Valorization Potential Assessment: South Africa

Table of contents

Introduction

The main objective of this assessment is to inform the development or revision of national access and benefit-sharing (ABS) frameworks and contribute to establishing an enabling environment for the valorization of genetic resources (GR).

South Africa can be considered a leader in Africa with respect to the valorization of GR. It launched in 2014 a bio economy strategy based on former biotechnology strategies. The country therefore has a good knowledge of the challenges it is facing as well as the actors that may be involved in the valorization of GR.

In light of the particular situation of South Africa and the considerable work it has carried out over the years on issues related to the valorization of biological diversity, bioprospecting and ABS, the main value added of this assessment are the findings related to an examination of the linkages between patent documents, value chains and markets included in section five.

In order to provide some context to the analysis contained in section five, sections one and two provide background information on the national bioeconomy strategy and the national ABS regulatory framework.

Section three presents an overview of the actors in South Africa potentially utilising or involved in R&D and the valorization of GR.

Section four, presents an overview of the economic potential of some species based on the separate study 'Biodiversity in the Patent System: South Africa[1]'. The main question examined in this section is: what can patent information teach us about the range of potential economic uses of African GR and traditional knowledge (TK).

In section five, the link between patent documents, value chains and markets is presented. Examples were selected to illustrate different types of commercialisation and to highlight the economic potential of some species. Analysis of the value chain 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 presented. Based on the information found, some of the country's strengths and weaknesses with regard to R&D on GR and their economic valorization are presented, from which country specific recommendations are drawn.

It should be noted that for the six countries (Cameroon, Kenya, Madagascar, Mozambique, South Africa and Senegal) general recommendations are presented in the synthesis report "Economic potential and valorization opportunities for genetic resources under the Nagoya Protocol in Africa". They seek to answer the following questions: What are the practical steps to improve the valorization of GR within the ABS framework? What kind of business, legislative and regulatory environment is favorable for this purpose?

[1] Oldham P, et al. 2013 Biodiversity in the patent system: South Africa.

1. A national bioeconomy strategy

A national bioeconomy strategy[2] was established in 2014. It aims at '*creating an enabling environment that will allow public organisations, industry, venture capital and other stakeholders to develop bio-based activities*[3]'. It sets the country's path to valorise its biological resources (BR), materials and processes with a focus on three key sectors. It builds on previous biotechnology strategies. It further integrates the fields of Information and Communication Technology (ICT), the environment, and the social sciences. Hence, the coordination amongst stakeholders is identified as a key success factors. Some key features of the document include a definition of bioeconomy[4], a holistic problem analysis, as well as key performance indicators. The following strategic objectives are set[5]:

- The agriculture sector: (…) *strengthen agricultural biosciences innovation to ensure food security, enhance nutrition and improve health, as well as enable job creation through the expansion and intensification of sustainable agricultural production and processing.*

- The health sector*: (…) support and strengthen the country's local research, development and innovation capabilities to manufacture active pharmaceutical ingredients, vaccines, biopharmaceuticals, African traditional medicines, diagnostics and medical devices to address the disease burden, while ensuring a secure supply of essential therapeutics and prophylactics.*

- The industrial and environmental sector: *(…) to prioritise and support research, development and innovation in biological processes for the production of goods and services, while enhancing water and waste-management practices to support a green economy.*

This strategy provides a solid basis for examining opportunities for South Africa to valorise its GR.

2. National ABS framework

South Africa adopted ABS measures prior to the adoption of the Nagoya Protocol, in accordance with the ABS provisions of the CBD. It ratified the Nagoya Protocol in January 2013.

The national ABS regulatory framework in South Africa is currently composed of the following measures:

- The National Environmental Management Biodiversity Act, 2004 (Act no 10 of 2004) (NEMBA)
- The Bioprospecting Access and Benefit-Sharing (BABS) Regulations (No R138 of 2008)

In addition, guidelines were developed by the Department of Environmental Affairs in order to assist users and providers with the implementation of the regulatory framework on bioprospecting, access and benefit-sharing.

