocol on ABS.

Other actors

There is limited information available on actors in Mozambique which may be involved in the utilization of GR. However, of particular relevance to this study, one national public research centre, and six companies, of which three are foreign, potentially doing R&D on Mozambique BR and GR biological and genetic resources were identified.

In the private sector, **Biooleos Cosmetics**²⁵ produces bodycare from natural ingredients. It is currently applying for a sustainability standard (UEBT) to certify its practices. The **National Seed Company**²⁶ produces and distributes seeds. In both cases, no further information was found on the utilization of GR.

A group of companies, including **Mozambique Bio-Fuel Industries**²⁷ and two South African ones (**Illovo**²⁸, **TSB sugar**²⁹) are involved in the Procana project for biofuel production in Massingir³⁰. **Prio foods**³¹, a subsidiary of **Nutre Group** (Portugal) is also active in agriculture and bio fuels. However no further information was found on both of these projects in order to determine the possible utilization of GR.

Finally, a list of agro-companies and NGOs is available online³².

2.2.3 Actors of the support environment

A few actors were identified which seem to contribute and/or support the valorization of BR and possibly GR in Mozambique:

- **CBI**³³, the Dutch development cooperation agency, provides capacity development, including the identification of value chains with potential for agrobusiness, to the **Mozambican Agency for the Promotion of Exports**³⁴ (Instituto para a Promoção de Exportações de Moçambiques - IPEX).

²⁵ <http://biooleos.com/>

²⁶

<https://www.google.fr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCKQFjAB&url=https%3A%2F%2Fwww.wageningenur.nl%2Fweb%2Ffile%3Fuuid%3D2b564779-1de2-4201-9388-0c623254e09f%26owner%3D1a616bd7-d3c1-493f-9533-d5d61aa53e4a&ei=eFZmVKHuElrUatiCgTg&usg=AFQjCNG6WquT1Roc1zSPE9Xu4FGi3Znmjg&bvm=bv.79914889,d.d2s>

²⁷ <http://mozambiquebiofuelindustries.wordpress.com>

²⁸ www.illovosugar.co.za/Contact/Operations.aspx

²⁹ www.tsb.co.za

³⁰ A group of investors linked to South African company Tsb Sugar plans to re-launch the failed Procana project came to a halt last year (2011) when the Mozambican government decided to cancel the Right to Use Land by investors due to non-compliance with some contractual clauses.

³¹ www.nutregroup.com/quem-somos/?lang=en

³² List of agro companies in Mozambique http://en.mocambiqueempresas.com/index.php?pc=dir_business_subcat§or_parent_id=101

List of NGOs active in Mozambique www.commonwealthofnations.org/sectors-mozambique/civil_society/international_ngos/

³³ www.cbi.eu/About%20CBI/countries/Mozambique/268

³⁴ www.cbi.eu/About%20CBI/CBI%20services/BSO%20Development%20programmes/BSOD-Instituto-para-a-Promo-o-de-Exporta-es-de-Mo-ambique-IPEX-/59240&type=module

- **The Center for the Promotion of Agriculture**³⁵ (CEPAGRI) produces analysis on agribusiness opportunities. The **German cooperation agency (GIZ)** co-organised with them a training on agricultural value chain analysis.
- **Phytotrade Africa**³⁶ is a continental business organisation and operates in the country. Its members make products using the species that are harvested by African rural producers. Members can access Phytotrade's expertise on R&D, market opportunities, ABS and regulatory knowledge.
- Finally, there is the **Center for the promotion of investments**³⁷ (Centro de Promoção de Investimentos) as well as two **business associations**: the Industry Business Association (Associação de Comércio e Indústria³⁸) and the Confederation of Business Associations³⁹, but no further information was found with respect to potential activities related to the valorization of biodiversity.

Two actors could potentially contribute to the valorization of GR.

