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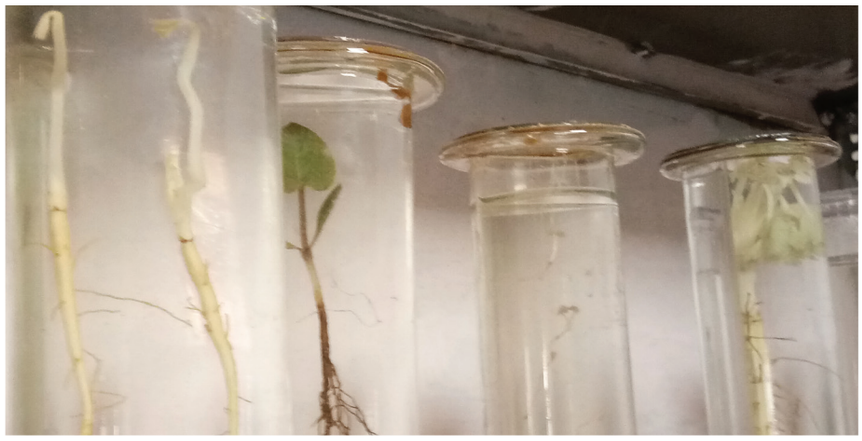

Conserving bioresources for better livelihoods

Identifying tradeable and potential bioresources for ABS in Garhwal, Uttarakhand

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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Programme/project description
Indo-German Biodiversity Programme
Access and Benefit Sharing Partnership project

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Design and Layout
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Photo credits
GIZ and CBED

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)

GIZ is responsible for the content of this publication.

New Delhi, 2019

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Foreword

DR. RAKESH SHAH,
CHAIRMAN UBB

Conservation of biodiversity, sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilisation of genetic resources are the three main objectives of the Convention of Biodiversity to which India is a party. In view of the International obligation and for achieving the objectives of the convention, Biological Diversity Act, 2002 was promulgated by the Government of India which became effective from 05th February 2003.

In view of the power conferred under Section 63 of the Act to State Governments, 'Uttarakhand Biodiversity Rule 2015' was notified by the Government of Uttarakhand on 4th of January 2017. Uttarakhand Biodiversity Board (UBB) is facilitating the implementation of the provisions of the Biological Biodiversity Act, 2002 and also helping in generating funds and other resources from the process of sharing the benefits arising out of the utilisation of genetic resources (ABS) which is strengthening the local people's ability to protect, conserve, develop and make sustainable use of natural resources.

As part of the Indo-German ABS partnership project, this is a preliminary study conducted in three disctricts of Garhwal region to assess the bio-resources and identify ABS potential species. Based on the findings of the study a detail study of potential ABS species and strengthening of the Biodiversity Management Committee's (BMC) through capacity development training workshops will be done as the next step in the project.

MR. S.S. RASAILY,
MEMBER SECRETARY UBB

India is one of the 17 mega-diverse countries in the world. Biodiversity supports millions of Indians in their livelihoods and ways of life, therefore, maintaining its rich bidoversity and natural resources is essential for achieving inclusive and sustainable development.

The ABS Partnership Project aims at strengthening the capacities of various stakeholders, as well as raising awareness and build the capacities of the commercial user groups of biological resources and associated knowledge for the effective implementation of ABS mechanisms under the Biological Diversity Act 2002, in keeping with India's commitments under the Nagoya Protocol, 2010.

UBB is working with different stakeholders to implement the Biodiversity Act 2002. Formation of BMC's is being done at block and village level. People's Biodiversity Registers's (PBR) are being developed to document the biodiversity at the local level.

This study conducted as part of the ABS partnership project is an attempt to get an idea of the traded bio-resources in the there districts of Uttarakhand in Garhwal region and to identify the potential bio-resources for ABS. The project will build upon the findings of this study to strengthen the mechanism of ABS in the state.

DR. KONRAD UEBELHÖR,
DIRECTOR IGBP GIZ

The ABS partnership project is a technical cooperation between India and Germany and is commissioned by the Federal Ministry for Economic Cooperation and Development (BMZ) under the Indo-German Biodiversity Programme.

The project is being implemented in partnership with the Ministry of Environment, Forest and Climate Change (MoEFCC), the National Biodiversity Authority (NBA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH within three pilot State Biodiversity Boards of Uttarakhand, Maharashtra and Tamil Nadu.

This document is part of the study conducted under the ABS partnership project in the selected districts of Garhwal region. The study gives a way forward to work towards ABS mechanism for some of the identified bio-resources by raising awareness and strengthening capacity of the BMC's in the region. GIZ along with UBB will be working on the findings of this study for better implementation of ABS in the state of Uttarakhand.

