# Plant-based Substances in Côte d'Ivoire
## Potential and Sustainable Development

## English Synthesis

IRD joint scientific assessment undertaken at the request of the Ministry of Higher Education and Scientific Research of Côte d'Ivoire (MESRS)

Under the leadership of Séraphin KATI-COULIBALY

Coordinating experts: Yves-Alain BÉKRO, Valérie BOISVERT, Mamidou Witabouna KONÉ and Jean-Yves PABST

**IRD Editions**
INSTITUT DE RECHERCHE POUR LE DEVELOPPEMENT

Expert Group Review Collection

Marseille, 2021

Sommaire

**Editing (compilation) and preparation for publication**

Marie-Laure PORTAL

**Cover design**

Michelle SAINT-LÉGER

**Inner design and layout**

Aline LUGAND – Gris Souris

**Production coordination**

Romain COSTA

**To quote this publication:**

KATI-COULIBALY S. *et al*., 2021 – *Plant-based Substances in Côte d'Ivoire. Potential and Sustainable Development*. Marseille, IRD Editions, Expert group review collection, bilingual French/English.



ISSN : 2739-9168

ISBN : 978-2-7099-2918-9

Sommaire

# Composition of the expert committee

**President**

Séraphin KATI-COULIBALY, professor of nutrition and pharmacology, Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire).

**Committee experts and thematic coordinators**

Yves-Alain BÉKRO, senior professor of organic chemistry, phytochemistry, chemistry of natural substances, director of the laboratory for bio-organic chemistry and chemistry of natural substances (LCBOSN), University of Nangui Abrogouan (Abidjan, Côte d'Ivoire).

Valérie BOISVERT, professor of ecological economy, Institute for geography and sustainability, University of Lausanne (Switzerland).

Mamidou Witabouna KONÉ, professor of plant-based biology, phytochemistry, African pharmacological substances and natural substances, Swiss scientific research centre in Côte d'Ivoire, University of Nangui Abrogoua (Abidjan, Côte d'Ivoire), Pasteur institute of Côte d'Ivoire (Abidjan, Côte d'Ivoire).

Jean-Yves PABST, professor of law and pharmacological economy, University of Strasbourg, Faculty of pharmacy (France).

**Committee experts**

Antoine-Serge AMARI, professor of pharmacological- and biological sciences, Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire).

Robin DUPONNOIS, director of microbiological research, The French National Research Insitut for Sustainalbe Development (UMR LSTM), IRD (Montpellier, France).

Tagro Simplice GUEHI, professor of biotechnology and microbiology, University of Nangui Abrogoua (Abidjan, Côte d'Ivoire).

Mohamed HADDAD, head of research, chemistry of natural substances, The French National Research Insitut for Sustainalbe Development (Pharma-DEV laboratory), IRD (Toulouse, France).

Sommaire

Jean-David N'GUESSAN, professor of biochemistry and pharmacology, laboratory for biology and health, UFR Biosciences, Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire).

Catherine VONTHRON, senior lecturer in chemistry, integrative biology and pharmacognosia, University of Strasbourg, laboratory for healthcare innovation (Strasbourg, France).

**Proofreaders**

Kagoyré KAMANZI, professor of botany, ethnobotany, phytochemistry, Félix Houphouët-Boigny University (Abidjan, Côte d'Ivoire).

N'golo FANNY, director of the Parks and Reserves Foundation of Côte d'Ivoire (Abidjan, Côte d'Ivoire).

The committee was supported in its works by the Mission assessments and consultancies of the IRD:

Alain KEITA, Coordination oversight of this joint assessment.

Ludovic MOLLIER and Régis FERRON, IRD joint assessments coordinators.

Jean ALBERGEL, director of the Mission: assessments and consultancies.

# Summary

*This document contains the compilation of the expert assessments and recommendations.*

*Annexes, including original expert assessments in French are in open source on the IRD Editions' webpage:*

*https://www.editions.ird.fr/collection/96/expertise-collective*

# Introduction : Plant-based substances, the richness of their potential and their contemporary societal significance

Like people the world over, the Ivorian people have managed to extract from their immediate surroundings all means necessary and useful for combating diseases. Among the many resources nature has placed at their disposition, special mention has to be made of plants, comprising the essence of what is designated by the term "traditional pharmacological stock" (or "pharmacopoeia").

The position of Côte d'Ivoire within the intertropical zone close to the ocean results in it possessing varied ecosystems and singular biotopes according to topography, pedology and climate. Benefitting from a long oceanic coastline (570 km) bordering the Gulf of Guinea, the country is also crisscrossed by four main rivers (the Bandama, the Comoe, the N'zi and the Cavalla), as well as by numerous watercourses and lagoons – from which the latter originate. Natural substances hold immense potential for the country's development, with many of them possessing health-related-, economic- or social value capable of achieving objectives related to healthcare, to job creation and to the conservation and sustainable management of resources such as are prioritised by the Ivorian government. It is for this reason that Côte d'Ivoire engages at both regional and international level in such processes, agreements and conventions as govern the exploitation of plant species for productive purposes.

Unfortunately, as a result of its geographic placement in proximity to both the ocean and the Equator, Côte d'Ivoire is a country currently in a position of great vulnerability vis-à-vis climate change. In addition its economy is dependent on an agricultural sector in want of modernisation and highly susceptible to climatic conditions. Within this context, two major challenges require addressing via timely and effective intervention. On the one hand, the economic growth model based on the exploitation of agricultural- and natural resources has to be both sustainable and supported. On the other hand, it should favour better distribution of the benefits derived from the utilisation of these natural resources without endangering future generations. As such, it seems well past time to engage in a study of

Sommaire

substances of potential value and such knowledge as are related to their exploitation.

Within a global context of ecological-, health-related-, economic- and cultural challenges of ever-increasing seriousness, an analysis of the situation simultaneously lends itself to more active awareness and to the adoption of adequate and innovative strategies capable of dealing in the most effective and sustainable way with the negative consequences of changes in our environment and our societies. As a result is seems timely to seek a proper understanding of both present and future challenges, thus enabling us to anticipate and respond to such changes as will require significant mitigation, adaptation and even the development of greater resilience to our planet's evolution, and that particularly in Côte d'Ivoire.

This assessment of plant-based substances (SOV – for *Substances d'Origine Végétale* in French) on the one hand aims at conducting an inventory, and on the other to provide food for thought with regard to formulating a response to the totality of these contemporary social concerns.

# 1. Flora under significant threat

Ivorian fauna is rich, comprising 232 mammal species of which 26 are classified by the International Union for Conservation of Nature (IUCN) as rare or threatened with extinction: 732 bird species, of which 36 are listed on the IUCN's red list of endangered species, 96 amphibian species, of which six are indigenous to Côte d'Ivoire. The aquatic ecosystem is equally rich, comprising 580 mollusc species, 302 crustacean species and 496 fish species.

Just as abundant, original and rich is the Ivorian land-based floral heritage, boasting more than 3 790 species of higher plant divided into 202 families. The totality of studies undertaken relying on the knowledge and participation of traditional healers has enabled the cataloguing of a considerable, albeit non-exhaustive, number of plants sporting medicinal qualities belonging to a wide variety of floral families on Ivorian soil. Among these species various indigenous plants have been identified, including 62 specifically Ivorian ones such as: *Andropogon curvifolius* Clayton (Poaceae)[1], *Cissus touraensis A. Chev.* (Vitaceae), *Albertisia*

[1] The listing of plant names in the text is done according to the APG classification (Angiosperm phylogeny group, 1998, 2003, 2009, 2016), i.e. using the most traditional form of reference.

*mangenotii* (Guillaumet & Debray) Forman (Menispermaceae), *Anthonotha sassandraensis* Aubrev. & Pellegr. (Caesalpiniaceae), *Macaranga beillei* Prain (Euphorbiaceae), *Dorstenia embergeri* L. (Moraceae), *Mapania ivorensis* (J. Raynal) J. Raynal (Cyperaceae). Here one also finds 470 species indigenous to West Africa: *Millettia rhodantha* Baill. (Papilionaceae), *Moghania faginea* (Guill.& Perr.) Kuntze (Papilionaceae), *Afzelia bella var gracilior* Keay (Caesalpiniaceae), *Aeglopsis chevalieri* Swingle (Rutaceae), *Drypetes aubrevillei* Léandri (Euphorbiaceae), *Morinda geminate* DC. (Rubiaceae), *Connarus thonningii* (DC.) Schellenb. (Connaraceae), *Diospyros heudelotii* Hiern. (Ebenaceae), *Tiliacora dinklagei* (Menispermaceae), *Placodiscus bancoensis* Aubrév. & Pellegr. (Sapindaceae). Finally, one also identifies the Sassandra[2] (or trans-Sassandra) species, of which the main examples are: *Afzelia bracteata* Aubrév. & Pellegr. (Caesalpiniaceae), *Calpocalyx aubrevillei* Pellegr. (Mimosaceae), *Cassipourea nialatou* Aubrév. & Pellegr. (Rhizophoraceae), *Hunteria umbellata* (K. Schum.) Hallier f. (Apocynaceae), *Hutchinsonia barbata* Robyns (Rubiaceae), *Inhambanella guereensis* Aubrév. & Pellegr. T. D. Penn. (Sapotaceae) and *Keayodendron bridelioides* Gilb. & Mildbr (Euphobiaceae).

The parts of the plant used in traditional medicine to treat, heal or prevent numerous diseases vary – among the most sought-after among rural populations may be noted: leaves, stems, roots, bark, fruit, and flowers. Some treatments require the use of the entire plant.

The beneficiary of all this botanic wealth is the population of Côte d'Ivoire, composed of an ethnic mosaic consisting of some sixty groups and speaking at least as many dialects, spread out and organised across four major sociocultural regions. These regions are characterised by shared traditions, knowledge, know-how and rituals belonging to the ethnic groups dominant in the area: the Mandélive in the northwest (Malinke, Dan, Guro, etc.) and the Gur in the northeast (Senoufo, Lobi, Koulango, etc.). The southwest is occupied by the Kru (Bete, We, Godié, Neo, etc.), while the southeast hosts the Akan (Baoulé, Agni, Abron, Attié, etc.).

These cultural spaces supersede artificial colonial borders; hence there may be similarities between Ivorian culinary and medicinal traditions and those of bordering countries. The Ivorian traditions have further been enriched by immigrant populations making their own cultural contributions, particularly in terms of the medical knowledge and the culinary practices of neighbouring countries. Thus in the area of Ivorian cuisine one also finds products of Burkina Faso origin (such as *zomko*, or *zoom-koom*, a drink

[2] Sassandra or trans-Sassandra: indigenous species found across the western Sassandra area. The term was first used in 1956 by G. Mangenot to designate species lending a unique appearance to the western Côte d'Ivoire swampweed forests.

made from millet powder or from a mixture of millet powder and rice), from Benin and Togo (like *abolo*, cake made from rice flour and/or corn flour), from Ghana and Benin (such as *akassa*, fermented paste made from corn flour), from Senegal (e.g. *tchep*, a speciality dish generally made from rice and fish) and from Asian and Lebanese origin (spring rolls and *shwarma*, respectively). In addition, the medical knowledge and practices the Peuls, the Hausa and the Chinese have also spread throughout the country.

The country has based its economic development simultaneously on the exploitation of forest resources and the diversification of its agricultural production, particularly coffee, cocoa, bananas, pineapple, palm oil, cotton, cane sugar and coconuts. The Ivorian economy is based on an agro-industrial type model, but in Côte d'Ivoire, as elsewhere, agricultural production is dependent on climatic variations having a significant impact on the environment. It continues to be considered a developing economy (GDP per inhabitant: 1 727, 284 USD in 2019 according to the World Bank). The country is well-positioned internationally as a result of its agricultural production, notably with regard to exportation. Nevertheless, Côte d'Ivoire depends on imported products for its internal consumption and its system of production.

Despite its advantages, Ivorian biodiversity is in a constant state of degradation, with serious threats posed to both its fauna and flora. As it stands, numerous species have already been exterminated, or nearly so. Such is the case of the African elephant (Loxodonta africana), the country's most iconic animal, of which the number of individual forest elephants has decreased from 1 611 in 1994 (Mc Pherson *et al*., 2000) to 225 today, representing a demographic decline of 86% over the last two decades (Kouakou *et al*., 2020).

The Ivorian forest canopy extends from Guinea-Konakry to Togo and encloses 2 800 vascular forest plant species, of which 23% are indigenous. The primary direct causes for the erosion of biological resources in Côte d'Ivoire are deforestation, forest fragmentation and poaching. For a long time now the country has manifested a rate of deforestation classified as among the highest in the world – while constituted of 16 million hectares at the turn of the previous century, today the Ivorian forest is made up of only 2 million hectares (Minefor, 2017). Other direct causes of biodiversity regression are overgrazing, the overexploitation of fishery resources, pollution, infectious diseases and encroachment by invasive species. As far as indirect causes are concerned, these are essentially related to demographic growth, to poverty, to urbanisation and, most recently, to climate change. These threats forecast challenges for the country's ability to utilise its natural resources in a sustainable way, the reserves of which have decreased by 26% between 1990 and 2014.According to the Intergovernmental Panel on Climate Change (IPCC), climate change could

lead to a reduction in GDP of between 380 and 770 billion CFA francs by 2040[3]. Accoding the Germanwatch NGO, in 2019 Côte d'Ivoire was listed 106th out of 169 countries ranked according to their resilience to climate change[4].