- The **Beira Agricultural Growth Corridor**⁴⁰ (**BAGC**) promotes investments in commercial agriculture and agribusiness within the Beira Corridor (Tete, Sofala and Manica Provinces). It is a partnership between the Government of Mozambique, private investors, farmer organisations and international agencies⁴¹.
- **Banco terra**⁴² is a bank for agriculture investments aiming to make financial services available to a greater number of enterprises and individuals in Mozambique. This project is financed by the Norwegian development bank. No further information was found to determine whether its activities could be relevant to the valorization of biodiversity.

2.3 Key findings

The key findings arising from the identification of actors involved in activities related to R&D, which may utilize GR are:

- Three international cooperation projects on ABS, biodiversity and GR and plant GR with respectively Spanish, Portuguese partners and the SADC, that may exchange and valorize GR.
- Five potential users of GR, four of them were part of the national ABS capacity development program, financed by the Spanish cooperation agency. Some of these (i.e. Institute of Marine Biotechnology, Biotechnology Center of the Eduardo Mondlane University, Research Institute for Water, Center for Research and Development of Ethnobotany) are particularly relevant to the valorisation of GR.

³⁵ <http://www.cpi.co.mz/index.php/en/>

³⁶ <http://phytotrade.com/tag/mozambique/>

³⁷ www.mozbusiness.gov.mz

³⁸ www.acismoz.com

³⁹ www.cta.org.mz

⁴⁰ www.beiracorridor.com

⁴¹ <http://www.beiracorridor.com/>

⁴² www.bancoterra.co.mz

- Some agricultural companies involved in bio fuel projects in place or under development.

The R&D capacity of national institutions and their level of engagement with foreign actors is unclear.

Although it is clear that the **Biotechnology Center of the Eduardo Mondlane University** is active on GR, a number of public research institutions may also potentially be carrying out research on GR (e.g. health, agriculture, and water). It seems that agriculture and marine resources are a core focus of the national research activities. Based on the information available, the breadth of the R&D taking place seems rather limited.

Apart from the four actors involved in the national ABS project, no other experienced actors can be easily identified, as no single actor or group of actors is active on the whole R&D process, from sampling to setting up a value chain, or demonstrate high level expertise in one specific research area or a R&D phase.

Finally, a few of the actors identified seem to contribute and/or support the valorization of BR and possibly GR. This includes collaborations with foreign development agencies on value chains, which could be further explored in relation to GR. However, as overall limited information was found, it is difficult to draw any conclusions regarding their potential effectiveness in promoting the valorization of GR in Mozambique.

3. Biodiversity in the patent system for Mozambique: overview of the economic potential of the species

The separate study “Biodiversity in the patent system: Mozambique’ available at: http://www.abs-initiative.info/fileadmin/media/Knowledge_Center/Pulications/Patent_Studies/Mozambique_Country_Report_12072013_complete_SMALL.pdf. It presents the results of the analysis of patent activity for the country’s GR and TK. Key insights are drawn from this study, related to the economic potential of species.

3.1 Species that are known to be distributed in Mozambique and elsewhere

GBIF⁴³ indicates 10 963 species name records for Mozambique. The analysis of the Mozambican biodiversity in the global data of patent system identified 1931 species. These species are shared with other countries. They are dominated by cosmopolitan agricultural species. There are also marine species, which reflects the large coastal territory of the country. The patent assignees (holders) range across a spectrum of biotechnology companies in areas such as biocides/insecticides and other agricultural concerns.

3.2 Species that were directly sourced from, or potentially originate from, Mozambique based on distribution data.

In total, a focus placed on patent documents making a direct reference to Mozambique identified ten species. They are very different from those found in the global data dominated by cosmopolitan agricultural species. They are mostly plantae with markets in sectors such as cosmetics, health food,

⁴³ The Global Biodiversity Information Facility (GBIF) is an international open data infrastructure, funded by governments. It allows anyone to access data about all types of life on Earth, shared across national boundaries via the Internet.

biotechnology and pharmaceuticals. Some species are the focus of activity for a range of different products and markets.