Background

The Access and Benefit Sharing (ABS) Partnership Project under the Indio-German Biodiversity Programme is implemented by the National Biodiversity Authority (NBA), Ministry of Environment, Forest and Climate Change, Government of India (MoEFCC) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The aims of the project are:

a. To create awareness and communication strategies for better understanding among different actors and stakeholder groups of the Biological Diversity Act 2002 (BDA), the ABS Guidelines and the Nagoya Protocol on ABS;

b. Development, documentation and dissemination of ABS good practices; and

c. Development of an IT-based ABS monitoring tool for NBA.

Introduction

Biological Resources (syn. Bio-Resources, BRs) are essential for economic and social development. In contrast to the vital importance for humanity, many human activities threaten the resilience of ecosystems and the survival of species. Species extinction caused by human activities continues at an alarming rate[1].

The globally growing awareness of people for biodiversity and the need of its conservation has given a strong mandate to governments to recognise biological diversity as an asset of global value for present and future generations. Hence, biodiversity issues became subject of several national and international policies and agreements including the Convention on Biological Diversity (CBD, 1992), the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES, 1975), the International Treaty on Plant Genetic Resources for Food and Agriculture (2002), and the Convention on Migratory Species (CMS, 1983). Today, governments and non-government organisations are working jointly on developing and implementing legal frameworks for the conservation and sustainable use of biodiversity. A key component in these efforts is the participation of local communities in conservation. This is to be achieved by ensuring local communities have access to their BRs. Sustainable use of BRs is thus regulated by the benefits which local communities obtain from the continuity of locally available BRs.

India signed the CBD in 1992 and it has made significant efforts towards achieving its objectives. In compliance with the CBD, India enacted the Biological Diversity Act (BDA) in 2002 and the BD Rules in 2004. The regulatory bodies of National Biodiversity Authority (NBA) in Chennai, the State Biodiversity Boards (SBBs) and Biodiversity Management Committees (BMCs) were constituted for the proper implementation of the Act and Rules at the national, state and local levels, respectively.

1 www.cbd.int

As a supplementary agreement to the CBD, the Nagoya Protocol provides a legal framework for the fair and equitable sharing of benefits arising out of the utilisation of genetic resources (ABS). The Nagoya Protocol mandates that any benefit arising from the commercial use of BRs and associated traditional knowledge should be equitably shared with the local communities.

The Nagoya Protocol entered into force on 12 October 2014. The same year, NBA developed the ABS Guidelines to achieve the targets set under the protocol. India's ABS Guidelines confirm that (1) BRs are to be managed and collected sustainably, and (2) benefit sharing from the utilisation of BRs ought to contribute concurrently to poverty alleviation.

India contributes 8.1% to the world's biodiversity within less than 2.5% of the world's area. India is home to 45,944 plant species and 89,317 animal species. Especially among the flowering plants (angiosperms) the share of endemic species is high (36%)[2]. In addition, the country is one of the important Vavilovian Centers of biodiversity as over 167 crop species, 320 wild crop species and several domesticated animals have their origin in India.

While India has traditionally been rather sensitive towards environment protection and conservation, the currently rapid and less controlled economic development poses serious threats to biodiversity. Therefore, there is a need for conservation, cultivation, and the repository of germplasm for future use[3].

A locally conducted study suggests that over 350 plant species are vulnerable and threatened in the state of Uttarakhand, which includes 161 species already categorised as rare and threatened plants[4]. The main reasons for this decline in biodiversity are loss of habitat, illegal exploitation, little or no regulatory mechanisms, unorganised collection and global climate change.

The ABS Partnership Project emphasises on strengthening the capacities of the National Biodiversity (NBA), the State Biodiversity Boards and the Biodiversity Management Committees and user groups for the effective implementation of the ABS mechanism. The present study, funded by GIZ under its Indo-German Biodiversity Programme (IGBP), aims to provide better understanding of existing BRs availability, the pattern of collection and harvesting procedures, the supply chains and related processes within selected districts of Garhwal in the State of Uttarakhand.

The study was carried out to (a) identify BRs with ABS potential in selected districts of Garhwal, and (b) to understand the existing supply chains of these traded BRs and to locate possible gaps. To achieve the above, the following individual objectives were formulated:

1. Provide an assessment of traded key Bio-Resources in three selected districts of Garhwal;
2. Generate a comprehensive list of those Bio-Resources and their uses which emerge as having promising ABS potential;
3. Identify all the key stakeholders who are or are to be involved in the trade of these Bio-Resources.

2 Chandrakar, A.K., 2012. Term Paper on Biodiversity in India https://www.researchgate.net/publication/277124537_Biodiversity_Conservation_in_India

3 Kala, C.P., Dhyani P.P., Sajwan B.S., 2006. Developing the medicinal plant sector in northern India: challenges and opportunities. Journal of Ethnobiology and Ethnomedicine, 2: 32.