## 2. Plants as healthcare products and multipurpose resource

The objective of this assessment is to create a reference document for studies on vegetation and its products. The plants noted serve first and foremost as examples representing other plants of the same species or sharing a similar process of extraction or processing.

The utilisation of plants with strong medicinal potential constitutes a key economic sector for the country. Nevertheless, from within the extremely vast range of vegetation and available source material the experts have compiled criteria for the selection of SOVs and of specific fields within which value can be extracted from them (table 1).

This assessment targets SOVs, whether in relation to entire plants, parts of plants (roots, tubers, bulbs, stems, leaves, vines, shoots, flowers, fruit, seeds…) as well as products derived from them, including harvesting by-products or products created as a result of processing. This includes non-wood forest-based products[5] (PFNL), although not exclusively. Plants taken into consideration can be either cultivated or in their natural state, regardless of their abundance or their distribution across the country. Some are certainly commonly-occurring in different sub-Saharan African countries or even in different tropical regions. On the other hand, the scope excludes products derived from wood crafting, micro-organisms (bacteria), and natural resources of mineral, aquatic or animal origin.

The scope of the assessment therefore is specific and not entirely representative of the usual categories used when dealing with conservation and the effective utilisation of biodiversity. Thus non-wood forest products constitute only part of the assessment. This category was included to

[3] https://afrique.latribune.fr/economie/2018-07-16/cote-d-ivoire-l-emergence-hypothequee-par-le-changement-climatique-785095.html [consulted on 14 January 2021].
[4] www.germanwatch.org/en/cri [consulted in March 2021].
[5] Non-wood forest-based products are, as the name implies, of biological origin other than wood, originating in forests, other wooded domains or from trees located outside of forest areas.

underscore a possible alternative to the exploitation of wood (i.e. to deforestation) due to the utilisation of certain forest resources (Peters, Gentry and Mendelsohn, 1989; Mendelsohn and Balick, 1997) which notably contributes to food security, to the battle against poverty and to development (Shackleton *et al*., 2008; Shackleton and Pandey, 2014). On the other hand, other classifications used extend beyond the domain of SOVs, such as "genetic resources" as mentioned in the Convention on biological diversity (CBD) and which indicate vegetal, animal, fungal, microbial or other biological material containing functional elements having an effective or potential value.

The Nagoya Protocol further expands the focus area by referring to designated "derivations", a term used to indicate "all biochemical composites which exist in a natural state resulting from genetic expression or from the metabolism of biological or genetic resources, even if it does not contain hereditary functional entities". These two texts aim primarily at research and development, whereas the present evaluation focuses on substances which are already globally known and studied from a sustainable development perspective. Biodiversity International uses a different definition, namely "neglected or underutilised species", plants which are essential for food and nutritional security but which have for a long time been neglected by agricultural development programmes (notably leafy vegetables, edible forest fruit trees, tubers)[6]. Finally, the category "perfume, aromatic and medicinal plants", although more linked to an economic approach, nonetheless partly includes vegetation which is the subject of this assessment. The scope as defined for the assessment concerns vegetal substances which are very heterogeneous from an economic point of view (organisation of production, franchises, diversity of products, market scale…).

The scope of the assessment is defined by the types of SOV under examination, but also by the sectors within which these products are used. Thus included are medicinal uses for both human and animal health (plant-based pharmaceutical plants and products).

As far as alimentation is concerned, only infusions, energy drinks or those having a physiological effect, as well as food enhancements (colorants, sweeteners and emulsifiers) are included in the field of study. The use of products for aromatic and cosmetic purposes related to well-being, to perfumery, to unguents is also considered valid for inclusion in the scope, as well as products processed for industry or as part of agricultural application.

[6] http://www.nuscommunity.org

Exclusively food-related uses of plants are not taken into account, e.g. those of *Amaranthus hybridus* L. (Amaranthaceae), *Ipomea batatas* (L.) Lam. (Convolvulaeae), *Basella alba* L. (Basellaceae), *Talinum triangulare* (Jacq.) Wild. (Portulacaceae) or *Colocasia esculenta* (L.) Schott (Araceae). This exclusion relates equally to human alimentation (cereals, legumes, fatty foodstuffs, spices and condiments) as to animal. Similarly, it has been decided not to include artisanal utilisation (such as textiles, decorations, utensils such as doormats, rope, baskets, brooms, etc.) nor ornamental applications (cut and dried flowers, horticulture, decorative gardening) nor combustible or biocarburant use of vegetable substances.

The use of SOVs as healthcare products constitutes a major public health interest for Côte d'Ivoire and offers vast economic potential for Ivorian phytopharmaceutical products, both in terms of traditional and modern Western medicine. As such, the pharmaceutical industry has long recognised the value of ethnomedicine to seek out new marketable medications made from natural products used by traditional healers or local populations as a whole. The Ministry of health has tabulated more than 2 000 traditional plants used for treating a diverse range of illnesses. But although Ivorian flora has been thoroughly studied in relation to botany, ethnobotany and ethnopharmacology, it has been less so in a chemical- and pharmacological context. As a result, questions concerning knowledge of, and research about, vegetation and its link to the country's development constitute a cross-cutting element of the assessment. Our assessment will focus on the medicinal use of SOVs, as well as on traditional medicine, but it will also highlight the diversity of additional possible value to be extracted from SOVs.

In parallel, although the importance of local biodiversity and its conservation has not served as a definitional criterion of SOVs, environmental criteria (preservation of vegetable resources and sustainable development of fields linked to SOVs in Côte d'Ivoire) do lead to the constant consideration of the ecology throughout the assessment and to its conception as an inescapable concern for the country in the short-, medium- and long terms. Indeed, the loss of terrestrial biodiversity is one of the major risk factors identified among the sustainable development goals. Such biodiversity could be ensured via the protection of ecosystems (preventing any degradation), their revivification and the increasing and preservation of endangered species.

| Categories | Inclusions | Exclusions |
|---|---|---|
| Types of SOV | ☐ Whole plants, parts of plants (roots, tubers, bulbs, stems, leaves, vines, shoots, flowers, fruit, seeds…)<br>☐ Products derived from SOVs (harvesting by-products or products created as a result of processing)<br>☐ Non-wood products | ☐ Wood-crafted products<br>☐ Micro-organisms<br>☐ Resources of mineral, aquatic or animal origin |
| Sectors of use | ☐ Medicinal uses for human and animal health<br>☐ Infusions, energy drinks or those having a physiological effect<br>☐ Food enhancements (colorants, sweeteners and emulsifiers)<br>☐ Aromatic use<br>☐ Cosmetic use<br>☐ Perfumery and unguents | ☐ Food-related uses (human and animal alimentation)<br>☐ Artisanal utilisation (textiles, decorations, etc.)<br>☐ Ornamental applications (cut and dried flowers, horticulture, decorative gardening)<br>☐ Combustible or biocarburant use |

**Table 1 : Scope of the assessment regarding SOVs in Côte d'Ivoire.**

## 3. Written sources and the oral tradition

This assessment is the result of an analysis of the available bibliography on SOVs in accordance with the scope as defined (i.e. type of SOV and sector of use) (box 1). As it stands, the data used derive from a number of sources: published sources, databases, university treatises and, finally, information gathered or engaged with in the course of training courses. The angiosperm listing used for the taxonomic categorisation of species is that devised by Arthur Cronquist (1981). Since then, phylogenetic

classification has resulted in major changes being made to listings of this kind (Angiosperm phylogeny group, 1998, 2003, 2009, 2016).

Led by Ivorian or foreign researchers, a number of efforts deal with plants with medicinal properties based on their indigenous usage, on phytochemistry combined with some biological and pharmacological applications, on ethnobotany and ethnopharmacology. Researchers have catalogued the species and resources making up the Ivorian natural heritage, and numerous publications have, on a regular basis, been devoted to the state of the country's biodiversity, without a proper evaluation of its manufacturing- and economic potential ever being carried out for all that. In 2018 a compilation of scientific monographs of 52 medicinal plants contained in the Ivorian pharmacological stock, a reliable source of information, was published. Although the ethnomedical uses of SOVs in Côte d'Ivoire are well-documented, their potential and their possible large-scale utilisation still need to be properly considered.

The national programme for the promotion of traditional medicine (PNPMT), created by the Ministry of health and public hygiene on 28 December 2001 in order to optimise healthcare provision to the public has put in place numerous tools regarding traditional medicine in order to collect local knowledge and know-how from the perspective of both the legal protection of this cultural heritage and the creation of an inventory of traditional healers. This structure has as objective to contribute to improvement in meeting the healthcare needs of the public via an effective and efficient of medicine and of the traditional pharmacological stock. This aim converges with the position of the United Nations industrial development organisation (UNIDO) which since 1969 has tried to convince developing countries of the importance of traditional medicine in order effectively to respond to medication needs in the long term. In Côte d'Ivoire the PNPMT has inventoried:

– 11 artisanal entities for the production of traditional medicines improved (TMI) in 2019;

– 475 traditional medicines catalogued, of which 100 analysed between 2017 and 2019;

– six approved products emerging from the field of traditional medicine in 2019: Dartran (1991) to combat *Pityriasis versicolor* (yeast skin rash), ringworm and scalp ringworm; Baume Alafia (2013) to treat muscle- and joint pain; Nutrasucre (2015) for diabetes; Nutrasel (2015) against hypertension; Bearic Cacao (2015) to treat high blood cholesterol, and finally AREH (salt) (2018) against hypertension;

– 390 georeferenced centres for traditional medicine, of which 100 were visited and 50 exclusively inventoried in 2017;

– 6 500 traditional healers listed in the national database comprising the pharmacological stock and traditional medicines by the 3rd quarter of 2020.

Apart from the PNPMT census data, we now also possess:

–a database of medicinal plants to facilitate research on the use of SOVs;

– specialised software aimed at facilitating the identification of traditional health practitioners within the 31 administrative regions of Côte d'Ivoire;

– finally, a national database of practitioners of traditional medicine by medical region and district, speciality and illnesses treated.

Other databases of ancestral knowledge linked to medicinal plants, such as PRELUDE[7] and PROTA[8], are also available for consultation.

Numerous university treatises and data emerging from training courses enabled the completion of a collection of documentation usable for the positive conclusion of the collective assessment.

[7] http://www.ethnopharmacologia.org/recherche-dans-prelude/ [consulted on 2 December 2020].
[8] https://uses.plantnet-project.org/fr/PROTA,_Introduction_%C3%A0_la_liste_des_esp%C3%A8ces [consulted on 2 December 2020].

**Box 1**

## Bibliographic methodology of IRD joint scientific assessment

For each of its joint scientific assessments, IRD creates a bibliographic reference guide for the ensemble of approaches to the study undertaken as determined by the expert working group involved. This guide serves as complement to the knowledge lent to the assessment by each individual expert within his or her discipline (notably referring to scientific output originating in the Southern hemisphere or those requiring payment to access) and thus enables other experts to identify material related to their own field of enquiry.

In addition, for this assessment of the SOVs in Côte d'Ivoire IRD wanted to put in place a means of specific methodological support for experts via the use of novel information technology solutions.

### Multi-support-based bibliographical research

Thus at the outset we conducted a bibliographical search of a number of online scientific information portals (HAL, Web of science, etc.), as well as of IRD database HAL Horizon (65 000 references) using numerous keywords related to the subject in question and with the assistance of IRD scientific and technical information service (IST). At the same time, wherever possible, publications dealing with SOVs and distributed via platforms like ResearchGate were gathered, as were those listed or catalogued on the websites of Ivorian research laboratories.

In total, the effort of bibliographic collection on SOVs in Côte d'Ivoire enabled the referencing of around 630 documents on Zotero[9], which in itself constitutes a very complete and effective reference tool particularly for students, but also indispensible for experts. What is more, part of the creation of this bibliography involved the cataloguing of major reference works on botany, on plant species within specific geographic areas and more, as well as treatises and theses related to Ivorian biodiversity and to the sub-region which are not publicly listed or which are only available for consultation within the training- and research units (UFR) of local universities.

Additional revues, reports and studies were consulted, and to these added relevant African references found in both published and unpublished works, including official Ivorian publications dealing with traditional medicine as well as guidebooks and manuals by international organisations

[9] https://www.zotero.org/support/fr/quick_start_guide [last accessed in November 2020].

or nongovernmental organisations (NGOs) on biological diversity or other subjects, these referred to by the websites of national institutions, notably that of the Côte d'Ivoire national bank (BNCI) which enabled the referencing of chapters from written works or articles dating from after 1995 dealing with SOVs. This material constitutes simultaneously an index of articles on broad themes (such as the mangrove) which could contain information on vegetation at various times, and more focused articles, for example on the organisation of dispensaries in Côte d'Ivoire.

Also explored was the websites of international organisations, such as that of the World Bank, which enabled the identification of 14 contracts linked to Côte d'Ivoire. For its part, the World Health Organisation has an inventory of health centres in Côte d'Ivoire, which allows for the creation of a detailed picture of the country's medical infrastructure. Regarding patents filed in relation to plants, these can be consulted on the website of the African organisation of intellectual property (AOIP)[10].

**Complementary bibliographic tools**

The input provided by the documents consulted enables a better understanding of the specific medical uses of plant-based medicines, or also to identify the multiple uses of the plants in question.

Ultimately we were able to put together a significant documentary collection, both in-depth and extensive in content. Nevertheless, this body of thousands of documents would prove difficult to analyse within a realistic timeframe, in light of which, in order to assist our researchers in this regard, we have had recourse to an information extraction- and classification programme based on artificial intelligence (Cogito[11]), enabling the identification, comprehension and management of large amounts of complex data gleaned from the scientific literature.