[2] www.gov.za/documents/download.php?f=207579
[3] www.gov.za/speeches/view.php?sid=42968
[4] Bioeconomy refers to activities that make use of bio-innovations, based on biological sources, materials and processes to generate sustainable economic, social and environmental development.
[5] The bioeconomy strategy, Republic of South Africa, 2014

Finally, the Department of Science and Technology (DST) has developed a policy on indigenous knowledge systems. It has also developed a Bill on the protection, promotion, development and management of indigenous knowledge systems as well as a National Recordal System.

Further information on the existing national ABS framework in South Africa and experience with its implementation can be found in a national study commissioned by the ABS Capacity Development Initiative in collaboration with the Government of South Africa and carried out by a national consultant in South Africa. The study can be found at: http://www.abs-initiative.info/countries-and-regions/global/ibsa/

Taking into account the provisions of the Nagoya Protocol and in light of its past experience with ABS implementation, South Africa is in the process of revising its national regulatory framework. Issues of relevance to the valorization of GR identified in this assessment may usefully inform the revision process.

3. Overview of South African actors potentially using or involved in R&D on GR

This section presents an overview of South African actors potentially using or involved in R&D on GR. It is mostly based on information found on the internet with a few elements drawn from the bioeconomy strategy. Detailed information is presented in annex two (list of all the actors identified), annex three (list of the most relevant actors examined) and annex four (qualitative analysis of the most relevant actors examined).

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 economic actors)
- An internet search based on key words was carried out. The key words used to identify actors relevant to R&D on GR are presented in annex one. Due to the sheer number of private actors, a focus was given to the biotechnology sector, which is one of the most developed. All the 69 actors identified in this research are presented in annex two.
- When possible, interviews were realised with individuals having a good knowledge of the actors related to the utilisation of GR, R&D and the valorization of biodiversity in the country[6].
- Specific internet research for each actor was carried out to identify: area(s) of R&D, maintenance of collections (e.g. genes), and potential uses of GR; any collaborations with foreign actors (as a basis for potential exchanges of genetic material). For the latter two categories, a basic Yes / No / Unclear categorisation was used
- Based on the facts compiled, 46 institutions stood out as potentially relevant for ABS as their activities are related to the utilisation of GR. They are presented in annex three (list) and in annex four (qualitative analysis of the main results). They were categorised as follows:
    - **Actors providing GR**: they are officially designated under national legislation as institutions with mandate to provide GR

[6] In the case of South Africa, Ms Karina Malherbe (Control Biodiversity Officer) and Ms. Lactitia Tshitwamulomoni (Deputy Director) at Dept. of Environmental Affairs were interviewed.

- **Actors that may utilise 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 an enabling valorization environment by providing financial, technical and organizational support to providers, users and other actors.

In the last category some foreign actors operating in the country are also identified.

Key findings

There is one provider of GR, the Ministry of Agriculture, Forestry and Fisheries. While it seems more relevant to the ITPGRFA, there may be activities that fall in the scope of the NP. A range of public organisations (e.g. botanical gardens) carry research across a large number of areas. R&D partnerships are encouraged through research councils and a wide range of initiatives and fora. There are many R&D collaborations with foreign actors.

There is a diversity of businesses and trade associations related to the bio-economy. Trade associations include actors serving different end markets (e.g. natural ingredients in food and cosmetics, health biotechnology). One NGO whose mission is very relevant to the valorization of GR was also identified. Finally, a number of actors together constitute an effective support environment for the valorization of BR and possibly GR.

A key strength for the valorization of GR is that some national R&D champions (e.g. CSIR[7]) or consortium of actors (e.g. Innovation Hub[8]) demonstrate capacity to be active almost on the whole R&D process, from sampling to setting up a value chain, or have high level expertise in a specific field.