4 Phondani, P.C., 2010. A study on prioritisation and categorisation of specific ailments in different high altitude tribal and non-tribal communities and their traditional plant based treatments in Central Himalaya. Ph.D. Thesis, H.N.B. Garhwal Central University, Srinagar (Garhwal), Uttarakhand, India.

Study Area

The study was conducted in the three selected districts of Haridwar, Pauri and Uttarkash within the Garhwal region of Uttarakhand.

FIG. 1 BCG MATRIX OF POTENTIAL BIO-RESOURCES FOR ABS IN THE KUMAUN REGION, UTTARAKHAND, INCLUDING THE ORIGINAL MATRIX NOMENCLATURE

Methodology

The study used a mixed-method approach:

I. DATA COLLECTION METHOD

1. **Literature reviews:** Secondary information were collected reviewing literature on various aspects of BRs management in the State. Data related to BRs from different government offices (Forest Department, State Biodiversity Board), academic institutes, Forest Research Institute (FRI) and Botanical Survey of India (BSI) were collected.
2. **Policy Review:** Laws and policies were reviewed in context to India and Uttarakhand.
3. **Expert consultation:** Various government and non-government organisation were visited and experts were consulted to understand the policies and framework for ABS.
4. **BRs Identification and categorisation:** Different BRs were identified at the three levels of Industry, Governmental/NGO level and Village.
    a. **Industrial level:** Industries based at Haridwar, Rishikesh and other areas were visited and consulted to understand existing value chains.

i. **Identification of industries associated with the forest-based BR trade chains:** Based on the discussions with the Forest Department and Agencies such as *Jila Bhesaj Sangh* and Uttarakhand Forest Development Corporation (UFDC), the main industries manufacturing herbal products were identified as Patanjali Pvt. Ltd. (YogPeeth and Padartha), Prabhat Herbals Pvt. Ltd., Gayatri Herbals, Divya Pharmacy and Padmavati Pvt. Ltd.

ii. **Primary data collection regarding BRs:** The following two methods were used to obtain information.

- **Personal Interviews:** Basic quantitative information about the industry from procurement to the final product manufacturing was collected[5].
- **Questionnaires: Questionnaire based information** related to forest-based BRs, their collection procedure, quantity, demand and supply mechanism, royalty or ABS information (if present), different cost, bi-products and its management and R&D related information were enquired during the meetings.[6]

iii. **Identification of the villages:** Villages from where the raw material was procured were enlisted based on the discussions with the forest officials. Following the random sampling method, eleven, nine and eight villages from the districts of Haridwar, Uttarkashi and Pauri, respectively, were selected for the study.

b. **Government and Non-government level:** Joint meetings were held with officials of the Forest Department, UFDC and *Jila Bhesaj Sangh* in each selected district to understand the existing BR value chains.

i. **Consultations with forest officials**

ii. **Secondary data collection:** Information on the trade of medicinal plant i.e., from collection to selling was collected from *Jila Bhesaj Sangh* and UFDC. The working plan provided by the forest officials was also looked upon to enlist the available Bio-Resources and their management practices.

iii. **Primary data collection regarding BRs:** The primary data was collected through personal Interviews and questionnaires, which included questions on availability and trade of medicinal plants.

c. **Village level:** The villages selected through random sampling were surveyed for data collection and documentation of traditional knowledge.

i. **Village-level interactions:** The villages were visited and primary data were collected by interviewing *Pradhan* (village head) or equivalent person, groups such as Self-Help Group (SHG), Biodiversity Management Committee (BMC), *Mahila Mangal Dal* (MMD), Yuva Mangal Dal (YMD) and others.

5 Muthu, C., Ayyanar, M., Raja, N. and Ignacimuthu, S., 2006. Medicinal plants used by traditional healers in Kancheepuram District of Tamil Nadu, India Journal of Ethnobiology and ethnomedicine, 2(1): 43.

6 Cheikhyoussef, A., Shapi, M., Matengu, K. and Ashekele, H.M., 2011. Ethnobotanical study of indigenous knowledge on medicinal plant use by traditional healers in Oshikoto region, Nambia. Journal of Ethnobiology and Ethnomedicine, 7(1): 10.

ii. **Data Collection:** A comprehensive survey was carried out for identification of the potential BRs, traditional knowledge, availability, access, distribution and trade.

iii. **Participatory Rural Appraisal:** PRA was conducted by involving SHG, MMD, BMC and YMD. Through mapping exercise, Bio-Resources available and collected from the forest, water, agriculture land, households were recorded (Chambers, 1994).[7]

iv. **Interviews:** Information on conservation strategies adopted and constrains faced by the villagers was retrieved via personal interview.

5. **Data compilation and analysis:** The raw data were processed using Microsoft Excel.