In addition, in order fully to examine the corpus of documents and in particular to identify the potential for value-extraction from, and for exploitation of, plant-based substances, we employed the technique of data mining, which enables searches of the documentary database that was created to be done. In this way, with the assistance of IRD's scientific information service, we generated a database of keywords by subject fields analysed, or *clusters* (botanical, legal, economic, industrial, diseases and symptoms); in the same way we also categorised others thesauruses and works of reference, e.g. the Convention on the international trade in endangered species (CITES) with regard to at-risk species, the National Centre for Biotechnology Information (NCBI) and linked open terminology

[10] https://www.oapi.int/index.php/fr [consulted in March 2021].
[11] https://expertsystem.com/fr/products/text-analytics-software-cogito-discover/ [last accessed in November 2020].

resources (LOTERRE) in relation to biodiversity, living organisms and micro-organisms, the UNESCO list of marine organisms, reference works on tropical and West African taxonomy[12] and the society for forestry development (Sodefor) regarding forest-based species of particular interest.

As a result, researchers were able to conduct their research using the database by filtering their searches by keyword and thus to consult directly online the reference works referred to in various articles, with the keyword (or words) selected displayed according to textual use. Similarly, we could as easily create cross-references by searching, for example, for natural substances documented according to their established use in traditional healing while simultaneously splicing the found texts together with articles describing the workings of molecules (structuring, toxicity...) present in these same substances, as well as patents for products in which the same molecules play an active role.

In order to provide a response to questions having motivated the drafting of this assessment, our presentation will be set out in three main parts, dealing with knowledge and availability of plant-based resources (part I), with the legal framework related to SOVs (part II) and with techniques, practices and know-how relative to SOVs (part III) – which will naturally lead to a series of recommendation (part IV). The latter will be structured around four main themes: the environment and the conservation of biodiversity, multidisciplinary research and accredited training; sectors for application and deriving value from practices; finally, economic development.

[12] Senckenberg: *African Plants*; Cirad: *Fleurs d'Afrique*; Aluka: *African Plants Initiative*; National museum of natural history (MNHN): *Herbier national Burkina Faso*; University of Hamburg: *Orchidaceae en Afrique centrale*; JSTOR: *global plants*; Missouri botanical garden: *Tropicos*, etc.

# PART I

# KNOWLEDGE AND AVAILABILITY OF PLANT-BASED RESOURCES

Sommaire

Knowledge regarding the SOVs in Côte d'Ivoire derives both from traditional knowledge shared among the population and from scientific study. Numerous plants, wild as well as domesticated or large-scale agricultural in nature are used for their medicinal properties. These plants, as well as the knowledge associated with them, make up an important part of the heritage of the African continent.

First we will turn to scientific research done with regard to whole plants, their different parts (roots, stems, leaves, fruit), their active properties in order thereafter to define such use as can be made of these for treating illnesses, for rites and rituals, for the wellness sector, cosmetics and food additives.

Secondly, we will focus our attention on the diversity of ecosystems, on protected areas and on protective measures with regard to forests in Côte d'Ivoire (the derivation of value from plant-based substances from environments rich in biodiversity often highlighted as a means of encouraging their conservation).

# Chapter I
# Inventory
# of scientific knowledge

Knowledge of plant-based substances can be viewed in two "inversely oppositional" ways, corresponding to the first two parts of this chapter: from the point of view of the plants themselves, each sporting numerous uses, or from the point of view of desired use (medicinal, cosmetic, etc.), which relies on multiple SOVs. Thus, the first part will look at some emblematic examples of multipurpose plants derived from both large-scale- and subsistence agriculture. The second part of the chapter examines different sectors deriving their operational resources from a multitude of plants: the medical sector, the intangible heritage sector, and the cosmetics- and well-being sector. Finally, the last part is cross-cutting in relation to the first two, since it concentrates on the identification of plants, as well as their related representation (notably with regard to use) by the country's different ethnic groups.

## 1. Plant use according to large-scale- or subsistence farming

One may distinguish between plant species derived from large-scale cultivation and those emerging from subsistence farming, both of which we will represent via two examples of SOVs. The selection of species was made based on numerical abundance and with regard to those the products of which are used in an artisanal or industrial context.

### 1.1. Large-scale produced plants: the cocoa tree and the cashew nut

The two plants chosen as representative of large-scale production are the cocoa tree and the cashew nut, of which the production rates are among

the highest in Côte d'Ivoire (fig. 1). They were also chosen because of the popularity of their cultivation, which serves as personal income generator, cocoa in the south of Côte d'Ivoire and cashew in the north. As it stands, the cocoa tree (*Theobroma cacao* L.) is mostly farmed by small-scale agriculturers on a combined surface area of more than two million hectares, annually producing 1.2 million tonnes of commercial cocoa. Over the last two decades national production has doubled, increasing from 700 000 tonnes in 1990 to 1 400 000 tonnes in 2005, before dropping back to around 1 200 000 tonnes.

Part of the Anacardiaceae family, the cashew plant (*Anacardium occidentale* L.), also known as the cashew apple tree, is a shrub farmed for its pulp-rich fruit, known as the cashew apple or cashew nut. Introduced to Côte d'Ivoire around 1957, the cashew tree was originally used primarily for the purposes of reforestation of the country's northern and central savannah regions. As of 1972, cashew nuts have been purchased from and exported to India. Following the disappearance of coffee tree orchards and cocoa trees from the country's dry inland forests, cashew plants have extended southward and occupied the space left by coffee and cocoa. Producers of cashew are currently organised into cooperatives, and the quantity of nuts exported has increased rapidly, totalling 400 000 tonnes in 2011 and reaching 761 000 tonnes in 2018 before decreasing slightly to 634 000 tonnes in 2019.

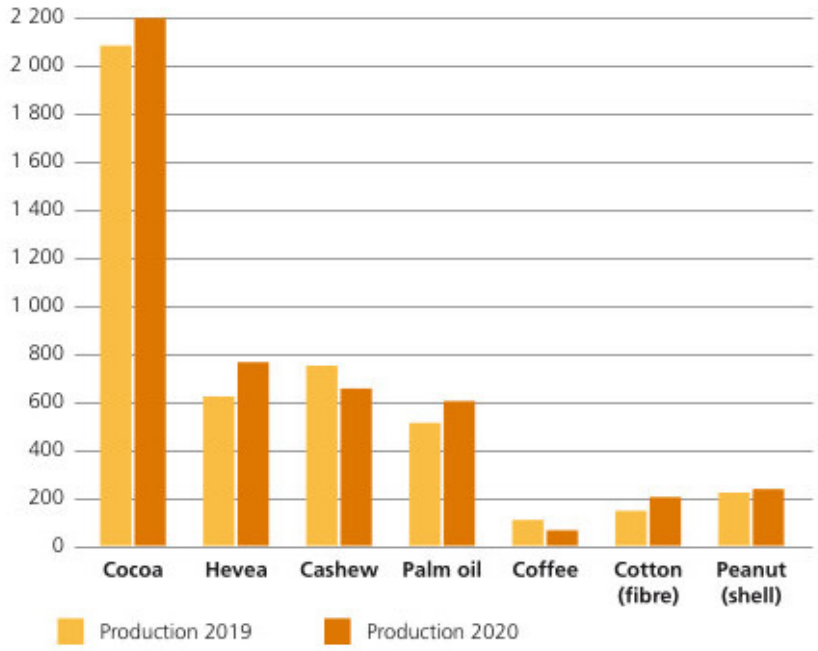


**Figure 1 : Volume of main large-scale farming crops production in Côte d'Ivoire in 2018 and 2019 (in millions of tonnes).**

**Source: Directorate of statistics, documentation and information (DSDI), Ministry of agriculture and sustainable development (Minader)**

The cocoa nut, produced by the cocoa tree (*Theobroma cacao* L. Sterculiaceae) was produced at a rate of 2 100 000 tonnes in 2018 and 2 200 000 tonnes in 2019 (fig. 1), mainly in the south of the country, i.e. a greater volume than produced in either Ghana or Nigeria (Anonymous, 2017). The uses related to the cocoa nut operate in the areas of nutrition, cosmetics and medicine. With regard to the latter, the different parts of the plant (leaves, fruit, flowers and the bark of the stem) enable the treatment of anxiety, fatigue, fever, cough, kidney stones, inflammations, cardiovascular diseases and infections (Dillinger *et al*., 2000). In Nigeria the seeds, roots and stems are used as stimulants, diuretics, analgesics and anti-inflammatories for toothache (Odugbemi *et al*., 2007). The bark of the stem is also used to improve memory (Elufioye *et al*., 2012).

The cultivation of cocoa trees has been practiced according to traditional methods in the country's southern forested area, using a system of rotating slash-and-burn farming. New farming techniques introduced and adopted some years ago have raised Côte d'Ivoire to rhe first rank of global cocoa producers and indeed, responsible for 40% of global production it is now the premier producer of cocoa in the world. About a quarter of the Ivorian population is directly or indirectly involved in its production, in almost 90% of cases in the form of small, family-based farming done on 2 to 4 ha.

As for the coffee sector, it has seen a notable decline over the course of the last few years. In 2002 Côte d'Ivoire was still producing 300 000 tonnes of coffee beans on a surface area of 1.3 million hectares, whereas in 2016 production reached only 130 000 tonnes on a little more than half that area. As a result of targeted investment production should increase again (to 400 000 tonnes in 2023), with an increase of 5.7% already recorded for the 2016-2017 season[13].

Regarding the cashew, since 2013 the sector has been managed by a cotton and cashew council, created by the government of Côte d'Ivoire in place of the cotton and cashew regulatory authority, to put in place and monitor a regulatory framework and an operational environment suitable for better management of the cotton- and cashew sectors. This political action has led to renewed interest, notably from enterprises and cooperatives.

[13] https://www.abh-ace.be/sites/default/files/studies/files/ivoorkust_landenstudie_fr_def.pdf

The production of cashew in Côte d'Ivoire represented 24.2% of global production in 2015, with the amount exported being 665 000 tonnes, i.e. 94% of production, notably to India, Vietnam and Brazil, countries sporting processing industries and manifesting a significant demand for cashew nuts. The remaining product is processed locally. In 2017, production stood at 711 236 tonnes of cashew nuts, close to the projected volume of 715 000 tonnes (Seters and Konnon, 2018).

The extension of cultivated land has enable Côte d'Ivoire, despite its low level of nut production (300 to 500 kg/ha) to rise to the premier rank of African cashew producing countries, and the second place globally (annual production in 2011: 400 000 tonnes) after India (730 000 tonnes in 2011).

The local processing of cashew products constitutes the weak link in the value chain related to investment in this sector, making for uncertain returns as a result of problems related to supply, financing and competition with export companies.

As it stands, very few processing plants for cashew products exist in Côte d'Ivoire, where processing on the ground involves little more than the shelling of cashew nuts. Activities related to the extraction of oil from the cashew kernel or value extraction from cashew byproducts all take place outside the country. This oil is highly prized in the agrofood milieu, as well as in cosmetics and in the pharmaceutical industry. In addition, oilcakes produced from processing are used as food for both humans and animals.

Other products derived from cashew (apple from the cashew apple or its nuts) are for alimentation purposes via the fabrication of fruit juice, pâté, jam, liqueur and pulp[14]. Due to local equipment provided for the processing of cashew apples by the Felix Houphouet-Boigny national polytechnic institute (INPHB), cooperative entities and women's groups have been able to produce products derived from cashew at a lower cost. On 1 October 2020 a new processing plant, the centre for cashew innovation and technologies (Cita) was inaugurated in Yamassoukrou.

## 1.2. Subsistence production: corn and cassava

The two plants selected to illustrate subsistence farming are corn and cassava. They make up part of the main subsistence farming production of Côte d'Ivoire, cassava in the south and centre of the country, and corn in the north. (fig. 2).

[14] https://www.agrici.net/actualites/cote-d-ivoire-la-pomme-d-anacarde-opportunite-alimentaire-et-d-optimisation-de-la-chaine-de-valeur.html
https://firca.ci/fciad/equipe-soro-doudjo-valorisation-de-la-pomme-de-cajou-en-bioproduits-jus-vin-vinaigre-et-biscuits/

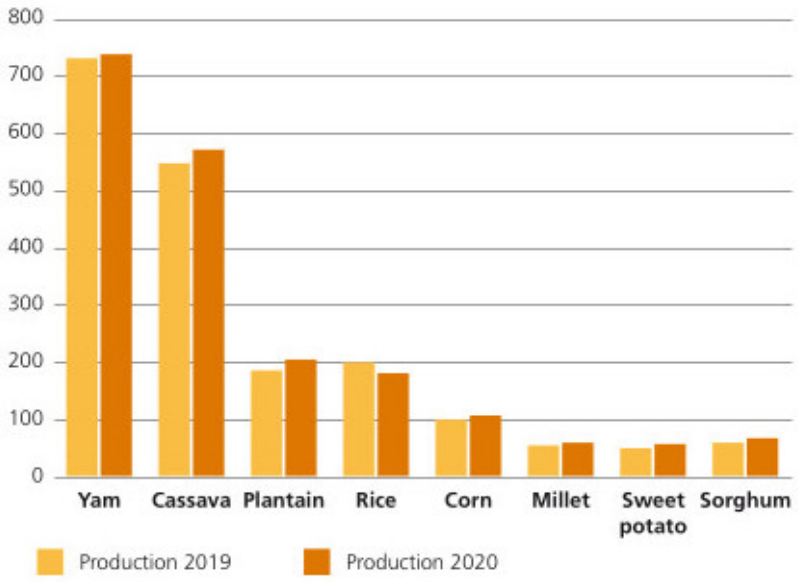



**Figure 2: Production rates of the main substence farming products in Côte d'Ivoire in 2018-2019 (in millions of tonnes).**

**Source: DSDI/Minader**

Produced at a rate of 640 000 tonnes in 2010 corn – or *Zea mays* (L) (Poaceae) – is used for food, medicine and cosmetics. In the north of Côte d'Ivoire, once having been made into flour, it serves in purée form as a confectionary called *tô*. It is also used in the creation of a millet beer called *tchapalo*. In flour form it also has other uses for both human and animal alimentation. A diuretic is derived from it (stigma), as is an excipient (starch). As medication it has been approved for selling as a treatment for benign hypertrophy of the prostate.