The top two claims in the patent documents refer to compounds and compositions. However close attention is required to both the type and the content of patent claims as well as where and whether the patent is in force. No patent documents particularly stand out but three species (*Micromonospora sp. Strain*, *Oryza sativa* and *Sesamum alatum*) appear as species with global reach. The analysis based on patent citations, revealed two species (*Lippia Javanica*, *Micromonospora sp.*) where there is indication of further economic potential connected to the patented inventions, respectively for an essential oil composition for killing or repelling ectoparasites and pests as well as for use as an anticancer treatment. The analysis of the patent family allowed the identification of four species of potentially high business importance to the applicants (*Micromonospora strain*, *Oryza sativa var. Gigante*, *Sesamum alatum*, *Brackhenridgea zanguebarica*), where further R&D partnerships could be explored.

4. Links between patent documents, value chains and markets

The ten species identified, potentially originating from Mozambique, were examined to illustrate different types of commercialization and to further explore the economic potential of the species. The table in annex four presents the patent documents with all the information identified on the status of the R&D and linkages with value chains and markets. Based on this data, a summary table of the patent documents examined is presented below.

In some cases this analysis uncovered additional information on the current R&D and commercial developments that can be of interest for future exploration of the economic potential of the species or the specific GR, which are also presented below, with full details in the annex.

Finally, the existence of TK related to the species was also reported. This information was either obtained from the patent document or incidentally found during the internet search. It is important to note that the information is only about the existence of TK on the species and it is not specifically related to the innovation. However, it can be of interest for future exploration of the economic potential of the TK associated to the species.

4.1 Methodology

An internet search was conducted in order to link patent documents to value chains and markets. This consisted of the following steps:

- The study of the country' biodiversity in the global patent systems provides a list of patent documents of potential economic interest as they directly relate to Mozambique (see separate study 'Biodiversity in the patent system: Mozambique')
- Each patent document of this list representing, ten species, found in over 27 patent documents⁴⁴, was then analysed in two phases:

⁴⁴ Two reasons explain the difference between the number of species (10) and the number of patent documents (27). First, different organisations can hold a patent on a same species. Secondly, an inventor generally seek to protect its innovation at different points in time

- First, in order to understand what the innovation is about, a thorough understanding of the patent document was necessary. For this purpose the analysis focussed on some sections of the patent document: title, abstract, main claims and prior art.
 - Secondly, an internet search was conducted in order to identify the status of the R&D and the presence of the GR in a value chain or on a market. For this purpose, specific key words were used (e.g. the species name, the patent assignee, the inventor, the innovation patented and the targeted market).
- When no product, service, or ongoing R&D could be found a second search was done by visiting the patent assignee's website to identify potential R&D hints.
 - Finally, the following classification, with a basic Yes / No / Unclear categorisation, was devised to indicate the degree of linkages with a value chain or a market :
 - Evidence that a product or service is marketed or under active R&D (code : yes)
 - Presumption that a product or a service is marketed or under active R&D but there is no clear evidence (code : unclear)
 - No information could be found about a product, a service or active R&D (code : no).

One limitation of this approach is that it mostly allows to access information regarding marketing activities in the 'business to consumer' segment, as information is often publicly and readily available. Other types of commercialization protected through licenses and trade secrets for example in the 'business to business' segment are difficult to capture because they are seldom publicly available. Furthermore, in many cases it was difficult to confirm the presence of a species in a product due to corporate marketing practices that rarely disclose such information (e.g. rebranding of species active molecule, trademarks). Also, in some jurisdictions companies are not legally required to disclose the product's list of ingredients.

4.2 Main results of analysis

4.2.1 Linking patent documents to value chains and markets

The ten species (covered in the 27 patent documents examined) are the focus of development of products in the cosmetics, health food, pharmaceuticals and agriculture sectors. They were analysed in order to identify linkages with value chains and markets.

For 20 patent documents, the innovation was linked to a market or a value chain with a final product. These are the patent documents for: a) *Elephantorrhiza elephantina* b) *Lippia javanica* c) *Sclerocarya birrea* d) *Sesamum alatum* e) *Micromonospora sp strain* and e) *Oryza sativa*. The latter two are of Mozambican origin and thought not to be distributed elsewhere.