II. METHOD FOR IDENTIFICATION OF SPECIES WITH POTENTIAL FOR ABS:

A four step methodology was adopted for the identification of BRs with ABS potential :

Step 1. At first, the list of identified species was prepared for all three districts. The prepared list was discussed with various stakeholders e.g. forest officials, villagers, *Jila Bhesaj Sangh* and UFDC for inputs. Subsequently, the enlisted species were cross-checked for their threat status (IUCN/CAMP Workshop), their occurrence (Indigenous/Exotic) and NBA's NTAC (Normally Traded As Commodities) list. Species which are threatened, exotic and/or in the NTAC list were excluded.

Step 2. BCG Matrix analysis: The Boston Consulting Group developed a tool called BCG matrix for categorising the products of a company in relation to the overall life cycle of the individual products. The life cycle of the products is based on observations and weighing pertaining to their market development. To analyse and weigh all the products offered by one company, the BCG matrix places each of the products according to the growth rate of the business and the relative market share that one individual product controls. The original BCG matrix included four categories of product performance named "Stars", "Cash Cows", "Question Marks", and "Dogs". By identifying into which quadrant of the BCG matrix a product falls can provide valuable guidance to management for evaluating the possible future and value of the specific product within the company's business portfolio.

In the present study, a BCG matrix was used to identify bio-resources with promising ABS potential.

A district-wise BCG matrix analysis[8] was conducted on the availability (high and low) and price (high and low) of local BR species (exclusions as above).

Step 3. Species Selection Index (SSI): In this method, five positive (values from 1 to 5) and five negative (-5 to -1) criteria were selected (Table 1). The index value for each species was derived as the sum of positive and negative criteria. The species with more positive index value were selected for ABS mechanism.

7 Chambers, R. (1994). Participatory rural appraisal (PRA): Analysis of experience. World development, 22(9): 1253-1268.

8 Mutandwa, E., Kanuma, N. T., Rusatira, E., Kwiringirimana, T., Mugenzi, P., Govere, I. and Foti, R., 2009. Analysis of coffee export marketing in Rwanda: Application of the Boston consulting group matrix. African Journal of Business Management, 3(5): 210-219.

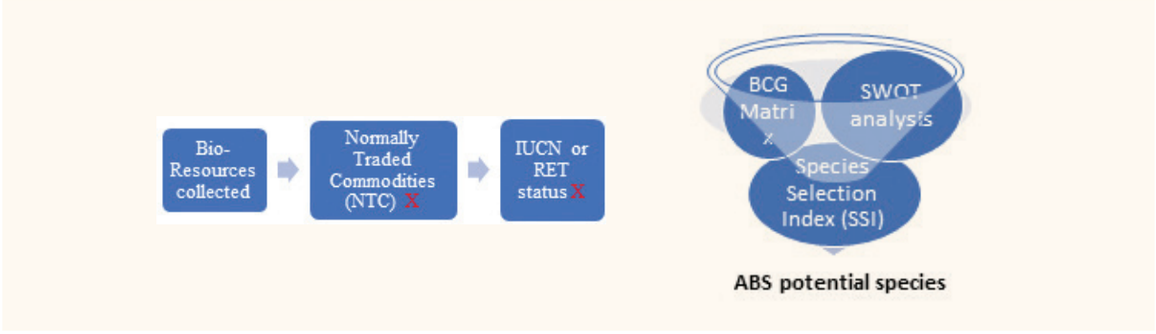
Table 1. Species Selection Index with their respective positive and negative criteria index value in relation to different criteria.

Positive Index	Availability	Price	Market availabilities	Traditional knowledge and diversified uses	Industrial Demand
1	Very low	Very low	Very low	Very low	Very low
2	Low	Low	Low	Low	Low
3	Medium	Medium	Medium	Medium	Medium
4	High	High	High	High	High
5	Very high	Very high	Very high	Very high	Very high

Negative Index	Labour cost	Time-bound	Accessibility	Collateral damage to regeneration	Storage issues
1	Very low	Entire Year	Very easy	Very low	Very low
2	Low	9 months	Easy	Low	Low
3	Medium	6 months	Medium	Medium	Medium
4	High	4 months	Difficult	High	High
5	Very high	Very seasonal	Very difficult	Very high	Very high

Step 4. SWOT (Strength, Weaknesses, Opportunities and Threats) analysis: A SWOT analysis was done to finalise the species selection having ABS potential. Strengths are the factors which can be of advantage. Weaknesses are those which can prove to be disadvantageous. Factors represent Opportunities, if they can be converted into advantages, and conversely, Threats are those factors which represent hurdles in achieving the objectives. The analysis was conducted on the selected species to support the result[9] and to identify the status of the medicinal plant for their tradability and conservation.