4. Biodiversity in the Patent System for South Africa: overview of the economic potential of the species

The separate study "Biodiversity in the patent system: South Africa' available at: http://www.abs-initiative.info/fileadmin//media/Knowledge_Center/Pulications/Patent_Studies/Chad_30102013.pdf. It presents the results of the analysis of patent activity for the country's GR and TK. Key insights related to the economic potential of some species are drawn from this study.

4.1. Species that are known to be distributed in South Africa and elsewhere

GBIF[9] indicates 49 702 species for South Africa. In total, 6415 species names that are known to occur in South Africa were identified in the patent data from the major jurisdictions.

The assignees in the overall data for species of relevance to South Africa range across a spectrum from biotechnology (i.e. Genentech), companies such as BASF and Bayer in areas such

[7] www.csir.co.za

[8] www.theinnovationhub.com/index.php?option=com_content&view=article&id=160&Itemid=14

9 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.

as biocides/insecticides, agriculture (i.e. Du Pont) and personal and household products such as Proctor and Gamble. More detailed analysis of technology areas revealed biopharmaceutical companies such as Oxigene Inc. which specialises in anti-cancer treatments. The Morinaga Milk Industry Co. is conducting research and development of supplements which improve pancreatic functions and offer other health benefits. As this makes clear there are a wide range of general and specialised technology areas and markets of relevance to biodiversity from South Africa (Oldham P, et al. 2013).

4.2. Species that were directly sourced from, or potentially originate from, South Africa based on distribution data.

In total, 110 species were identified (amongst these, five were examined to identify the link with value chains and markets). The main technology areas are, pharmaceuticals, disorders (descriptive), heterocyclic and carbocyclic compounds. They are mostly plantae with markets in sectors such as cosmetics, health food, biotechnology and pharmaceuticals.

The top three claims in the patent documents refer to compounds, methods of producing a plant, process for producing a desired product, composition (e.g. extracts, compounds, or combination of ingredients). In practice 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.

The analysis based on patent citations, revealed three species where there is indication of further economic potential connected to the patented inventions. On the basis of the analysis of the patent family, two species of potentially high business importance to the applicants were identified. R&D partnerships could be explored for these species.

5. Links between patent documents, value chains and markets

Out of the 69 species identified in the patent study, five species were selected to illustrate different types of commercialization and to further explore the economic potential of the species. The table in annex five 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 five.

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.

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 South Africa (see separate patent study 'Biodiversity in the patent system: South Africa')
- From this list, five species, found in 69 patent documents[10], were selected using the following criteria:
    - The species that were most referred to in the patent documents, or that had a high number of patent citations[11] or large patent families[12] were analyzed in priority
    - When there were too many patent documents to examine for a same species, either a focus was given to those held by the patent assignees that hold the majority of them or in some complex cases a random selection was realized
- Finally, 34 specific patent documents (spanning across the five species) were selected
- Each patent document was then analysed in two phases:
    - 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 the 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 carried out 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.

Main results of analysis

[10] Two reasons explain the difference between the number of species and the number of patent documents. First, different organisations can hold a patent on a same species. Secondly, an inventor generally seeks to protect its innovation at different points in time as its R&D progress and also diversifies (e.g. University of Arizona has three patents on Cephalodiscus gilchristi).

[11] The more often that a patent is cited by later patents is a measure of importance and impact of that patent within the patent system.

[12] A patent family is a set of patents that links back to an original parent filing.

5.1. Linking patent documents to value chains and markets

The five species (covered in the 34 patent documents examined) are the focus of development of products in the cosmetics, health food, pharmaceuticals and agriculture sectors. Some species are considered as endemic. The five species are diverse (e.g. bacteria, fungi, and plantae) which seems to be rather unusual as in the other five countries examined for this project plantae are generally the focus of the patent documents.

In two cases, the patents documents were related to a market. For the *Zantedeschia sprengeri* 20 patent documents related to new and distinct cultivars of calla lily, botanically known as *Zantedeschia sprengeri* were linked to a final product (horticulture)[13]. For *Sorangium cellulosum,* one patent document regarding the anti-cancer Ixabepilone[14] was related to a market[15].