As for cassava, it is essentially known for the production of human alimentation, along with acheke (fermented cassava), and for cattle feed (box 2). The market is an important one, both in Côte d'Ivoire and in the countries of the sub-region, as well as in Europe. Improvement in production could be achieved via stabilisation of product quality and the extension of expiration dates[15].

The production of cassava as food requires wringing from which results a very great quantity of starch. Spilled near processing sites, it causes numerous unpleasant effects such as unsanitary conditions and the degradation of the environment, bad smells or the production of methane. These inconveniences explain the search for means of deriving benefit from

[15] http://agroforesterie.ci/manioc.php

waste products created in the course of acheke production. As such, the production of bio-ethanol constitutes a promising initiative for the sustainable management of waste[16] from cassava and could serve as carburant or for pharmaceutical use.

The potential of ethanol for the pharmaceutical industry is effectively enormous: as reaction agent, cleaning agent but also as solvent for the production of antibiotics, vaccines, etc.[17]. Other uses of starch are well known, such as for the production of industrial-strength glue or for the preservation of textiles.

**Box 2**

**The great diversity of cassava byproducts for use in industry and alimentation**

On a global level the market for cassava starch is primarily Asian. In 2016, 94% of cassava starch traded in the world found their way to Asian countries, notably China, Indonesia and Malaysia.

Cassava starch is obtained by the grinding or grating of fresh cassava tubers. The ground tubers are sifted and moist starch extracted via settling. The moist starch is then sun-dried before being sold. In Côte d'Ivoire, cassava starch is most often obtained from the processing of juice squeezed out during the production of acheke, garri (cassava flour) or plakali (cooked cassava dough). This starch is used for both manufacturing and food-related uses.

**Deriving manufacturing value from cassava starch**

Cassava starch possesses qualities enabling its use in the creation of manufactured products such as glue (hot-melt adhesives, stamps, bindings, envelopes, labels), paper (paper coating, disposable covers), components for combustibles (matchhead bindings), for construction (bindings for concrete blocks, plywood adhesives), for metals (sintered metal glue, binding for foundry cores) for the textile industry (material finishing, printing), for the cosmetics industry (make-up products, beauty creams), for pharmaceutical products (tablet coating, dispersants) for mining (metal flotation and concentration) or for other uses (biodegradable plastic wrap, dry cell batteries…).

The Agricultural research centre for international development

[16] TMI Report – évaluation des besoins en technologies et plans d'action technologiques aux fins d'adaptation aux changements climatiques – Côte d'Ivoire: http://tech-action.org/[last accessed, November 2020].

[17] https://www.alcool-bioethanol.net/alcool-traditionnel/cosmetologie-et-pharmacie/ [last accessed, November 2020].

(Cirad), in collaboration with the International centre for tropical agriculture has carried out a study of the physiochemical and functional properties of cassava starch which could lead to more useful applications in the manufacturing sector and open up new markets for this tropical product. The study revealed, along with other data, that gels derived from waxy cassava starch – i.e. starch lacking in amylose and derived from a mutated cassava genotype – is very clear and develop a maximal absorption wavelength when combined with a significantly reduced amount of iodine compared to normal cassava; yet at the same time it sports a noticeably greater viscosity.

Its unique functional properties and its lower production cost in comparison to its competitor products currently available on the market (such as potatoes and cereals) render waxy cassava starch a very promising manufacturing component. This new type of starch will certainly lend itself to applications in the field of natural (i.e. non-genetically- or chemically modified) starches, primarily with regard to products the manufacture of which requires gels of high viscosity and clarity, as well as for frozen or refrigerated food products.

**A multitude of cassava-based food products**

Apart from the manufacturing uses of its starch, cassava is also one of the most widespread food products. Acheke is the main foodstuff derived from the processing of cassava in Côte d'Ivoire, with fresh cassava stripped of its leaves, washed and then ground up, followed by a stage of fermentation of the crushed cassava and then a stage of pressing in order to extract remaining water. The fermented dough that remains is then grained, winnowed and dried. Finally the semolina recovered from this process is steam-cooked. Acheke is a product that has to be consumed fresh, as it only remains edible for a few days.

Apart from acheke one also finds garri, which is the dried semolina of fermented cassava. The stages of processing required to turn fresh cassava into garri are very similar to those related to acheke, differing only insofar as concerns the cooking stage, which for garri is done dry. For consumption garri has to be rehydrated, and can be preserved for several weeks.

Another cassava-based food product is plakali, i.e. fermented cassava dough obtained by fermenting fresh, ground cassava and then pressing it in order to extract excess water. The following stages are similar to the initial steps in the processing of fresh cassava into acheke or garri, though plakali only keeps for a few days. Ivorian women also make fermented dough from cassava similar to plakali, which serves as intermediary stage toward the production of acheke. This fermented dough

is also produced for exporting to neighbouring countries (Mali, Burkina Faso) where it is made into acheke.

Tapioca is yet another cassava-based food product, obtained by the rolling to seed and drying of moist starch while, finally, cassava is also made into flour: fresh cassava is cut up into thin strips (known as "cosettes" in French). These are then dried and kneaded into cassava flour. They can also be fermented before drying and processing into flour, producing a product that is greatly sought-after in a number of central African countries (Democratic Republic of Congo, Rwanda, Burundi), there used to make cassava dough.

**Côte d'Ivoire and the starch trade**

Côte d'Ivoire exports between 8 000 and 10 000 tonnes of acheke, plakali and other cassava starch products per year to Mail and Burkina Faso. The second most prolific exporter of these products – in processed form – is Nigeria with 2 000 to 3 000 tonnes per year exported to Niger.

Other types of starch are also used, such as that derived from corn, and of which importation to Côte d'Ivoire has seen a significant increase over the last few years, estimated at between 2 000 and 4 700 tonnes per year for the period 2004-2013 and reaching 7000 tonnes in 2016[18]. This increase in importation is primarily linked to the competitive pricing offered by Turkey which, along with the Netherlands, Spain and Italy, constitute the main exporters to Côte d'Ivoire.

A shared problem encountered by plant cultivation on both a large scale and at a subsistence level is competition for the occupation of arable land between crop- and livestock farmers. Notably faced with the challenge posed by global warming the cultivation of grazing plants for animal feed, and especially for cattle, raises the question of priority of use.

## 2. Knowledge of the uses of SOVs

Areas to be examined for the utilisation of SOVs are firstly and principally human and animal health, then cosmetics, well-being and food additives.

[18] Étude sur la filière amidon de manioc en Côte d'Ivoire, p. 12: https://www.nitidae.org/fr/search?q=%C3%A9tude+sur+la+fili%C3%A8re+amidon+en+C%C3%B4te+d%27Ivoire

## 2.1. Usage and knowledge in the medical sector

In Côte d'Ivoire, Ivorian researchers have identified close to 1 500 plant species used in the fabrication of traditional medicines (Neuwinger 1996; Ministry of the environment, 1999), i.e. close to 40% of the flora comprising vascular plants (Aké Assi, 2001; 2002). This number is almost certainly an under-estimation, since ethnobotanical investigations continue in some areas not yet inventoried. The World health organisation considers as medicinal in nature "plants, vegetable matter, plant-based preparations and end products containing parts of plants, other vegetable matter or plant-associated matter as active element", a definition quite similar to that adopted by the French public health authorities. The catalogue of the French pharmacological stock (11th ed. 2016) currently defines as medicinal plant a "vegetable-based drug, in the sense used in the European pharmacological stock, of which at least one part contains medicinal properties" capable of preventing or treating diseases such as, among others, malaria, haemorrhoids, rheumatism, dermatitis, febricity, impotence, hypertension, diabetes, urinary- and bacterial infections, cancer, tooth decay, sinusitis, psychological problems, etc. A "vegetable-based drug" is, among other things, a plant or part of a plant used in its vegetable state, either – and most commonly – in dried form, or fresh[19].

### *2.1.1. Some examples of medicinal plants*

We will be looking at three plants representative of medical utilisation: Cola nitida (Vent.) Schott & Endl., *Hibiscus sabdariffa* L. and *Desmodium adscendens* (Sw.) D. C.

*Cola nitida* is used in many sectors, especially in pharmacology, dyeing, cosmetology and agro-alimentation (fizzy drinks, toners, wines, liqueurs, etc.)[20]. Numerous Ivorian families are able to subsist due to its production. Currently Côte d'Ivoire is its primary global producer, with 260 000 tonnes produced in 2016, of which 200 000 tonnes were exported. 20% of exports went to North Africa (Tunisia, Morocco, Algeria), Europe, the US and Asia, while the rest is imported by Nigeria and the countries of the East African economic community (official online portal of the government of Côte d'Ivoire [POGCI], 2019).

With more than 2 000 Ivorian producers, the field is marked by significant interest and operates on plantations which can extend to as much

[19] https://cpcms.fr/guide-stage/knowledge-base/phytotherapie-et-aromatherapie/ [consulted in January 2021].
[20] http://www.gouv.ci/_actualite-article.php?d=6&recordID=9867&p=15. Consulted on 29/01/2020

as 10 hectares in size. However, despite the socioeconomic role played by this form of agriculture, both the production and commercialisation of *Cola nitada* is marked by difficulties which have led the Ivorian state to create a professional association of producers and exporters of cola in Côte d'Ivoire (Apprexco-CI) in order to modernise and develop the sector. This desire extends to the entire supply chain: production (optimisation of processes, creation of agricultural cooperatives), commercialisation (exploitation of new markets, notably Asian, coordination in the setting of purchase price), regulation, taxation and communication among actors in the field. In complementary fashion the state in September 2018 created an inter-professional agricultural organisation for cola (Oiacola) to help regulate structural problems in the sector.

*Hibiscus sabdariffa* is a plant used in the alimentary, medical and industrial sectors (Obouayeba *et al*., 2014). In East Africa (Côte d'Ivoire, Mali, Senegal...) the dried and boiled flowers enable the creation of a much-appreciated drink called "*bissap*". The flower petals also serve to prepare sauces. As far as the medical sector is concerned, the plant is rich in organic acids, phenolic acids, flavonoids, anthocyanins, trace elements and vitamins. The petals are used for treating hypertension. Finally, the presence of 3% of pectin in the petals allows them to be used in the preservative industry.

As for *Prunus africana* (Hook. f.) Kalkm. (Rosaceae), the production of *Desmodium adscendens* is regularly the object of a global shortage. This vine is used as a medicinal plant via the decoction or infusion of its fresh, dried or ground leaves. In particular it serves to treat liver diseases (having a hepatoprotective function) by reducing the concentration of transaminases in the blood. It further treats sprains and pains, bronchial asthma and allergies, (ovarian) inflammation, diarrhoea, fever and epilepsy (Magielse *et al*., 2013).

### *2.1.2. Traditional human medicine and animal health*

In Côte d'Ivoire knowledge derived from tradition is linked to a community's or a collective's systems of spiritual and religious belief. As such they bear a profound symbolic value characterising said community or collective, but also reflect values related to well-being and the country's development. Their use relates to a number of different activity fields, first and foremost being the medical sector. Illness is therefore considered as an imbalance between the constituent elements of a human being (Haxaire, 1994b): his body, his spirit or "souls" (diverse types according to the people in question). Treating illness thus consists of re-establishing the balance and the harmonious relationships with the supernatural entities. In Ivorian rural areas a significant part of the population use traditional plants for their primary health care needs, for reasons of custom and based on their

knowledge of the medicinal properties of specific plants on the one hand, and because of weak purchasing power relative to the elevated prices of modern medicine and the scarcity of healthcare centres on the other.

Traditional medicinal plants are studied within the context of chemistry, biology, pharmacology and therapy. Research done in Côte d'Ivoire and elsewhere aims at utilising the medical and economic potential of SOVs, but also to safeguard the species.

In the countries bordering Côte d'Ivoire (Burkina Faso, Mali, Senegal, Ghana) it is interesting to consider the implications of traditional medicine used for healthcare (box 3) and to compare the situation with that in Côte d'Ivoire.

**Box 3**

**Use of medicinal plants in countries bordering Côte d'Ivoire**

The geographic and floral proximity of Côte d'Ivoire to Burkina Faso, Mali, Senegal and Ghana leads to a comparison to these countries with regard to the utilisation of medicinal plants for the primary healthcare needs of the populations.

Close to 70% of the inhabitants of Burkina Faso use plants for self-medication (WHO, 2002) and consumes an average of 480g per person per year[21]. The figure for the utilisation of traditional medicine for primary care is the same in Ghana, and rises to close to 80% in Mali[22].