The mechanisms used for the primary and final selection of species having ABS Potential in the Garhwal region are visualised in the schematic representation below:



9 CBD, 2011. Analysis of existing biodiversity-poverty mechanisms, initiatives and processes relevant to mainstreaming biodiversity with poverty eradication and development. SWOT Analysis for Expert Group Meeting on Biodiversity for Poverty Eradication and Development Dehradun, India, December 12-15, 2011, pp 1-114.

Key Findings

The findings of the study for each district are summarised below:

Haridwar

Eleven villages namely Shyampur, Chindipur, Kangari, Dyahuala, Haripur, Taufwala, Dhula dyalwala, Raserpura, Pathi, Kaugri, and Chiriapur, were selected and surveyed in Haridwar district. From all villages together, 22 species were identified for which the trade could be improved. Generally, they are of medicinal use, both for humans and livestock. Some are used for religious purposes as well. Except *Acorus calamus* which occurs in and around water bodies, all other species are terrestrial.

Uttarkashi

Nine villages namely Kapnol, Bansali, Nitala, Rana Chatti, Ojri, Kuthnar, Sald, Gwana Ganeshpur and Maneri, were surveyed in Uttarkashi district. Sixteen traded BRs were identified during the survey.

Pauri

Eight villages namely Sanei, Chothani, Gwad, Syoli Talli, Budesu, Palkot, Jamargaddi, and Amsod, were surveyed in Pauri district as part of the study. 15 plant species were identified from the selected villages which are commonly used and traded by the communities.

In all the three districts Amla and Tejpatta (Bay leaves) were found common and under trade. *Bael*, *Brahmi*, *Giloy* and *Kadi Patta* were common BRs in Haridwar and Pauri districts, Lichen and Moss were traded BRs from Pauri and Uttarkashi whereas *Van Tulsi* was common BR traded from Haridwar and Uttarkashi districts of Garhwal (Table 2).

Of the various BRs collected from Haridwar disctrict, *Terminalia chebula* (Harar), *T. bellirica* (Bahera), *Aegle marmelos* (Bael), *Bauhinia vahlii* (Mahajan or Maldhan) and *Phyllanthus emblica* (Amla) were extensively being utilised by the different industries to produce various end products and thus contribute largely towards the improvement of livelihoods in the region.

Similarly, in Pauri, species like *Cinnamomum tamala* (Dalchini), *Murraya koenigii* (*Kadi Patta*), and *Zanthoxylem armatum* (*Timbru*) contribute towards the enhancement of local livelihoods.

Picrorhiza kurroa (*Kutki*), *Saussurea lappa* (*Kuth*), *Jurinea macrocephala* (*Guggal*), *Rhododendron spp.* (*Burans*), *Berberis aristata* (*Kingoda*), *Pinus roxburghii* (*Chir pine*), *Cinnamomum tamala* (*Tejpatta*), and *Nardostachys jatamansi* (*Jatamansi*) helped in the improvement of local economy of the community in collection and trade of these BRs.

A comprehensive list of BRs identified across all the three districts, their habit, habitat and uses are given in Table 2.

Table 2: List of Tradeable Bio-resources screened in the three selected districts of Gharwal

Species Name	Scientific Name	Herb/ shrub/Tree	Habitat	Part Used	Uses
Haridwar district					
Kadi Patta	*Murraya koenigii* (L.) Spreng. (Rutaceae)	Shrub	Tropical evergreen and deciduous forest	Leaves	As spice
Bael	*Aegle marmelos* (L.) Correa (Rutaceae)	Tree	Up to 1200 m	Fruit, root	Diabetes, diarrhea, Ear problems
Amla	*Phyllanthus emblica L.* (Euphorbiaceae)	Tree	Deciduous forest, up to 1400 m	Fruit	Pickles, in Triphla and other medicines
Kadu Panchang	*Acorus calamus L.* (Acoraceae)	Herb	Emergent plant in or near water bodies. Up to 2800 m	Whole	Panchang medicines
Basa Panchang	*Justicia adhatoda L.* (Acanthaceae)	Shrub	Up to 2800 m	Whole	Bronchitis, asthma
Harar	*Terminalia chebula Retz.* (Combretaceae)	Canopy tree	Tropical broad-leaved forest and dry deciduous forest and Tropical wet evergreen forest up to 1500 m.	Fruit	As one of the ingredients of Triphla
Bahera	*Terminalia bellirica (Gaertn)* Roxb. (Combretaceae)	Canopy tree	Tropical moist and dry deciduous forest	Fruit	As one of the ingredients of Triphla
Mahajan	Bauhinia vahlii Wight & Arn. (Caesalpiniaceae)	Woody climber (vine)	Moist forest up to 1800 m	Leaves	As leaf bowl at roadside stalls
Rohini	*Mallotus philippensis* (Lam.) Mull. Arg. (Euphorbiaceae)	Under canopy tree	Deciduous forest	Seeds	In dyes
Van Tulsi	*Ocimum gratissimum L.* [Lamiaceae (Labiatae)]	Herb	Moist and dry deciduous forest	Whole	Cough, herbal tea.
Amaltas	*Cassia fistula* L. (Caesalpiniaceae)	Tree	Deciduous forest upto 1220 m.	Pod	In Jamalghota, dye, Heart disease
Kharenti	*Sida cordifolia* L. (Malvaceae)	Shrub	Up to 1500 m	Leaves	Used in boils
Chirchita	*Achyranthes aspera* L. (Amaranthaceae)	Herb	1000-1800 m	Whole	Medicinal important for skin and stomach, Anti-inflammatory
Brahmi	*Bacopa monnieri* (L) Wettst. (Scrophulariaceae)	Herb	At all heights	Whole	Brain tonic, hair problems
Ber	*Ziziphus mauritiana* Lam. (Rhamnaceae)	Shrub/Tree	Tropical moist and dry deciduous forest and tropical thorn forest	Fruit	As food and in religious ceremony
Bhabar grass	*Eulaliopsis binata* (Retz.) C.E. Hubb. (Poaceae)	Grass	Alluvial zone near shiwalik hills	Whole	Fibre, fodder and paper
Dhatura	*Datura stramonium* L. (Solanaceae)	Herb	Temperate forest up to 2500 m	Fruit, Flower	For religious ceremony