With respect to the other three patent documents the link with a market or value chain was unclear:

as its R&D progress and also diversifies. For instance, an invention related to a medicines containing peptides from the *Micromonospora sp strain* was patented 10 times by the same company between 1995 and 2009.

- *Biophytum petersianum*: it is unclear if the extract is used in products distributed by the patent assignee, as the products' ingredients are not disclosed. The patent assignee is a US cosmetics company that makes and sells over 200 cosmetic products in more than 35 countries.
- *Millettia stuhlmannii*: the patent assignee announced the launch of a nutraceutical product using an anti-inflammatory extract during the first-half of 2014. *Millettia stuhlmannii* is not named but as the company provides information on a) the origin of the extract: 'the extract was obtained from a dense woody plant species that is indigenous of sub-Saharan Africa' and b) the relation with African TK, it is possible that the new product is based on *Millettia stuhlmannii*.
- *Nothobranchius rachovi*: This patent document relates to a business to business service for in vivo testing. There is limited publicly information available and no information was found regarding the use of this service. However, the patent assignee has partnerships with large companies that might use this technology.

For the remaining two patent documents for *Brackenridgea zanguebarica*, no link with a value chain or a market could be identified.

It is also interesting to note that in thirteen patent documents there is TK related to the species: *Biophytum petersianum*, *Elephantorrhiza elephantina*, *Lippia javanica*, *Sclerocarya birrea*, *Sesamum alatum*, and *Brackenridgea zanguebarica*. However, the link between the TK and the invention subject to the patent documents was not examined.

Species	Spatial origin of the species ⁴⁵	Methodology to analyse the patent document	Kingdom	Status of commercialisation or R&D.	Sector	Traditional knowledge on the species
Biophytum petersianum	Distributed in other countries	There is only one patent document.	Plantae	Unclear	Skin care product	Yes
Elephantorrhiza elephantina	Distributed in other countries	There are two patent documents owned by the same assignee.	Plantae	Yes	Cosmetic	Yes

⁴⁵ This column indicate if the patent document directly refer to the species as originating from the country (Mozanbican origin) or if distribution data suggest that the species is distributed in other countries (Distributed in other countries).

Lippia javanica	Distributed in other countries	There are four patent documents. They were all examined as they relate to the same invention.	Plantae	Yes	Head lice removal	Yes
Sclerocarya birrea	Distributed in other countries	There is only one patent document.	Plantae	Yes	Cosmetics	Yes
Sesamum alatum	Distributed in other countries	There are three patent documents that are owned by the same assignee.	Plantae	Yes	Health food supplement	Yes
Brackenridgea zanguebarica	Mozambican origin	There are two patent documents owned by the same assignee.	Plantae	No	Unclear	Yes
Micromonospora sp strain	Mozambican origin	There are ten patent documents owned by the same assignee. They were all examined as they related to the same invention.	Bacteria	Yes	Anticancer agent	No
Millettia stuhlmannii	Mozambican origin	There is one patent document.	Plantae	Unclear	Nutraceutical, immunosuppressant	No
Nothobranchius rachovi	Mozambican origin	There is one patent document.	Animalia (fish)	Unclear	Unclear	No
Oryza sativa	Mozambican origin	There are two patent documents. Both were examined.	Plantae	Yes	Agriculture (rice)	No

Table 1: links between species in the patent documents with value chains and markets

4.2.2. Wider industrial and scientific information related to the patent document(s)

Based on the internet research conducted it would seem that some species have economic potential beyond the value chain and markets identified in relation to the patent documents. As identified some species are subject to on-going research.

- *Biophytum petersianum*: A pectic polysaccharide has been obtained from a hot water extract of the aerial parts of the species⁴⁶
- *Brackenridgea zanguebarica*: Antibacterial, antiviral, antiproliferative and apoptosis-inducing properties of the species⁴⁷
- *Lippia javanica*: There is research on the cytotoxicity⁴⁸ and antimicrobial⁴⁹ activities of the plant

⁴⁶ Inngjerdingen M., et al. 2008

⁴⁷ Möller M., et al. 2006).