For the remaining 14 patent documents for *Sclerochiton ilicifolius, Cephalodiscus gilchristi, Cryptococcus amylolentus,* no link with a value chain or a market could be identified.

TK related to the species was only identified in the case of *Sclerochiton ilicifolius*. This may be explained by the fact that the species examined include animalia, fungi and bacteria which are generally not the focus of TK. The link between the TK and the invention subject to the patent was not examined.

[13] www.sandegroup.nl/en/calla/info/pot/rood/allure
[14] Ixabepilone is produced from Sorangium cellulosum. http://en.wikipedia.org/wiki/Ixabepilone
[15] http://books.google.fr/books?id=FEIJ_ujLXbYC&pg=PA43&lpg=PA43&dq=Sorangium+cellulosum+BRISTOL-MYERS+SQUIBB&source=bl&ots=DOHh7vnVtd&sig=rFknDr7Rp08KprO8rXrmdRIIaJY&hl=fr&sa=X&ei=k5frU7PyMKKt0QWk-4DwAg&ved=0CD8Q6AEwAw#v=onepage&q=Sorangium%20cellulosum%20BRISTOL-MYERS%20SQUIBB&f=false

Species South Africa	Spatial origin of the species[16]	Methodology to analyse the patent document	Kingdom	Sector	Status of commercialisation or R&D	Traditional knowledge on the species
Sclerochiton ilicifolius	South African origin	There are 17 patent documents. Focus was given to one assignee that has the most patents (ten), they were all examined. They all relate to the potential of monatin as a sweetener.	plantae	Food	No	Yes
Zantedeschia sprengeri	Distributed in other countries	There are 19 patent documents related to the same product from one patent assignee. They were all examined.	plantae	Horticulture	Yes	No information found.
Cephalodiscus gilchristi	Distributed in other countries	There are four patent documents. Focus was done on the three patent documents held by one assignee.	animalia	Pharmaceutical	No	No information found.
Cryptococcus amylolentus	Distributed in other countries	There are 23 patent documents. They are mostly held by South African actors (including CSIR). The analysis focused on one patent document.	fungi	Chemicals	No	No information found.
Sorangium cellulosum	South African origin	There are six patent documents. The analysis focused on one patent document.	bacteria	Pharmaceutical	Yes	No information found.

Table 1: status of commercialisation and R&D of species related to the patent documents

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

5.2. 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. This is a clear indication of the economic potential of the species.

- *Sclerochiton ilicifolius*: The patent literature shows interest in the sweetener for use in a wide range of products. Various processes have been described by other companies as alternatives to extraction from the root bark of the plant.

- *Cephalodiscus gilchristi*: Cephalostatins are among the most powerful anticancer agents tested by the National Cancer Institute[17] [18]. The bioactivity pattern of cephalostatins has been found quite different from known anticancer agents, indicating a new mechanism of actions, possibly offering the potential for treatment of drug-resistant cancers.

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 South Africa and that in some cases the patent documents can be linked to concrete products on the markets in some sectors (i.e. horticulture, pharmaceutical).

The R&D is diversified across sectors (e.g. food, pharmaceutical, chemicals and horticulture). The species are mostly used in the 'business to consumer' segment. All the patent holders are foreign companies. There is no information available on the potential (South African) partners or providers of these GR. The information available did not demonstrate whether ABS requirements were taken into account for the R&D activities that were examined for the species referred to above.

Finally, internet research provided evidence that beyond the innovation protected in the patent documents, R&D is ongoing on some species. It seems that in most cases, there is potential utilisation 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 GRs are of value for public and private actors doing R&D across different sectors. There are therefore potential economic opportunities to further valorise South African GR.