Species Name	Scientific Name	Herb/ shrub/Tree	Habitat	Part Used	Uses
Giloy	*Tinospora cordifolia* (Willd.) Miers. Menispermaceae	Climber	Deciduous forest	Leaves	Dengue fever, typhoid
Lemon grass	*Cymbopogon spp.* L. Spreng. (Poaceae)	Grass	Up to 1500 m	Leaves	Diabetes, tea
Tejpatta	*Cinnamomum tamala* (Buch.-Ham.) *T.Nees & Eberm.* (Lauraceae)	Tree	Up to 1800 m in moist areas	Leaves	As Spice
Sarpagandha	*Rauvolfia serpentina* (L.) Benth. Ex Kurz (Apocynaceae)	Herb	Up to 2500 m	Roots	Used in the treatment of sugar, blood pressure. Also used for scorpion and snake bite
Safed Bel	*Vallaris heynei Burm.f.* (Apocynaceae)	Climber	Moist areas	Stem and Bark	Used as fibre
Pauri district					
Dalchini/ tejpatta	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & Eberm. (Lauraceae)	Tree	Up to 1800 m in moist areas	Leaves/ bark	As spice
Kadipatta	*Murraya koenigii* (L.) Spreng. (Rutaceae)	Tree	Lower evergreen and deciduous forest	Fruit, root	As spice
Timburu	*Zanthoxylum armatum* DC.(Rutaceae)	Tree	Up to 1200 m	Fruit, bark, stem	Used for toothache, cough and asthma
Semal	*Bombax ceiba* L. (Bombacaceae)	Tree	Deciduous forest up to 1200 m	Leaves, stem, flower	Skin infections, flower as vegetables
Patharchatta	*Bryophyllum pinnatum* (Lam.) Oken. (Crassulaceae)	Herb	Shady places, arid lowlands and moist uplands.	Leaves, roots	In kidney stones and abdominal problems
Van Haldi	*Curcuma aromatica Salisb.* (Zingiberaceae)	Herb	Temperate forest	Leaves	In Traditional marriage system for religious ceremony
Kala baans	*Ageratina adenophora* (Spreng.) King & H.Rob.(Asteraceae)	Shrub	Up to 2500 m	Leaves	Extract of leaves are being used in cut or wound as antibiotics.
Giloy	*Tinospora cordifolia* (Willd.) Miers. (Menispermaceae)	Climber	Deciduous forest	Leaves	As leaf bowl
Amla	*Phyllanthus emblica* L. (Euphorbiaceae)	Tree	Deciduous forest, up to 1400 m	Fruit	Pickles, in Trifala and other medicines.
Genthi	*Dioscorea bulbifera* L. (Dioscoreaceae)	Herb	Temperate forest	Roots/ Rhizome	In diabetes, Eating, arthritis, asthma
Bael	*Aegle marmelos* (L.) Correa (Rutaceae)	Tree	Up to 1200 m	Fruits, roots	Diabetes, Diarrhoea, Ear problems
Ghrit Kumari	*Aloe vera* (L.) Burm.f. (Liliaceae)	Herb	Warm and humid places	Leaves	Skin, hair problems and used for burns