⁴⁸ Samie A., et al., 2009

⁴⁹ Manenzhe NJ, et al. 2004

- *Micromonospora sp strain*: Micromonosporaceae are promising as they are found to be a potent source of anticancer agents that target proteasome function and their industrial potential is validated by several pharmaceuticals⁵⁰
- *Nothobranchius rachovi*: There are studies on the effects of environmental manipulations and/or pharmacological treatments on longevity⁵¹
- *Oryza sativa (Var Gigante)*: Rice yellow mottle virus (RYMV) of the genus Sobemovirus is present in all rice-growing African countries. The highest level of resistance was provided by a cultivar of *Oryza sativa indica*, 'Gigante', and a few cultivars of *Oryza glaberrima* series⁵².

3.1 Key findings

Considering the small number of species analysed, only preliminary conclusions can be drawn. Generally, these cases confirm that R&D is currently taking place on species found in Mozambique and that in some cases the patent documents can be linked to concrete products on the markets.

The R&D is concentrated in the cosmetics sector with some activities in the health food, pharmaceutical and agriculture sectors. The species are mostly used in the 'business to consumer' segment (e.g. skin care). Contrary to other countries, a considerable number of patent documents could be related to a value chain or a market. This may be explained by the fact that the species are commercialised in the cosmetics and functional food sectors, where the success rate of R&D is higher than for instance in the pharmaceutical sector. In the specific case of *Millettia stuhlmannii*, where a nutraceutical product is under development, the origin of the species and the associated TK used by the patent assignee could be confirmed as a next step.

Finally, internet research provided evidence that beyond the innovation protected in the patent documents, some species are under ongoing R&D. It seems that in most cases, there is potential utilization of GR. Hence this clearly indicates the economic potential of the species.

Conclusion and recommendations

This study shows that there is ongoing R&D on the country's biodiversity and that GR are of value for public and private actors doing R&D across different sectors. There are therefore potential economic opportunities to further valorize Mozambican GR.

Concretely, the analysis of the patent documents focusing on Mozambican species - where there is utilisation of GR – allowed to identify links with value chains, markets or on-going R&D. The analysis of actors provides a clearer picture of the institutions related to biodiversity conservation and to the valorisation of BR and GR. There are a few initiatives, with foreign partners, with potential to valorise the GR. However, due to the limited information available, it is not possible to determine with certainty: a) which Mozambican actors are clearly using to GR and b) which actors provided the genetic

⁵⁰ Sithranga Boopathy and Kathiresan, 2010

⁵¹ T. Genade, et al., 2005

⁵² E., Hébrard et al., 2006

material used for the R&D related to the patent documents. Hence, based on the information available, it is impossible to establish a link between identified users and potential providers. This could be further researched in next steps.

The table two below presents the country’s strengths and weaknesses with regard to R&D on GR and their economic valorization. The strengths relate to features that were identified in this project. The weaknesses relate to characteristics that are clearly missing.

Strengths	Weaknesses
<ul style="list-style-type: none"> - A national biotechnology strategy - Public research centers including a gene bank, a seed bank, a marine resources bank and a millet bank; - A new public program on marine resources (financed by the Spanish cooperation) and private projects on biofuel - One company producing cosmetic products and ingredients with a sustainable certification (UEBT) - Collaborations with foreign research institutions 	<ul style="list-style-type: none"> - The recent failures of large foreign investment projects (e.g. mining, biofuel) show the country’s difficult business environment - Limited support to the business environment - Few corporate actors, NGOs or civil society organizations

Table 2: Strengths, weaknesses for R&D and to valorise GR under the ABS framework

Insufficient information was available regarding a number of key elements of a valorization strategy for genetic resources. They could be further explored as next steps in order to further inform the analysis of the strengths and weaknesses. These are:

- ABS procedures
- The evaluation of the success and challenges of the bioprospecting strategy
- The valorization of TK
- Level of scientific expertise (e.g. scientific publications) and capacity of national actors involved in R&D in Mozambique to a) respond to R&D requirements of users to and b) transit from the research to the development phases (e.g. stable production for industrial phase).