Concretely, links between patent documents focusing on South African species - where there is utilisation of GR – were identified with value chains, markets or on-going R&D. The analysis of actors provides a partial picture of the institutions related to the valorization of GR. Due to the limited

[17] Lee S. at al., 2009

[18] The first marine bioprospecting took place along the cost of South Africa (1972-1981) were facilitated by Arizona State University. It was followed by many other collaborative marine bioprospecting programmes but no products have yet emerged from them.

information found, it is not possible to determine with certainty: a) which South African actors are clearly using to GR and b) which actors provided the genetic 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.

On this basis, table two below presents some of 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
- A national bioeconomy strategy and a national framework for ABS - High biodiversity with R&D carried out across a range of species (e.g. plantae, bacteria) and sectors (e.g. cosmetics, biotechnology) - Diversity of national actors doing R&D (e.g. universities, public research centers, companies) and some public bioprospecting initiatives with high R&D expertise - A strong biotechnology sector (compared to the other countries examined) - A large support system with actors capable to link research with value chain development and market needs.	- Formal provider of GR, apart for food and alimentation, have limited visibility on the internet which may complicate potential users R&D approach.

Table 2: Strengths and weaknesses for R&D and the valorization of GR under the ABS framework

Overall, there are a range of strengths that position the country well for the valorization of its GR. The breadth of the research areas covered by public institutions, the existing R&D capacity both in the public and private sectors, the alignment of research with international users' R&D needs (e.g. extremophile for biotechnology, pollution control, health food), the presence of transversal R&D programmes covering a range of actors, and the large support system helping actors transiting from the research to the development phase are strongly positioning the country to efficiently valorise its GR. It is however difficult to come to any definite conclusions on the basis of the research carried out for this assessment, as limited information could be found regarding the challenges and success of the national bioeconomy strategy and the former biotechnology strategy.

This set up offers a range of opportunities for South Africa to consider for further valorising its GR including:

- Out of the 69 species identified in the patent studies, only five were covered in this country assessment. A similar exploration regarding the links between patent documents, value chains and

markets for the remaining 64 could uncover other economic opportunities, potential partners, as well as lessons to learn.

- As TK often appeared for the 69 species identified in the patent study, the confirmation of the link between the innovation in the patent documents and the TK can lead to further valorization opportunities as the scientific validation of the traditional provides credibility for undertaking further R&D.

Overall, this raises two key questions for the public policy on ABS and the economic valorization of GR. First, in practice, how to best take advantage of economic valorization 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 South Africa a specific recommendation can be put forward.

As indicated in the bio-economy strategy, there are some gaps and weaknesses in the bio-innovation value chain. For instance, the country has identified some limitations in the pharmaceutical sector such as the capacity for full scale manufacturing, and the lack of small biotech companies. A similar exercise could be carried out for each of the bioeconomy strategic sectors (i.e. agriculture, health, industrial and environmental) in order to further close the R&D gap. For this purpose, the development of an analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT) at a sector level should allow to identify the key levers to valorize GR. This could include the following activities:

- **Clarify the South African actors' needs and constraints to valorize GR**. Identify the relevant actors and clarify the scope of their activities, R&D capacities, needs and constraints.

It is recommended to have a solid understanding of the national actors' aspirations with regard to R&D and the valorization of GR. For instance, what are the priority research areas of universities in the next decade? Are there existing partnerships with foreign actors? What are the private sector marketing objectives? What are the goals of development and conservation NGOs in this area? Hence, a mechanism or a forum for each priority sector to further support the valorization of GR at the country level could be set up to crystalize the actors' perspectives.

- **Clarify users R&D requirements and how GR and TK are utilized by different users.** These elements are further presented in the Sectoral Analysis.

    - **Identify the user requirements that should be met by South African R&D actors** to enter in an R&D process. For instance, in existing cases, understand how the GR were accessed, who were the key actors and what specificities did they bring to the R&D process. Build on the trust established with some private partners to improve the understanding of user challenges.

    - **Analyze the structure and the governance of the value chains** for the patent documents linked to markets (e.g. actors' roles, responsibilities, rights and value gained at different level). Consider both the 'business to consumer' and 'business to business' segments to gain a wide picture of the different practices.