**Factors making for success**

This success can be explained by four primary factors: in the first place, the abundance of plant-based resources[23]. Thus in Burkina Faso close to 900 000 and 300 000 tonnes of medicinal plants are sold in Ouagadougou and in Bobo-Dioulasso respectively each year. In Ghana, more than 800 forest plants and many herbaceous plants are known as having medicinal

[21] World Bank-PROMETRA-Burkina: Médecine et Pharmacopée Traditionnelle: espoirs de la santé pour tous. L'hebdomadaire-Burkina Faso 27/6/2003:http://www.fasonet.bf/hebdo/actualite2/hebdo222/societebanquemondiale222.htm

[22] *Drissa Diallo. Etat de la recherche en médecine traditionnelle au Mali de 1960 à nos jours*;http://mail.cnom.sante.gov.ml/docs/pdf/Microsoft%20PowerPoint%20%20Pr%C3%A9sentation%20CNOP%20Cinquantenaire.pdf

[23] Rokia Sanogo. Développement, environnement et santé, Médecine traditionnelle et sauvegarde de biodiversité;https://www.sifee.org/static/uploaded/Files/ressources/actes-des-colloques/bamako/session-9/A_Sanogo.pdf

properties[24]. Treatments are prepared in Burkina Faso, Mali (Sanogo, 2006a) and Senegal for each patient immediately following procuring of the necessary resources. In the second place, recourse to healthcare via plants derives from limited financial resources on the part of patients, plant-based medication being both more easily accessible and cheaper. A third reason for this phenomenon is a lack of human capital operating in the field of modern medicine, making for an equivalent lack of accessibility to the modern healthcare infrastructure: in Burkina Faso there is only one doctor for more than 22 000 inhabitants and in Mali only one doctor for nearly every 21 000 inhabitants. In Ghana the rate is one doctor trained in conventional medicine for every 1 200 patients. Finally, the widespread use of SOVs for self-medication can be explained by a 4th cause: the high number of practitioners of traditional medicine. Thus in Mali and Burkina Faso one finds a traditional healer for only every 500 persons, with – in the latter case – more than 3 000 in total, affiliated with 30 associations (Zerbo *et al*., 2011). In Mali there are 100 times as many traditional practitioners as medical officers working in the field of modern medicine. Finally, Ghana boasts one traditional practitioner for every 400 patients.

**Recourse to traditional medicine in non-urban settings**

The concentration of practitioners of modern medicine in cities further explains the elevated proportion of traditional practitioners in rural settings: hence, in Senegal 70% of doctors and 80% of pharmacists and dentists operate in Dakar[25]. In the same country, despite the extensive use made of plants by the population, the view of traditional medicine among the ruling elites is not a favourable one due to a law prohibiting the practice since 1966 (No. 66-069 of 4 July); however, since 2017 a legislative process has been underway to legalise it.

An example of a centre for traditional care is the Keur Massar hospital in Senegal, which offers consultations in traditional medicine and a pharmacy which sells some forty types of medication prepared on the premises and made from plants grown in the hospital garden, in surrounding orchards or gathered from the field.

As for Ghana, since the 1990s it has served as an example of progress in strengthening the position of traditional medicines. Its practice however remains mostly informal, with many micro-entrepreneurs operating in the field, which poses some challenges for aligning the practice with political objectives.

[24] Technical centre for agricultural and rural cooperation, 2014**:**The CTA Youth Strategy Synthesis 2013-2017; https://cgspace.cgiar.org/handle/10568/60052

[25] « Statistiques Banque mondiale » [archive] 2016, consulted on *5 January 19,* https://fr.wikipedia.org/wiki/Sant%C3%A9_au_S%C3%A9n%C3%A9gal

Despite the recognition of their value, traditional medicines improved (TMI – see p. 51) could be better exploited via better orientation and programmation of scientific and technological research. Higher education- and research institutions could benefit from subscribing to the programme "The pharmacological stock and traditional African medicine" (PMTA) created in 1974 by the African and Malagasy council for higher education (Cames)[26]. This programme aims at supporting the development and exploitation of phytomedicines. It unites 19 African francophone countries of the sub-Saharan- and Indian Ocean region. Among its objectives are:

–integration of the TMIs into training programmes for healthcare personnel;

– the promotion of TMIs within healthcare structures (via workshops, colloquia or training seminars);

– financial and technical advancement of research towards the conception of new TMIs;

– finally, decoupling applied research into TMIs from their introduction onto the market.

Illnesses treated with TMIs and their associated therapeutic practices are numerous. For people the pharmacological stock is utilised to treat physical ailments, psychological disorders linked to psycho-social conflicts and those which can be attributed to causes external to the patient.

The symptomatic treatment of physical ailments27 (notably microbial and parasitical infections, illnesses of the digestive tract, malfunctions of the respiratory system, cancer, diabetes, hypertension, paediatric care and fractures) is done through self-medication or via the intervention of acquaintances or a healer. For example, *Adenia lobata* in traditional medicine serves for treating headaches, jaundice, otitis, malaria and infant asthma. *Disodium ascendes* is a galactagogue, antipyretic and aphrodisiac. *Glyphea brevis* for its part helps combat sore eyes and throat, but also sterility. *Palisota hirsuta* is used against gonorrhoea, adenitis, joint

[26] To date 17 colloquia have been organised and the proceedings published in the Cames "Revue Pharmacopée et Médecine Traditionnelles Africaines" online.

[27] Bouquet and Débray, 1974; Visser, 1975; Adjanohoun and Aké-Assi, 1979; von Maydell, 1983; Aké-Assi, 1984; Vangah-Manda, 1986; Chenu, 1987; Aké-Assi and Guinko, 1991; Lorougnon, 1993; Tra Bi, 1997; Weiss, 1997; Koné, 1998; Koné et al., 2002a, b; Aké et al., 2006; N'guessan et al., 2008; N'guessan et al., 2009; Kamanzi et al., 2010; Koné et al., 2012; Yao, 2012; Malan et al., 2015; Adou et al., 2016; Koulibaly et al., 2016; Lagou et al., 2016; Monyn et al., 2016; Ouattara et al., 2016; Kouassi et al., 2017; Sylla et al., 2019

pain, Guinea worm and it also possesses haemostatic and aphrodisiac properties. As for *Secamone afzelii*, it has long been used in traditional medicine for the treatment of pregnant women until after birth. The leaves of *Heterotis rotundifolia* are also commonly utilised in traditional medicine for purposes of first-aid.

Plants can also achieve a psychic rebalancing to treat psychological problems (marriage problems, infidelity…) (Yao, 2012; Tchéro, 2013).They also assist in combating health problems linked to God, to genies, to the ancestors, to totems or to sorcery (Yao, 2012; Tchéro, 2013) and thus aid against poisoning and the consequences of not respecting totems or possessions.

Treatments associated with addressing these disorders are either medical in nature (traditional prescriptions of plant-based, animal or mineral matter), or spiritual, or a combination of the two.

Regarding animal health, the therapeutic practices aim at treating and protecting livestock and poultry from digestive problems, eliminate external or internal parasites or cure gastro-intestinal maladies (Aké-Assi, 1992; Koné *et al*., 2008; Azokou *et al*., 2016). As for ailments considered as supernatural in origin (curses or evil spells) these can be addressed by consulting a diviner who determines the cause and heals the illness through sacrifices, offerings or potions. These practices can also have a preventative function.

### *2.1.3. State of the research and study programmes*

In the medical and pharmacological domain plants have been used empirically for their active qualities since time immemorial. The reorganisation of the higher education system and scientific research in Côte d'Ivoire has retained the creation of a branch for value-extraction from natural substances. Numerous research programmes have bearing on SOVs, among which the botany and phytotherapy section of the University of Nagui Abrogoua's natural sciences training and research unit, the biodiversity and bioproduction sections of the Swiss centre for scientific research (CSRS) and the "biomolecules" and "new molecules" programmes at the Côte d'Ivoire Pasteur institute (IPCI) (box 4).

Some initiatives in Côte d'Ivoire concentrate on exploratory approaches to research into SOVs, such as Ivorian research promotion week (Sepri), as well as the prizes awarded for research and innovation.

## Box 4

## The SOV programme at the Côte d'Ivoire Pasteur institute (IPCI)

Resistance to antibiotics is a major concern in the context of hospitalisation as well as within the community-at-large. The lack of new antibiotics and the growth of multiresistance pose the danger of an eventual increase in bacterial infections. As a result, seeking out new types of medication capable of addressing these risks has become a necessity and medicinal plants, widely used within the Ivorian context, could provide a primary therapeutic alternative.

### Bacterial resistance, a major medical concern

At the Côte d'Ivoire Pasteur institute a research initiative entitled "Natural substances and multiresistant bacteria" is devoted to the study of the effect of plant properties on micro-organism pathogen dynamics. The resistance exhibited by numerous bacterial species and the worrisome advance of multiresistance induced the WHO, in 2015, to sound the alarm and to begin encouraging the scientific community to direct their research efforts toward finding innovative solutions in this regard. The IPCI, relying on the Ivorian pharmacological stock – rich in medicinal plants and recipes for the creation of plant-based medications – launched this study programme with an eye to come up with possible treatments in the fight against multiresistant pathogen agents. The objective of this research initiative is to evaluate the antibacterial effects of water- and alcohol-based extracts from plants listed on the Ivorian pharmacological stock on multiresistant bacteria.

### The methodology of the IPCI programme

Plants used in the programme are selected based on common knowledge within a local family or as part of local tradition, via blind screening and without presupposing the effectiveness of the substance, although sharing a chemical element with another plant already known for having medicinal properties. In this way a series of 25 plants were targeted by the IPCI teams, working in collaboration with the Félix Houphouët-Boigny and Nangui Abrogoua universities. The plants were collected from different regions of Côte d'Ivoire and selected for their medicinal use in the country. All parts of the whole plant together, as well as its different parts separately (stem, roots, leaves, bark and fruit) are used, as well as various combinations of the same, in each case following drying and transformation into powered form. The plant extracts are prepared via steeping, decoction

or infusion in order to produce 70% ethanolic- or 90% hexane- or hydromethanolic solutions.

The therapeutic effects are evaluated through different methods in order to determine the bacteriostatic or bactericide effects of the plant extracts under examination. The phytochemical sorting of the plants, carried out via different methods as well – notably thin layer chromatography (TLC), colorimetry or high performance liquid chromatography (HPLC) combined with peak detection methods such as high resolution mass spectrometry – has enabled the identification of both the chemical groupings present in the plants as well as the active elements responsible for the effects observed. As for their structures, these are determined by magnetic nuclear resonance or by X-ray crystallography,

The extracts studied in relation to bacteria have revealed bactericide or bacteriostatic properties with wide-ranging minimal inhibitory concentrations (MIC). The determination of the phytochemical composition has also revealed the presence of phenols, flavonoids, tannins, saponins, sterols, terpenes and cardiotonic glyocides, alcaloids, sesquiterpene lactones, coumarins, free radical quinones and gallotannins.

The plants making up the Ivorian pharmacological stock are endowed with medicinal potential deserving of being highlighted via a systematic determination of their phytochemical composition and their therapeutic effects, leading to the production of traditional medicine improved that will be effective in combating multiresistance bacteria.

Institutions in Côte d'Ivoire conduct research on SOVs with foreign partners in Africa (Benin, South Africa, Kenya, Madagascar) and Europe (France, Switzerland and Great Britain) and in Russia (see electronic version, I, annexes 4 and 5).

Due to this research and to the development of analytical utensils and instruments, modern medicine is showing a growing interest in the exploitation of SOVs in order to integrate them into the formulae for creating medication. In terms of treating different ailments, the main therapeutic developmental approaches based on the actions effectuated by plants can be organised according to eight categories, of which we will describe such research as is underway, as well as known characteristics (see electronic version, IV, 4.2): SOVs acting respectively as antioxidants, as aphrodisiacs, as antibacterials, as anticancer substances, as anti-inflammatories, as antiparasitic agents, as anti-haemorrhoid substances and, finally, as antihypertensives.

### 2.1.3.1. ANTIOXIDANT SOVs[28]

One of the main plants sporting an antioxidant action is the cocoa plant already mentioned above as product of large-scale agriculture. This property is conferred on the plant by the presence of polyphenolic composites. Nevertheless, in Côte d'Ivoire the cocoa plant is only grown to produce chocolate and its medicinal properties are not extensively studied in the country.

The extraction of active substances from the cocoa plant is done according to an exact procedure following the drying and crushing of the plant's different sections. After a number of extraction and concentration operations the oxidant strength is measured using a UV spectrometer. Laboratory studies are currently underway to identify alkaloids, flavonoids, polyphenols, steroids, terpenes, tannins, sterols, saponines and leucoanthocyanins present in the extracts.

Other species display the same antioxidant properties, for example *Ficus elasticoides*, *F. lyrata*, *F. umbelleta*, *F. thonningii*, *F. mucuso*, *Xylopia quintasii*, *Sherbournia calycina* and *Myrianthus libericus*. The active substances are extracted from different parts of these plants (leaves and fruit). Research in this regard is still at an exploratory stage (TLC) (box 5).