Species Name	Scientific Name	Herb/ shrub/Tree	Habitat	Part Used	Uses
Moss	-	Herb	Moist and shady places	Whole	In nurseries
Brahmi	*Bacopa monnieri* (L) Wettst. (Scrophulariaceae)	Herb	Marshy areas	Whole	Brain tonic, hair problems
Lichen	*Parmelia spp.* (L.) Ach. (Parmeliaceae)	Lichen	Oak forest	Fruit	In preparation of Spices, Dyes, etc.
Satavar	*Asparagus racemosus Willd.* (Asparagaceae)	Climber	Tropical and subtropical forest	Roots, leaves	Reproductive tonic, Demulcent in digestive systems.
Uttarkashi district					
Lichen	*Parmelia spp.* (L.) Ach. (Parmeliaceae)	Lichen	Oak forest	Whole	Used as spice for flavour
Kutki	*Picrorhiza kurroa Royle ex Benth* (Plantaginaceae)	Herb	2700 to 4500 m	Roots	Given as medicine in fever and diarrhoea. Also proved to be useful in the treatment of scorpion bite.
Kuth	*Saussurea lappa* (Decne.) Sch. Bip(Asteraceae)	Herb	2500 to 3000 m	Roots	Strengthens the digestion, cleanses the body of toxic accumulations, given as a medicine for cough and asthma.
Atish	*Aconitum heterophyllum* Wall. ex Royle (Ranunculaceae)	Herb	2000 to 3900 m	Roots	Given in vomiting and intestine related problems
Guggul	*Jurinea macrocephala DC.* (Compositae)	Tree	Open alpine slopes up to 3800 m	Roots	Roots used for incense stick, also given in fewer and pain
Satua	*Paris polyphylla Sm.* (Melanthiaceae)	Herb	Moist places up to 3300 m	Rhizome	In abdominal pain
Moss	-	Herb	Moist and shady places	Whole	In nurseries
Burans	*Rhododendron spp.* Sm. (Ericaceae)	Tree	Evergreen forest	Flowers	Juice preparation which is good for heart and lungs
Kingoda	*Berberis aristata* DC. (Berberidaceae)	Shrub	Up to 3000 m	Roots	In eye-related disorders and inflammation
Moru	*Quercus floribunda* Lindl. ex A. Camus (Fagaceae)	Tree	Broad-leaved hill forest	Leaves	Used as fodder, fuelwood and charcoal
Chir pine	*Pinus roxburghii* Sarg. (Pinaceae)	Tree	Up to 450-2300 m	Resin	Used for making paint, varnish and for treating kidney and bladder problem
Van Tulsi	*Ocimum gratissimum* L. [Lamiaceae (Labiatae)]	Herb	Moist and dry deciduous forest	Whole	Useful for digestive system

Species Name	Scientific Name	Herb/ shrub/Tree	Habitat	Part Used	Uses
Kari patta	*Murraya koenigii* (L.) *Spreng.* (Rutaceae)	Tree	Lower evergreen and deciduous forest	Leaves	Used in frying, curry for flavour
Tejpatta	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & Eberm. (Lauraceae)	Tree	Tropical and subtropical moist climate up to 2000 m	Leaves	Used as spice
Amla	*Phyllanthus emblica* L. (Euphorbiaceae)	Tree	Deciduous forest, up to 1400 m	Fruit	Given in cough and urine infections
Jatamansi	*Nardostachys jatamansi* (D.Don) DC.(Caprifoliaceae)	Herb	1500 to 4000 m	Roots	Used as a tonic for digestive issues and respiratory problems.

BCG Matrix: Potential species for ABS

Based on BCG Matrix (Mutandwa et al. 2009) and Species Selection Index the following potential species for ABS were identified:

Haridwar: *Terminalia chebula Retz.* (Combretaceae), *T. bellirica* (Gaertn) Roxb., *Aegle marmelos* (L.) Correa (Rutaceae), *Mallotus philippensis* (Lam.) Mull. Arg. (Euphorbiaceae) and *Ocimum gratissimum* L. [Lamiaceae (Labiatae)].

Uttrakashi: *Ocimmum gratissimum and Parmelia spp.* have high availability and high price in the region and have potential for ABS in future.

Pauri: *Parmelia spp.* (L.) Ach. (Parmeliaceae), Moss *Grass*, *Aegle marmelos* (L.) Correa (Rutaceae), *Bryophyllum pinnatum* (Lam.) Oken (Crassulaceae), *Zanthoxylum armatum* DC. (Rutaceae), *Bombax ceiba* L. (Bombacaceae) and *Dioscorea bulbifera* L. (Dioscoreaceae).

BCG matrix analysis and Species Selection Index (SSI) were carried out to identify the species with high potential for ABS. The results showed that BRs like *Parmelia spp.,* Moss and *Bryophyllum pinnatum* have high availability and high price in the region. Hence, they can be considered for ABS. In contrast, *Curcuma aromatica* should not be considered because of its low price and availability.