- **Improve understanding of the markets needs** in order to determine how to respond to specific demand. In this context, business and trade organisations could be further encouraged to be active on the valorization of biodiversity and GR.

- **Explore the economic potential of the TK**: clarify the link between the TKon the species and the invention covered by the patent documents

- **Develop a strategy**

  - **Identify opportunities and key threats**, including the societal needs and the related market opportunities at the national, regional and international level

  - **Benchmark** the country's position relative to other countries as well as towards the users R&D requirements

  - **Identify the key success factors to valorize GR** as a synthesis of the strengths, weaknesses, potential opportunities and threats (SWOT) analysis

  - **Identify the social, environmental and economic profits expected and develop a realistic budget.**

In light of the recommendations above, policy makers may wish to consider taking into account these elements for the valorization of BR and GR in the implementation of sector specific strategies as well as in the revision of the national ABS regulatory framework.

Bibliography

Oldham P, et al. 2013 Biodiversity in the patent system: South Africa.

Seongmin Lee,a Thomas G. LaCour,b and Philip L. Fuchsb. 2009. Chemistry of Trisdecacyclic Pyrazine Antineoplastics: The Cephalostatins and Ritterazines. Chem Rev. Jun 2009; 109(6): 2275–2314. doi: 10.1021/cr800365m www.ncbi.nlm.nih.gov/pmc/articles/PMC2769019/

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 federation
   - University
   - Herbarium
   - Musem
   - 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&D[19]:
   - 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, valorization, extraction, metabolic processes, molecular technique, nanotechnology, liquid chromatography devices, nuclear magnetic resonance, spectometers.

[19] 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 this assessment related to R&D and the economic valorization 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 this assessment related to R&D and the economic valorization of genetic resources**

Click here to view annex 3.

Annex 4: Qualitative analysis of the most relevant actors related to R&D and the economic valorization of biodiversity, biological and genetic resources

The following examines the actors that seem of particular relevance to the valorization of GR. Although all these actors are involved in activities related to the valorization of BR, it is unclear if and how they utilize GR. A range of foreign actors operating in South Africa are also identified in the category of the support environment.

National actors

- **Actors providing GR**

The **Ministry of Agriculture, Forestry and Fisheries** was identified as a formal provider of GR. It has a strategic plan for agriculture[20] and it is considering to improve its sustainability by developing plant breeding strategies that maintain and enhance genetic diversity. While it seems more relevant to the ITPGRFA, there may be activities that fall in the scope of the NP.

- **Actors which may utilise GR in the context of their broader activity**

  - Public research institutions

Seven **national research centers** on industrial R&D, agriculture, insect, marine and fisheries, **12 universities** and 27 **botanical gardens**[21] were identified. As they have various research departments working on BR and potentially using GR, their main activity or key examples of the research related to GR is indicated.

The **South African National Biodiversity Institute (SANBI)**[22] which coordinates research on the state of biodiversity in South Africa manages a network of ten National Botanical Gardens[23]. There are also three herbariums, two libraries and a website on South African plants[24].

- Research centres

Medical Research Council (MRC)[25] carries out research, development and technology transfer to promote the improvement of health. There is one research unit on traditional knowledge.

Council for Scientific and Industrial Research (CSIR)[26] is a leading research organisation and has bioprospection projects. It provides science and technology services and also seeks to develop opportunities where new technologies can be further developed in the private and public sectors.

National Research Foundation (NRF)[27] supports research including on indigenous knowledge. It co-initiated a funding programme for bioinformatics and functional genomics in 2009.

[20] www.nda.agric.za/docs/sectorplan/sectorplanE.htm
[21] www.bgci.org/garden_search.php?action=Find&ftrCountry=ZA&ftrKeyword=&x=52&y=15
[22] www.sanbi.org/information
[23] www.sanbi.org/gardens
[24] www.daff.gov.za/doadev/sidemenu/links/Digest16.htm
[25] www.mrc.ac.za
[26] www.csir.co.za
[27] www.nrf.ac.za

Agriculture Research Center (ARC) [28] conducts research in the agricultural sector and in plant biotechnology[29].