**Box 5**

**Thin layer chromatography (TLC), a separation analysis- and/or preparatory technique applicable to SOVs**

TLC is a separation technique based mainly on two physical phenomena, namely adsorption (the clinging to a solid surface of molecules belonging to a solution or a substance in suspension) and capillarity (a phenomenon by which liquid is seemingly aspirated by contact with a solid substance) (Ministry of health and public hygiene, 2018). TLC sports a wide range of applications in various industries: pharmaceutical, agrofoods, cosmetics, phytochemical, etc. For example, in phytochemistry applying TLC enables the identification of the phytochemical composition of plant-based extracts due to the appearance of differently-coloured molecular impressions characteristic of each phytochemical family, brought to light by

[28] Main reference works on the antioxidant effects of SOVs: Ahoua *et al.*, 2012; Azizah *et al.*, 2007; Baguia-Broune *et al.*, 2018; Diomandé *et al.*, 2018; Ehouman *et al.*, 2015; Etekpo *et al.*, 2018 ; Konan *et al.*, 2016; Konan *et al.*, 2017; Moussa *et al.*, 2018; Yao *et al.*, 2014.

the application of chemical revealing agents and ultraviolet light at 254 or 365 nm (photo 1).

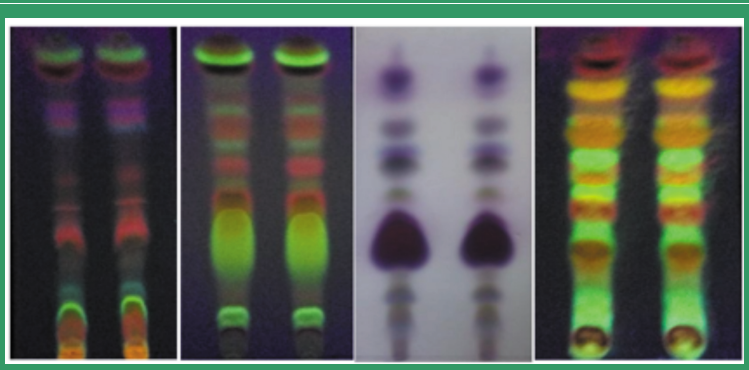


**Photo 1: Preliminary phytochemical composition of plant-based extracts brought to light by TLC.**

**Credits: Laboratory for bio-organic chemistry and natural substances (LCBOSN) of the University of Nangui Abroua in Abidjan.**

For adsorption, the mobile phase is a solvent or a mixture of solvents which travels along a rigid phase, called "stationary" (generally silicon or alumina gels) attached to a sheet of glass or plastic, or metal (generally aluminium) via a connector.

When the sample to be analysed, dissolved in a suitable solvent or a mixture of solvents, is placed on the baseline of the stationary phase (chromatoplate) – which is then inserted into a glass tank filled with pure solvent or a mixture of solvents (called "eluent" or "developing solvent") – capillarity enables the sample's constituent elements to separate slowly via migration, the speed depending on their chemical structure. Thus it is understandable that substances of low polarity, or non-polar substances, migrate faster than those with high polarity (called "polar").

The following species are used in traditional medicine for their antioxidant effect: *Psorospermum febrifugum* (Spach.), *Myrianthus arboreus* (P. Beauv.), *Rhynchosia buettneri* (Lour.), *Beilschmiedia mannii* (Meisn.) Benth. & Hook. f., *Solanum macrocarpum* (L.), *Ceratotheca sesamoides* (Endl.), *Cleo megynandra* (L.) and *Justicia galeopsis* (T. Anderson ex C. B. Clarke). Numerous articles and exchanges in the course of colloquia serve as output of the scientific research conducted concerning the antioxidant properties of SOVs. However, physiological, pharmacological and toxicological testing, as well as the conducting of clinical trials in relation to SOVs, has not been carried out in any systematic way.

### 2.1.3.2. SOVs ACTING AS APHRODISIACS[29]

Only one plant has been studied in directed manner in Côte d'Ivoire with regard to its properties serving to combat erectile dysfunction, namely *Palisota hirsuta* (Thunb.) K. Schum. (Commelinaceae). Its leaves are rinsed, dried and then crushed. Then the resulting powder is subjected to a process of extraction of its active properties via two specific techniques of steeping. Photochemical analyses are carried out via chromatographic scan. The research on the aphrodisiac effect of *Palisota hirsuta* is currently at the laboratory stage and is producing encouraging results. Pharmacological tests involving the sexual stimulation of male rats have proven positive. The potential for development based on this plant species offers very promising perspectives for economic exploitation.

### 2.1.3.3. SOVs ACTING AS ANTIBACTERIALS[30]

Many varieties of plant are known for their antibacterial properties: *Acacia polyacantha* (Hochst. ex A. Rich), *Alternantheria pungens* (Kunth), *Andira inermis* (W. Wright.) Kunth ex DC. (Fabaceae), *Asparagus africanus* (Lam), *Combretun molle* (R. Br. ex G. Don), *Cussonia aborea* (Hochst. ex A. Rich.), *Danielli oliveri* (Rolfe) Hutch., *Entada abyssinica* (Steud. ex A. Rich.) G. C. C. Gilbert & Boutique, *Erythrina senegalensis* (D. C.), *Erythrina vogelii* Hook. f. (Queiroz *et al*., 2002), *Garcinia afzelii* (Engl.), *Keetiahispida* Benth. Bridson, *Phyllanthus muellerianus* (Kuntze) Exell., *Piliostigma thonningii* (Hochst.), *Pseudarthria hookeri* (Wight & Arn. var. hooker), *Terminalia schimperiana* (Planch. ex Benth.), *Uapaca togoensis* Pax, *Waltheria lanceolata* (R. Br. ex Mast) and *Anogeissus leiocarpus* (D. C.) Guill. & Perr.They are used in traditional medicine in the north of Côte d'Ivoire, except Anogeissus leiocarpus.

Croton hirtus (L'Hér.) is known for its antibacterial benefits and as a muscle relaxant. Many other plants are used in traditional medicine to treat diverse illnesses, such as *Guiera senegalensis* (J. F. Gmel.) and *Pseudocedrela kotschyi* (Schweinf.) Harms.

To extract the active properties of a number of vegetable species (*Acacia polyacantha*, *Alternantheria pungens*, *Anidra inermis*, *Asparagus africanus*...) the fresh parts were dried, then crushed and the powder used in a suspension, or else a steeped concoction of extracts was created. Thereafter antibacterial tests were carried out and the phytochemical characterisation of the extracts done via TLC.

---

[29] Main reference works on the aphrodisiac effects of SOVs: Boua*et al*., 2008a, 2008b.
[30] Main reference works on the antibacterial effects of SOVs: Ahoua *et al*., 2015; Bolou *et al*., 2011; Guessan *et al*., 2018; Sanogo *et al*., 2016; Traoré *et al*., 2015.

In the case of *Thonningia sanguinea* (Vahl.) fresh flowers were dried and then crushed, after which the remaining powder was steeped. Tests of antibacterial effects have been carried out on isolated pathogen bacteria, but the phytochemical characterisation of the active qualities has not yet been effectuated. The phytochemical profiling of the active elements has led to the isolation of brevifolin carboxylic acid and gallic acid (N'guessan *et al*., 2007a). The liquid extraction of *Thonningia sanguinea* flowers has also produced an antibacterial effect on *Salmonella typhi*, suggesting potential future effectiveness in combating typhoid (N'guessan *et al*., 2007).

In the case of *Cassia sieberiana* and *Khaya grandifoliola* it is the roots and the bark of the stem respectively which are cut off, dried and then turned into powder to make a decoction. Antibacterial tests of the final residue are done in vitro but a phytochemical characterisation remains to be done.

For *Croton hirtus* the active substances in the oils are identified through gas chromatography combined with mass spectrometry (GC-MS). The antibacterial properties of Staphylococcus aureus ATCC 25923 and *Escherichia coli* ATCC 25922 have been established. The phytochemical screening of the extracts has not yet been carried out.

Research on the antibacterial properties of SOVs remain at a rudimentary stage, even though tests have been carried out on pathogen-resistant micro-organisms provided by specialist laboratories such as the Pasteur institute or by hospitals. At this stage only the scientific exploitation of research programmes has been initiated. The numerous research institutions which are working on this subject (see electronic annexed version: tabl 1 of Chap 4, 4.2.3).

#### 2.1.3.4. SOVs ACTING AS ANTICANCER AGENTS[31]

A number of vegetal species are examined for therapeutic effects related to the battle against cancer, notably *Ximenia Americana*, *Gmelina arborea* (Roxb.), *Ageratum conyzoïdes* (L.), *Anthocleista djalonensis* (A. Chev. H.), *Baphia nitida* (var. pubescens A. Chev.), *Combretum paniculatum* (Vent.), *Desmodium adscendens* (Sw.), *Mallotus oppositifolius* (Geiseler) Müll. Arg, *Monodora myristica* (Gaertn.) Dunal., *Nymphaea lotus* (var. parviflora Peter), *Piper guineense* (var. congolense De Wild. Ex C. DC.) and *Ximenia americana* (L).

The chemical profiling of *Ximenia americana* has not yet been undertaken, as opposed to that of *Solanum aethiopicum*. Thus, while some testing has been carried out on pathogen bacteria taken from afflicted

[31] Main reference works on the anti cancer effects of SOVs: Kabran *et al*., 2017; Kouassi *et al*., 2016.

patients, the research remains at a basic stage with regard to the anticancer effects of SOVs in Côte d'Ivoire. For now neither pharmacological application nor clinical testing is planned. The economic exploitation of these plants is not yet on the agenda.

#### 2.1.3.5. SOVs AS ANTI-INFLAMMATORY AGENTS[32]

Research on anti-inflammatory plants has focused on various species in Côte d'Ivoire: *Parkia biglobosa*, *Cassia sieberiana* and *Khaya grandifoliola*. *Parkia biglobosa* and *Cassia sieberiana*. The first two are common tree types, the first particularly in the north of Côte d'Ivoire, the second especially in the savannah zone and dry forests. In traditional medicine Cassia sieberiana is used in the treatment of numerous health problems (such as joint pains and toothache). Similarly, *Khaya grandifoliola* is a plant known for treating notably rheumatism.

Research on the anti-inflammatory effects of these three SOVs remains at a basic stage in Côte d'Ivoire and no clinical trials have been properly identified. These plant species have been studied by research institutions in France and Côte d'Ivoire, but the prospects for economic exploitation of the research remain to be realised.

#### 2.1.3.6. SOVs AS ANTI-PARASITIC AGENTS[33]

The selection of plants presented for their anti-parasitic effects depends on their prevalence as well as on the availability of information regarding them. The antiparasitic effects of numerous SOVs currently found in West Africa have been pointed out, notably *Anogeissus leiocarpus*, *Croton lobatus*, *Parinari excelsa*, *Zanthoxylum rubescens*, *Enantia polycarpa* and *Funtumia elastica*. *Anogeissus leiocarpus* is a plant known in Côte d'Ivoire for its anthelmintic effects. *Enantia polycarpa* is traditionally used for treating malaria: the raw extract of bark stem demonstrates a significant in vitro effect against *Plasmodium falciparum*. *Croton lobatus* is used for treating notably malaria. For the treatment of this disease, *Zanthoxylum rubescens* (bark of the trunk) and *Parinari excelsa* are widely used in Côte d'Ivoire as part of the practice of traditional medicine, the latter also serving as anthelmintic. As for the therapeutic range of *Enantia polycarpa*, it is quite broad, since this medicinal plant is widely used in Côte d'Ivoire for treating bacterial and fungal infections, various parasitic infections and leprosy. For its part, *Funtumia elastica* is used in the treatment of malaria and parasitic infections.

[32] Main reference works on the anti-inflammatory effects of SOVs: Kouadio *et al*., 2000; Traoré *et al*., 2014.
[33] Main reference works on the anti-parasitic effects of SOVs: Attioua *et al*., 2007, 2012; Soro *et al*., 2013; Kamanzi *et al*., 2004; Penali *et al*., 2007.

The roots, stem or leaves of *Anogeissus leiocarpus*, of *Croton lobatus*, of *Parinari excels* and *Funtumia elastica*, of *Zanthoxylum rubescens* and of *Enantia polycarpa* are dried and then turned into powder before undergoing different preparatory processes for extraction of their active elements.

Research regarding the antiparasitic effects of SOVs in Côte d'Ivoire has not yet reached the stage of clinical trials. It currently remains at an essentially basic stage, despite some pharmacological testing such as the in vivo tests done on nematode faecal eggs as well as on its adult form.

### 2.1.3.7. SOVs AS ANTI-HAEMORRHOID AGENTS[34]

The species Mezoneuron benthamianum, *Nauclea latifolia*, *Securidaca longepedunculata*, *Trichilia emetica*, *Margaritaria discoidea*, *Parkia biglobosa* and *Paullinia pinnata* are known in Côte d'Ivoire for their therapeutic value in treating haemorrhoid-related afflictions. Using powders extracted from the plant, phytochemical sampling is done via TLC on the extracts to determine their total complement of phenols, flavonoids and tannins.

*Anchomanes difformis* is also a plant of which its anti-haemorrhoidal effects have been explored via research. Very well known in traditional medicine in Côte d'Ivoire, it is also widely prescribed for treating constipation. With regard to this plant no clinical trials on patients are currently planned, although tests of pharmacological effectiveness have been carried out on the duodenum of rabbits. The scientific exploitation of the basic research holds great potential, but its current stage of advancement does not yet allow for the envisaging of any future economic development.

### 2.1.3.8. SOVs AS ANTI-HYPERTENSION AGENTS[35]

Numerous species are known in Côte d'Ivoire as useful in combating arterial hypertension, and these have been the subject of research. They are, among others, *Morinda lucida*, *Solanum aethiopicum*, *Solenostemon monostachyus*, *Trema guineensis*, *Sida acuta*, *Paullinia pinnata*, *Ocimum gratissimum*, *Blighia unijugata*, *Vernonia colorata*, *Alchornea cordifolia*, *Fagara macrophylla*, *Milicia excelsa* and *Musa paradisiaca*.