Overall, a minimum set up required for the effective and efficient valorization of GR appears to be in place in the biotechnology and in the marine sectors as some domestic actors seem to have real potential for meeting users’ demands and needs. Apart from that, there is limited capacity for the valorization of GR. In summary, there are a few actors capable of doing research on GR (with existing foreign partnerships), however the capacity to transit towards the development phases seems rather limited, especially in consideration of the limited support environment. In light of the information available, it is impossible to come to any definite conclusions. While the specific threats were not in the scope of this research, this set up nevertheless does offer a range of opportunities for Mozambique to valorize its GR for bio-prospecting and R&D:

- Activities at the regional level could be further explored to identify R&D synergies where partners put together their core expertise, in particular with South Africa as a continental leader.
- Furthermore, the confirmation of the link between the innovation in the patent documents and traditional knowledge could lead to further valorisation opportunities.

Overall, this raises two main questions for the public policy on ABS and the economic valorization of GR. First, in practice, how to close the gap in order to take advantage of economic valorisation opportunities related to GR. Second, what are the policy needs to create a favourable institutional and business environment in order to facilitate access to GR and share in fair and equitable manner the benefits arising from their utilization? For this purpose, general recommendations are presented in the synthesis “Economic potential and valorization opportunities for genetic resources in six African countries” for the six countries. However, for Mozambique a specific recommendation is to gain a wider understanding of the links between patent documents, value chains and markets by further exploring the patent documents for the ten species that were analysed in this project, especially in considering both the ‘business to consumer’ and ‘business to business’ segments.

In light of the recommendations above and in the synthesis, policy makers may wish to consider the usefulness of developing a valorization strategy. This would take advantage of the economic, environmental and social opportunities related to the utilization of GR, while taking into account the existing gaps between users and providers in innovation and R&D processes.

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Annex 1: Key words used to identify actors relevant to R&D on GR

Note: traditional knowledge was not in the scope of this institutional analysis.

- a. Generic websites
 - For all countries : World Bank : strategy for developing agriculture in the country, focusafrica.gov.in,
 - For English speaking countries : www.commonwealthofnations.org
- b. Generic key words for key stakeholders
 - Chamber of commerce
 - Trade associations and business federations
 - University
 - Herbarium
 - Museum
 - Laboratory
 - Research institutes
 - Botanical gardens
- c. Specific actors (mostly international actors likely to do R&D and use GR from the country)
 - Research (CIRAD, CIFOR, Kew, IRD (Sud Expert Plantes), CBI)
 - Development (FAO, ITCSD, UNDP)
 - Development agencies (AFD, GIZ, USAID)
- d. Types of genetic resource: forest, marine, animal, agricultural, plantae, microbe, microorganisms, bacteria, fungi
- e. Sectors and R&D⁵³:
 - Pharmaceutical
 - Biotechnology
 - Horticulture
 - Food : crop improvement, breeding, pest protection, stress resistance
 - Health food : nutraceutical, agro-biodiversity, plant for food and alimentations
 - Cosmetics: Oils, fats and waxes, gums, extracts and saps, colorants, formulation, anti-oxidant
- f. R&D activities, processes and technologies: bioprospection, raw material, sample, valorisation, extraction, metabolic processes, molecular technique, nanotechnology, liquid chromatography devices, nuclear magnetic resonance, spectrometers.

⁵³ A focus was done on the health food and cosmetics sectors as they are thought to be the easiest targets for providers of GR to engage with in R&D processes.

Annex 2: List of all the actors found in the scope of the assessment related to R&D and the economic valorisation of biodiversity, biological and genetic resources.

[Click here to view annex 2.](#)

Annex 3: List of the most relevant actors found in the scope of the assessment related to R&D and the economic valorization of biodiversity, biological and genetic resources

[Click here to view annex 3.](#)

Annex 4 : List of the patent documents examined for linking species with markets and value chains

[Click here to view annex 4.](#)