South African Institute for Aquatic Biodiversity (SAIAB)[30] focuses on understanding the biodiversity and functioning of globally significant aquatic ecosystems.

- Universities

Cape Peninsula University of Technology [31] : environmental remediation, molecular pathogenic microbiology, energy, agrifood and functional food research units.

Central University of Technology[32]: applied food, safety and biotechnology, applied health technology, and biotechnology.

Durban University of Technology[33] : it has developed a simulation to studying research questions in the fields of ecology, biology, engineering and science.

Nelson Mandela Metropolitan University[34]: nanoscale materials characterization, new materials and processes.

North-West University[35]: nutrition and pharmaceutical sciences.

Rhodes University[36]: biomedical biotechnology, biopharmaceutics, biotechnology, and the Unilever Centre for Environmental Water Quality.

University of Cape Town: biopharming, marine, and nanosciences.

University of Johannesburg[37]**:** nanomaterials, and plant DNA-barcoding.

University of Pretoria[38] : animal diseases, genomics, food nutrition, well-being, and energy.

University of Stellenbosch[39]: biomedical research.

University of the Free State[40]: advanced biomolecular research materials and nanosciences.

University of the Witwatersrand[41]: molecular biosciences.

- Other actors

[28] www.arc.agric.za
[29] www.arc.agric.za/arc-vopi/Pages/ARC-VOPI-Homepage.aspx
[30] www.saiab.ac.za
[31] www.cput.ac.za
[32] www.cut.ac.za
[33] www.dut.ac.za
[34] http://research.nmmu.ac.za/Research/Institution-Research-Themes
[35] www.nwu.ac.za
[36] www.ru.ac.za
[37] www.uj.ac.za/EN/Pages/Home.aspx
[38] web.up.ac.za
[39] www.sun.ac.za
[40] www.ufs.ac.za
[41] www.wits.ac.za

The national survey on South African biotechnology companies[42] provides an overview of the national biotechnology market. However, the 106 companies surveyed are not listed. Nevertheless, 13 companies potentially doing R&D on South African BR and GR were identified: **Solaltech**[43] (healthy aging), **Afriplex**[44] (supplier of wellness product solutions based on African botanicals), **Nativa**[45] (a pharmaceutical company that entered the natural health market), **Malee Natural Science**[46] (natural body care products), **AECI** [47] (a chemicals group that also operates in food and cosmetics), **Bioventures** [48] (Biotechnology and Life Sciences Venture Capital Fund), **Synexa Life Sciences** [49] (biotechnology), **McNabs**[50] (healthy food). Finally, the **Innovation Hub**[51] is a business cluster and houses five biosciences companies: **Africabio, Altis Biologics, eGoLiBio, Matayo Biofuels.** In all these cases, no further information was found on the utilisation of GR.

There is also the **Cosmetic Export Council of South Africa** that facilitates export opportunities for the South African cosmetic industry where further details are available on the member companies[52]. Some of them may utilise GR in R&D projects.

- **Actors of the support environment**

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

Phytotrade Africa[53] is a regional trade association with several members in South Africa. It is registered in Botswana and South Africa. Its members make products using the species that are harvested by African rural producers. Its purpose is to alleviate poverty and protect biodiversity by developing an industry that is economically successful and also ethical, sustainable and ABS compliant. Members can access Phytotrade's expertise on R&D, market opportunities, ABS and regulatory knowledge.

The **Technology Innovation Agency**[54] stimulates technological innovation by, for instance, identifying and bridging gaps in the innovation value chain, and linking technology developers to the market needs through partnerships with commercial players.