For *Morinda Iucida* and *Solanum aethiopicum* the phytochemical sampling of the extracts has been carried out by TLC and a pharmacological study has been done on male rabbits.

---

[34] Main reference works on the anti-haemorrhoid effects of SOVs: Ouattara *et al*., 2016.
[35] Main reference works on the anti-hypertensive effects of SOVs: N'Guessan *et al*., 2011a, 2011b; Boua *et al*., 2013.

For *Solenostemon monostachyus*, *Trema guineensis*, *Morinda lucida*, *Sida acuta*, *Paullinia pinnata*, *Ocimum gratissimum*, *Blighia unijugata*, *Vernonia colorata*, *Alchornea cordifolia* and *Zanthoxylum gillettii* (De Wild), TLC allowed for the profiling of the obtained extracts from a phytochemical point of view.

Other research concerns *Milicia excelsa* and *Musa paradisiacal*: phytochemical and pharmacological tests have been carried out on male rabbits, and also phytochemical sampling via TLC. Pharmacological studies on SOVs and animal testing are currently still rare however.

## 2.2. Importance of SOVs for the intangible Ivorian heritage

Apart from the scientific knowledge related to SOVs, traditional knowledge and their associated rituals make up an important part of the intangible Ivorian heritage: the yam festival, Dipri, initiation rituals of the Poro and the Tchologi, *Komians* (totemic priests), etc. Therefore, we will now explore those rites in which plants play a central role, whether with regard to medical care, cosmetics and hygiene, or traditional practices.

### *2.2.1. Representations and rituals linked to medical applications*

SOVs are used to treat and prevent illnesses, but also to protect and in the practice of exorcism (Haxaire, 1985, 1994c). For example, among the Wé (located in the west of Côte d'Ivoire), SOVs enable the re-establishment of balance disrupted as a result of illnesses or unacceptable behaviour (Hubens and Tchamba, 2011).

Re-establishing balance disrupted by one's actions or by sorcery can also involve battling against certain religious or magical practices employed by particular individuals in order to make one sick. These practices explain the existence of protective family- or individual rituals used to combat evil spells of malevolent actions carried out by sorcerers. As Ivorian examples of plants used as part of these protective practices, one may note the stem of *Ocimum gratissimum* L. (steeped as a means of revealing people having evil intentions), a foot of *Jatropha gossypiifolia* L. (to plant on one's property to protect against lightning, particularly lightning of non-natural origin) or a few drops of the sap of *Entada rheedei* Spreeng (added to the bathwater of children in order to protect them) (Malan, 2009).

Plants therefore operate on two complementary diagnostic levels, simultaneously to treat health problems directly (infection, lesions, bodily dysfunction, etc.) and to alleviate punishment inflicted by invisible beings. As a result, traditional practitioners (healers, diviners) may prescribe a

plant-based treatment as well as, in parallel, offerings or sacrifices in order to re-establish a harmonious wholeness.

Throughout the country traditional Ivorian practitioners adhere to very similar cultural protocols in order to collect medicinal plants, which are also very similar to that of neighbouring countries (Burkina Faso and Mali). Every plant is considered as a genie imbued with the power of healing or with maleficent power.

It is for this reason that the practitioner pronounces incantations (a salutation, a request for permission before harvesting) when the plant is picked or even when the remedy is prepared. For example, in the Cascades region of Burkina Faso the healer asks forgiveness before harvesting and explains his motivations in order to ensure the effectiveness of the remedy (Sanogo, 2014). In order to establish communication with genies, spirits or ancestors, and in order to propitiate them, practitioners may also make libation offerings (water, millet beer, palm wine – or *bandji* – etc.), all while saying the relevant words. In some cases they are not allowed to speak to anyone else before having finished the harvesting. They may also remove their shoes or clothes before picking the plants. Sometimes the harvesting is done before sunrise or after sunset, or facing in the direction of the rising or setting sun.

### *2.2.2. Rituals related to cosmetics and hygiene*

Plant species used in the fabrication of cosmetics, such as soaps, are often protected. Some peoples (Tagbana, Djimini) also have rituals to ensure the production of traditional soap: thus men and pregnant women alike are prohibited from entering the area of production; similarly the soap maker is obliged to ensure that his shadow never falls on the pot in which the substance is prepared (Ouattara *et al*., 2017).

### *2.2.3. Traditional rites and practices*

Some rites require a precise knowledge of the species of SOV employed as part of their performance, as well as of the plants' specific properties.

Thus as part of the Gopô (a public ceremony in which criminal conduct is confessed to, practiced by the Bëté), the accused have to imbibe a liquid containing a substance lethal to those predetermined to be guilty, but harmless to those presumed innocent. In a similar way, among the Akan, as part of ceremonies carried out in order to identify those guilty of murder via supernatural means, a group of people are selected as bearers of the coffin of "accusation". An SOV supposedly conducive to communication with the spirits is usually served to these individuals before the start of the ceremony.

### *2.2.4. Uses and knowledge in other sectors*

While the medical sector focuses a great amount of knowledge on plants, other sectors have also been identified as fields for exploration within the context of the assessment: cosmetics, well-being and food additives will be the subjects of our attention in this regard. It is estimated that more than 800 plants are used for purposes other than medicine.

While numerous plants have cosmetic benefits (Mamyrbékova-Békro *et al*., 2009; Katou *et al*., 2017), we will here present three examples: shea (*Vitellaria paradoxa*), *Myianthus arboreus* and *Afzelia africana*.

As far as the production of cosmetic products is concerned, the two indispensible ingredients are fatty tissue and potash. The most-used plants for fatty tissue are *Carapa procera* (condou) and *Vitellaria paradoxa* (shea); for potash they are *Ceiba pentandra* (Kapok tree), *Cussonia arborea* (Ouattara *et al*., 2017).

Shea fruit comes from a wild tree growing in the forested savannahs of West Africa. Every tree produces on average 25 kg per year. Shea butter, which is extracted from it, possesses numerous uses, particularly for agro-alimentation, crafts, bioenergies, cosmetics or as part of the pharmacological stock. As cosmetic this product is highly prized by women, which has earned it the nickname "women's gold".

Produced in the north of the country, shea is the third most exported product of Côte d'Ivoire after cotton and cashew. It is estimated that 20 000 women are involved in the exploitation of a total production estimated at 400 000 tonnes in the country, i.e. around 1/12th of the estimated global demand (5 000 000 tonnes). Ivorian shea production is structured and has recently been awarded a certification as "organic", thus opening up the possibility of exportation to the United States and Europe[36].

Fatty tissue for cosmetics can also be obtained from *Myrianthus arboreus*. The seeds of this tropical tree are cleaned, peeled and the almonds then steamed and turned into powder. Different manipulations enable one to obtain a fatty tissue of which the physical and chemical characteristics have been determined.

*Afzelia Africana* also serves to produce fatty vegetable tissue. This tree, spread across West Africa, is used as thickener, but also in woodworking for its highly-prized wood and in naval construction.

[36] https://firca.ci/wp-content/uploads/2019/02/Fili%C3%A8re-Karit%C3%A9.pdf http://www.agriculture.gouv.ci/uploads/SIA_2019_- [consulted in November 2020]. La_certification_du_karit%C3%A9_ouvre_la_porte_%C3%A0_l%E2%80%99exportation _du_produit.pdf [consulted in November 2020].

The technique for extracting fatty tissue from seeds is known – the seeds are dried and crushed and the resulting powder mixed with waterless sodium sulphate serving as desiccating agent.

The phytochemical profiling of the fatty acids of *A. Africana* is documented via gas chromatography combined with mass spectrometry, though the lipidic matrix composition of the Ivorian species has not yet been done. For this species only basic research is currently underway.

Studies done on *A. africana* and *M. Arobreus* in relation to cosmetic use are carried out by two Ivorian universities (electronic annexed version: Chap 4, 4.3.3).

In the field of well-being, a number of SOV species are well known, but the primary one remains *Lippia multiflora*. This herbaceous, perennial and odoriferous plant grows wild in the Sudanese savannahs of West and East Africa. In Côte d'Ivoire it is found in the centre of the country's north. Currently it is primarily a product gathered in the wild. In economic terms its potential is significant provided this plant is domesticated in order to transform it into a product for exportation from Côte d'Ivoire.

Other plants are also used in the wellness sector: *Ocimum canum*, *Afraegle Paniculata*, *Ocimum gratissimum*, *Monodora myristica*, *Melanthera scandens*.

Another plant is *Melanthera scandens*, a herbaceous plant abundant in swampy zones and particularly on the sides of the road. Its leaves are used to treat malaria, diabetes, but also to ensure the healthy growth of a fœtus. This plant further serves as treatment for diarrhoea, dysentery, and as laxative and antidote against poisoning. Skin infection, gastroenteritis, stomach ache, haemorrhoids and appendicitis are treated with leafy branches.

Research on essential oils (Soro *et al*., 2015; Tonzibo *et al*., 2008) remains at a basic stage and no clinical trials are planned as of yet.

Apart from some cultivated species most of the species presented here are found in a wild state in the Ivorian savannahs and forests. In order to obtain the most reliable results, it is increasingly recommended to make use of the most advanced techniques of phytochemical sampling. In all other cases one would refer to preliminary phytochemical sampling instead.

The significant amount of data obtained from research on the benefits of SOVs has but rarely led to pharmacological and clinical testing, which would constitute a preliminary stage towards possible commercialisation (see electronic version, IV, annex 2).

Finally, as representative of plants used as food additives, one may note *Thaumatococcus daniellii*. This plant, grown in Ghana, is utilised for the extraction of thaumatin, a powerful natural sweetener (E 957) and taste

intensifier. The extraction of the active element is done via selective ultrafiltration of the aril or else of the fruit pulp, which is then subjected to a number of operations. This type of food additive is greatly in demand as a result of the supposed health risks posed by artificial sweeteners. The global market is growing rapidly, with production growing from 138 million tonnes in 2012 to almost 170 million tonnes in 2017 and predicted to reach 250 million tonnes at the end of 2025[37].

## 3. Names and representations of SOVs

The characterisation of the active substances and associated techniques has now been briefly reviewed with regard to the therapeutic effects of the SOVs and the relevant sectors (see electronic version, I, annex 7) (Aké-Assi, 2011; Piba *et al*., 2015; Ministry of health and public hygiene, 2018).

While the scientific names of plant species tend to reflect an international consensus, local names are revealing in terms of their reflecting local knowledge. Thus, taking as example some of the plants already mentioned, *Secamone afzelii* is known in Côte d'Ivoire by the names "*donien*" (in the Baoulé dialect) and "*nonfon-egbelèni*" (in the Malinké dialect). The African forest tree *Funtumia elastic* is popularly called "*ireh*". As for *Myrianthus Arboreus*, it is known by the following names: "*tikriti*" (Bété), "*wougan*" (Abbaye), "*djin*" (Akyé), "*pissia*" (Dida) and "*Angama*" (Baoulé). Much utilised as infusion, *Lippia multiflora* is widely known as "savannah tea" or "Gambian tea". In general there has been a loss of knowledge regarding the etymology of the names of plants within all four ethnocultural zones of Côte d'Ivoire and the literature on this subject is limited (Ambé and Malaisse, 2000; Téré, 2007; Sidio and N'guessan, 2020). The attribution of a name is often related to an environment, employment, a morphological or organoleptic aspect or characteristic, effects on the body or resemblance to an animal (form, behaviour, socio-cultural concepts, etc.) (Sanogo, 2006).