The BCG matrix for species prioritisation in the three selected districts are given below:

BCG matrix for species prioritisation in Haridwar

BCG Matrix		Availability	
		High	Low
Price	High	*Terminalia chebula* Retz. (Combretaceae) *Terminalia bellirica* (Gaertn) Roxb. (Combretaceae) *Aegle marmelos* (L.) Correa (Rutaceae) *Mallotus philippensis* (Lam.) Mull. Arg. (Euphorbiaceae)	*Ocimum gratissimum* L. [Lamiaceae (Labiatae)] *Rauvolfia serpentina* (L.) Benth. Ex Kurz (Apocynaceae)
	Low	*Bauhinia vahlii* Wight & Arn.(Caesalpiniaceae) *Eulaliopsis binata* (Retz.) C.E. Hubb. (Poaceae)	Vallaries heynei

BCG matrix for species prioritisation in Pauri

BCG Matrix		Availability	
		High	Low
Price	High	*Parmelia spp.* (L.) Ach. (Parmeliaceae) Moss *Ghaans* *Bryophyllum pinnatum* (Lam.) Oken. (Crassulaceae)	*Asparagus racemosus* Willd. (Asparagaceae) *Ageratina adenophora* (Spreng.) King & H.Rob.(Asteraceae) *Aegle marmelos* (L.) Correa (Rutaceae)
	Low	*Bombax ceiba* L. (Bombacaceae)	*Curcuma aromatica* Salisb. (Zingiberaceae)

BCG matrix for species prioritisation in Uttarkashi

BCG Matrix		Availability	
		High	Low
Price	High	*Ocimum gratissimum* L. [Lamiaceae (Labiatae)] *Parmelia spp.* (L.) Ach. (Parmeliaceae)	*Paris polyphylla* Sm. (Melanthiaceae) *Rhododendron* spp. Sm. (Ericaceae).
	Low	*Quercus floribunda* Lindl. ex A. Camus (Fagaceae) Lichen	*Saussurea lappa* (Decne.) Sch.Bip (Asteraceae)

Strengths, Weaknesses, Opportunities and Threats (SWOT) Matrix analysis

Selected BRs were subjected to SWOT analysis to identify the status, tradability and conservation measures to be taken for the sustainable supply of BRs. The factors identified in the SWOT analysis of a BR are given below:

Strengths

- Availability of BRs
- Sustainable management of BRs
- Systematic institutional extraction of BRs
- Traditional Knowledge and multiple use

Weaknesses

- Inadequate awareness among the stakeholders
- Unreachable sites of harvesting
- Labor cost and time-consuming harvesting
- Loopholes including illegal trading and smuggling
- Inadequate R&D on processing technology of BRs
- Poor harvesting practices

SWOT

Opportunities

- Industrial opportunities
- More jobs, profit and organic products
- Diversified uses in different industries
- R&D activities

Threats

- Uncontrolled or unmanaged extraction of BRs
- Natural calamities including forest fire
- Industrial explosion leading pressure on forest for the extraction of BR

Recommendations

The key recommendations from the study conducted in the three districts of Garhwal are:

1. Those species should be promoted for cultivation whose consumption is high, and which are frequently used and can be easily cultivated.
2. Lichens, Moss Grass and *Timbru (Zanthoxylum armatum)* are collected in large amounts. Lichens grow mainly in association with Banj Oak *(Quercus leucotrichophora)* forest. For improved sustainability, a prime focus should be laid on the conservation of these forests.
3. Modern forestry tools and practices like controlled lopping, systematic collection of BRs, etc., should be checked for improving sustainability of extraction and processing of BRs.
4. Often, simple post-processing of the harvest at village level can improve the quality of the produce for better trade return.
5. Establishing market linkages between the producers (e.g., BMCs) and the manufacturers can improve local economy and foster dissemination of sustainability aspects.
6. Since most of the BRs are used by the communities for many generations, a rich traditional knowledge exists which must be considered for documentation.

Conclusion

The Garwhal region of Uttarakhand has a very high diversity of medicinal plants. Similarly, the commercial utilisation of Bio-Resources, especially of plants, is significant. To reduce the dependency of the industries on forest-based BRs, cultivation of plants should be prioritised. This will improve the local livelihoods which are dependent on the sustainable use of Bio-Resources.

This study, conducted as part of the Indo German ABS partnership project, helped in identifying the districts in Garhwal region harbouring species with high potential for inclusion in the ABS mechanism. The study revealed that Uttarkashi is the most promising district as compared to Haridwar and Pauri. Therefore the district may be prioritised for the formation of BMCs to facilitate effective implementation of ABS.

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