The **Department of Science and Technology (DST)**[55] conducts large-scale social-scientific projects through the implementation of enabling policy instruments for all stakeholders. It has a technology innovation programme that aims to promote the realisation of commercial products, processes and services from R&D outputs in areas such as nanotechnology[56] and biotechnology[57]. It also works on an Indigenous Knowledge System (IKS). The National Recordal System documents and records indigenous

[42] OECD 2003
[43] www.solaltech.com/ing/ingsearch.php
[44] www.afriplex.co.za
[45] www.nativa.co.za
[46] www.maleeonline.com
[47] www.aeci.co.za
[48] http://webfactory.co.za/portfolio/bioventures/investments.htm
[49] www.synexagroup.com
[50] www.mcnabs.biz
[51] www.theinnovationhub.com/index.php?option=com_content&view=article&id=160&Itemid=14
[52] www.cecosa.co.za/index.php/members
[53] www.phytotradeafrica.com
[54] www.tia.org.za
[55] www.dst.gov.za
[56] Two nanotechnology innovation centres were established at the Council for Scientific and Industrial Research (CSIR) and Mintek
[57] Research is being conducted on understanding the nutritional components of food indigenous to South Africa, with the aim of making those with a high nutritional value available and accessible to the majority of people.

knowledge. Indigenous knowledge research chairs were also awarded to the **University of KwaZulu-Natal** and **Walter Sisulu University**. Finally, it has a biosafety programme to support innovation in biotechnology by ensuring the development of safe and sustainable products.

Southern African Research & Innovation Management Association (SARIMA)[58] is a stakeholder organisation that provides a platform for best practice in research and innovation in Southern Africa.

The **Industrial Development Corporation**[59] provides finance for industrial development projects, and promotes partnerships across industries within and outside the country.

The **National Advisory Council on Innovation (NACI)**[60] advises the Minister of Science and Technology on the role and contribution of innovation in promoting and achieving national objectives. It organises an annual national seminar on biodiversity bioprospection which reports provides an overview of the key national developments and organisations[61].

The **National Intellectual Property Management Office (NIPMO)**[62] manages the commercialisation of the intellectual property related to recipient of public R&D funds.

The **Agribusiness in Sustainable Natural African Plant Products** (ASSNAP)[63] aims to develop South African agribusinesses in the natural products sector with a focus on supply chains.

The **Licensing Executives Society of South Africa**[64] is an association of licensing and technology transfer professionals dedicated to the creation of business opportunities through equitable technology licensing, both locally and internationally.

Biowatch[65] is an NGO that monitors and researches issues of genetic modification to promote biological diversity and sustainable livelihoods.

The **Department of Agriculture, Forests and Fisheries** has a list of **NGOs and development bodies** pertaining to agriculture[66]. Some of them are also active in environmental and development issues of relevance to ABS and the valorization of GR.

Foreign actors of the support environment in operation:

The **Southern Alliance for Indigenous Resources**[67] (SAFIRE) is a regional NGO. It retails cosmetic, beverage and nutraceutical products.

[58] www.sarima.co.za
[59] www.idc.co.za
[60] www.naci.org.za
[61] www.naci.org.za/wp-content/uploads/Position-Paper-on-Bioprospecting-in-South-Africa.pdf
[62] www.nipmo.org.za
[63] www.asnapp.org.za
[64] www.licensing.co.za
[65] www.biowatch.org.za
[66] www.daff.gov.za/doadev/sidemenu/links/Digest17.htm
[67] www.safireweb.org

Biotechnology Regional Innovation Centers (BRIC) emanates from the National Biotechnology Strategy (2001). It aims to develop the biotechnology industry. It is structured into four divisions: BioPAD[68] (partnerships), CapeBio[69] (venture capital), EcoBio (Health) and PlantBio (Plant).

The **Silicon Cape Initiative**[70] is a community of biotechnology entrepreneurs.

[68] www.speer.co.za/test/biopad/aboutus.htm
[69] www.csir.co.za/pdf/publications/sciencescope/corporate2_image_sciencescope.pdf
[70] www.siliconcape.com/group/bioentrepreneurs.

Annex 5: List of the patent documents examined for linking species with markets and value chains

Click here to view annex 5.