Apart from the particularities of their names, plants are also identified by the symbolism that is often attached to them based on the form of one of their parts, their smell or one of their qualities (invasive plant…). Table 2 recalls the names of some vegetal species, the symbolism associated

[37] https://www.wiseguyreports.com/Sample-Request/3291877-global-thaumatin-Market-Research-Report-2018[consulted in November 2020].

with them and the ethnic group that uses them. These few examples illustrate the diversity of names given by the various ethnic groups.

| **Plant species** | **Local Name** | **Traditional Associations** | **Ethnic groups** | **References** |
|---|---|---|---|---|
| *Beilschmiedia mannii* | *Bitei*<br>*Blèriè*<br>*Bilihè* | Twisted or beaten: to obtain a sauce, the seeds are dried and turned into powder. This powder is then poured into warm water and beaten with a small, special broom. | Bété<br>Oubi<br>Guere | |
| *Combretum molle* | *Kahadjaba* | "Divider of the village": the wood of this plant is never to be used for preparing a meal | Senufo (Ferkessédougou) | Koné (1998) |
| *Chromolaena odorata* | *Zrégbéyi*<br>*Zaglohè* | "Which day did you arrive?", so named because of the rapidly-invasive nature of the plant following the clearing of a field | Bété (Gagnoa)<br>Guere | Sidio and N'guessan, 2021<br>Téré (1996) |
| *Combretum racemosum* | *Goubli youéda*<br>*N'lhôhou*<br>*Gopôtigué* | To assure the good health of mother and newborn<br>"Elephant spine": the huge thorns growing on the stem are even dangerous for elephants, or at least almost as large as them | Bété (Gagnoa)<br>Guere<br>Senufo (Ferkessédougou) | Sidio and N'guessan, 2021<br>Téré (1996)<br>Koné (1998) |

| | | | | |
|---|---|---|---|---|
| | | "Rooster plant", so named because its thorns resemble the mane of a rooster | | |
| *Irvingia gabonensis* | *Kplé-tou* | "Patience": much patience and care are required to extract the fruit almonds in order to prepare a sauce. Women spend an entire day working on it | Guere | |
| *Tetrapleura tetraptera* | *Kousèkèsèkè* | To ward off bad luck and terrifying spirits (the plant serves as a kind of incense which gives off a sharp odour when burned) | Bété (Gagnoa) | Sidio and N'guessan, 2021 |
| *Rhygiocarya racemiflora* | *Liglotiti* | For extreme cases | Bété (Gagnoa) | Sidio and N'guessan, 2021 |
| *Sida urens* | *Bôh gboudou* | "Disputed property" or "jealously guarded house", so named because this plant is jealously protected by elephants, which are very fond of it | Bété (Gagnoa) | Sidio and N'guessan, 2021 |
| *Acanthospermum hispidum* | *Sohon-ô Gbahè* | "Rooster's mane", named for the form and placement of the thorns on the stem | Guere | Téré, 1996 |
| *Ageratum conyzoides* | *Po'Nôn* | "Stinky" or "smelly", named for | Guere | Téré, 1996 |

| | | | | |
|---|---|---|---|---|
| | *Ploulou wouli titi* | the very repellent odour given off by the leaves and stem<br><br>"White-haired plant", named for the white-coloured flower heads resembling an old man's hair | Bété (Gagnoa) | Sidio and N'guessan, 2021 |
| *Cola nitida* | *Yé-tou* | Roadside tree (named for the pathways made as a result of the gathering of its pods) | Guere | Téré, 1996 |
| *Rauvolfia vomitoria* | *Pbinbolo* | "Upset stomach" | Lobi | Hoffmann, 1987 |
| *Tetrapleura tetraptera* | *Essé-essé*<br><br>*Blouhou-méhien* | "Cervical vertebra of the neck", so named because the fruit, a winged pod, resembles a cervical vertebra | Common name<br><br>Guere | Téré, 1996 |
| *Tinnea barteri* | *Bikibir gnokpona*<br><br>*Baar n gbembal* | "Calabash of stillborn children"<br><br>"Hare bell": the fruit resembles the bells carried by some dancers during traditional festivals | Lobi<br><br>Siamou | Hoffmann, 1987<br><br>Boyd *et al.* 2014 |
| *Vernonia nigritiana* | | "Poor man's soap"<br>A herbaceous plant of which the pounded bark foams like soap | Lobi | Hoffmann, 1987 |

**Table 2: Everyday plant names used in Côte d'Ivoire and their traditional associations for different ethnic groups.**

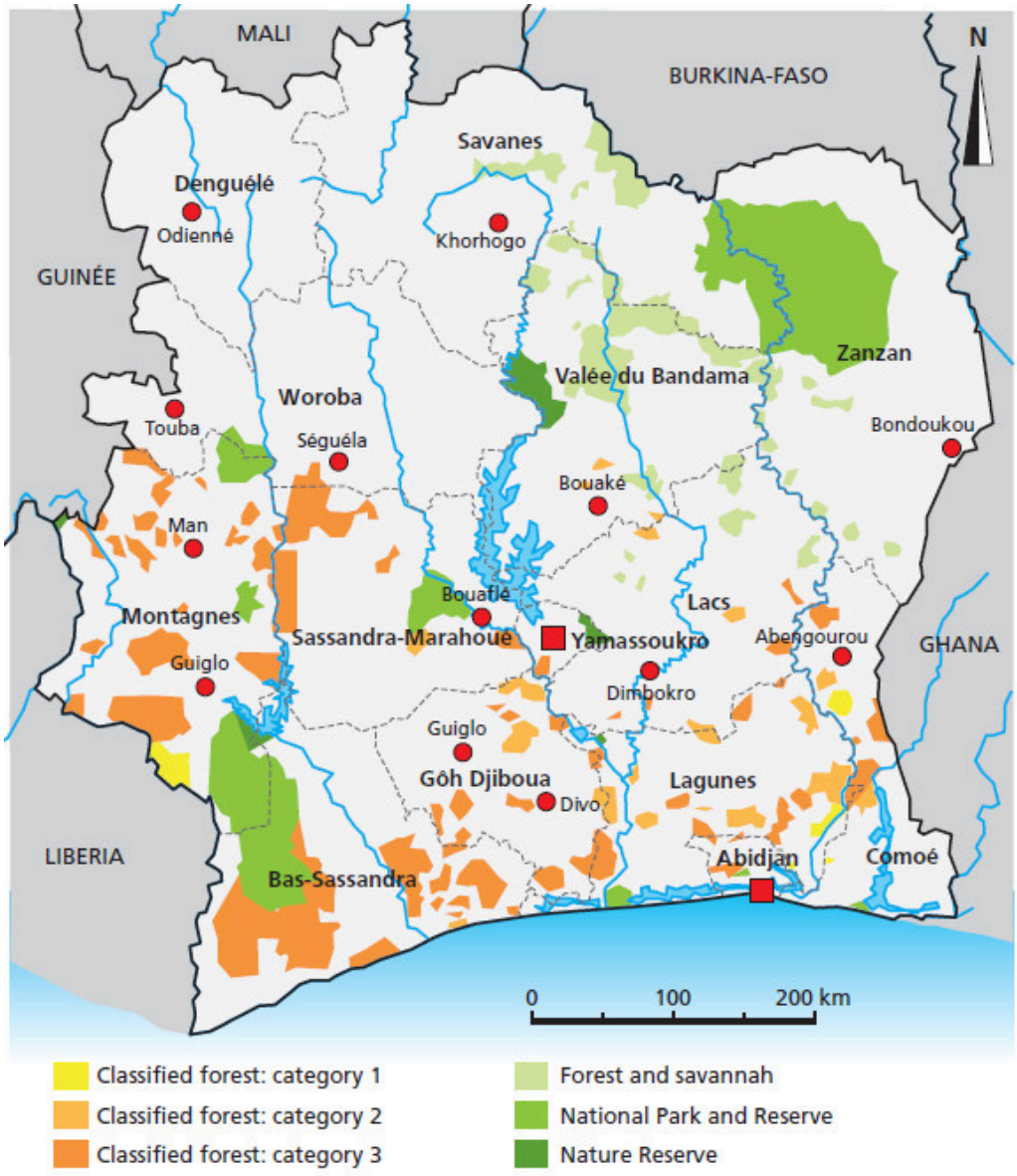
# Chapter II
# distribution and management of sovs across the country

The diversity of scientific and traditional knowledge regarding SOVs and their uses in Côte d'Ivoire reflects the diversity of the country's ecosystems. As it happens, the country is made up of plains and plateaux with some mountainous formations (in the west), granite and ferruginous masses (across the entire territory). To these geological particularities are added two significant climatic influences: the Sudanese and Guinean climates operating within a transitional zone between the humid equatorial and the dry tropical climates. The totality of these particularities results in a distribution of wild and cultivated plants across the different Ivorian regions, with forests in the south and west alternating with different types of savannah in the centre and in the north.

Sacred woods, forests and mountains serve as zones of conservation of wild plants as a result of the social role they play, and indeed these natural areas play different roles according to the geographic and cultural space concerned with regards to initiation and the familial, political and religious life of the members of the community. Serving as sanctuaries, they are used as spaces in which to honour traditional deities and genies, as well as the ancestors. Religious ceremonies are held here (yam festivals, festivals of generations…) and also the internment of important figures (kings, queens, traditional chieftains, high-ranking initiates). They are sometimes used to store masks (which play a role in Ivorian society that is simultaneously religious, political and social) and house certain sacred plant species. Finally, they sometimes serve as locations for traditional healing and also preserve vegetal diversity.

We will be looking at the distribution of parks and forests across the national territory (map 1), which will lead us to consideration of the management of these havens of biodiversity, simultaneously as natural ecosystems and in relation to precise ritual prescriptions put in place to regulate access to them. Violation of these rules, apart from such possible legal consequences as may result, can also lead to the imposition of curses or to calamities which can endanger the future or the transgressors themselves (Directorate-general for sustainable development, 2016).

Sommaire




**Map 1: Côte d'Ivoire protected zones.**

# 1. Distribution of Ivorian parks, reserves and forests

The Ivorian forest heritage is made up of classified forests, national parks and reserves covering around 6.4 million hectares divided into 70%

Sommaire

forested and forest-savannah areas and 30% savannah (Minefor, 2017). Ivorian forests cover half of the country's south, but since the 1970 have been subject to accelerated degradation. The country sports eight national parks covering a total surface area of 1 732 100 ha, six nature reserves covering 339 630 ha and 16 botanical reserves spanning a surface area of 198 418 ha devoted to *in situ* conservation (i.e. 6.5% of the entire area containing the Ivorian biodiversity), 234 classified forests covering a surface of 4 200 000 ha (i.e. 13% of the country's landmass), 6 702 sacred forests of 36 434 ha (Croix Verte, 1998) and six Ramsar sites[38].

The national parks are under state control, and serve exclusively for the propagation, protection, conservation and management of plant life: any destruction or gathering of plants here is prohibited. In the nature reserves, which are also under state control, any disturbance of the flora is also prohibited. In forests any gathering done in the name of the right-to-use has to be done in a manner that respects the principle of sustainable management, though this right does not apply to forests belonging to rural communities or to other privately-owned forest areas. In classified forests the right-to-use regarding SOVs is limited to edible or medicinal plants, and to plant roots and leaves alone. Côte d'Ivoire has more than 5 000 sacred forests according to a survey conducted by representative of the Croix Verte (an environmental protection organisation), covering a surface area of around 36 434 ha, i.e. 1% of the total Ivorian forest landscape. These forests are reserved for use for cultural practices by specific communities for which they serve as spaces of religious awe and veneration (serving as cemeteries, as initiation- and ritual ceremonial spaces and as "homes" for masks); access to them is regulated by the tribal authorities, as is their management.

## 1.1. National parks, classified forests and rural forested areas in the South

### *1.1.1. National park of the Ehotilé islands (*Parc national des îles Ehotilé*)*

The national park of the Ehotilé islands is situated in the southeast of the country. The park is made up of six islands and was classified as a national park in 1974. The sacred Bosson-Assoun Island is reserved exclusively for the rituals of the Ehotilé community. On its 550 hectares this park contains 8% of Ivorian flora, with a significant proportion of rare and indigenous plants, as well as those classified as rare or on their way to

[38] A Ramsar site indicates a humid zone of international significance listed on the stock established by the Ramsar convention (2 February 1971) by a signatory state.

extinction in Côte d'Ivoire. The Assokomonobaha (or Assoko), Balouaté, Méha, Nyamouan and Elouamin islands house 315 species divided into 241 genera and 83 families. Among these the Rubiaceae (33 species), the Fabaceae (19 species), the Annonaceae (17 species) and the Euphorbiaceae (12 species) are the most numerous. Among the 241 genera, the *Ficus* (eight species), the *Uvaria* (five species), the *Adenia* and the *Culcasia* (4 species each) are the most abundant (Malan *et al*., 2007).

### *1.1.2. Classified forest of Agbo (*Forêt classée d'Agbo*)*

Located in the Mé region, this forest occupies 15 575 hectares, within which the floral inventory has tabulated 686 plant species (428 genera and 101 families), of which the most numerous are Fabaceae (78 species), Rubiaceae (47 species), Malvaceae (35 species), Apocynaceae (35 species), and Euphorbiaceae (29 species). Among these plants are found six indigenous Ivorian species, 13 West African species and 42 species named on the red list of the IUCN (N'Guessan and N'Dja, 2018).

### *1.1.3. Classified forest of Besso (*Forêt classée de la Besso*)*

Situated in the Mé region, the dense forest of Besso covers 23 100 hectares. Inventories made of the forest's plants have categorised 474 vegetal species (330 genera and 91 families), among which are found in significant number Fabaceae (47 species), Rubiaceae (30 species), Apocynaceae and Euphorbiaceae (27 species each), Malvaceae (23 species), Meliaceae (16 species), Moraceae (13 species), Annonaceae (12 species), Sapindaceae and Poaceae (11 species each) (N'Dja *et al*., 2017).

### *1.1.4. Yapo-Abbé classified forest (*Forêt classée Yapo-Abbé*)*

Stretching across 24 592 hectares, this forest is divided into three zones (Yapo, Mambo and Abbé). A total of 690 vegetal species (390 genera and 101 families) have been recorded here, among which the Rubiaceae, the Fabaceae, the Apocynaceae, the Euphorbiaceae, the Malvaceae, the Annonaceae and the Sapindaceae are the most represented botanical families (Piba, 2016).

### *1.1.5. Taï national park (*Parc national de Taï*)*

Extending over a land surface of 457 261 hectares, this national park is one of the biggest in Côte d'Ivoire, after that of Comoé. Within its limits have been inventoried more than 1 231 species, of which 150 indigenous to the West African forested massif. In this park the focus is mainly on the preservation of the primary forest.

In the park's southern zone, comprising around 100 000 hectares, 908 species (550 genera and 116 families) have been classified. The most numerous families are the Rubiaceae, the Euphorbiaceae and the Caesalpiniaceae. In this sector is found 175 indigenous plants (11 indigenous to Côte d'Ivoire and 61 "Sassandra" species) (Adou Yao and N'Guessan, 2005).

### *1.1.6. Azagny national park (*Parc national d'Azagny*)*

This park extends across 21 850 hectares between the Grand-Lahou and Jacqueville departments. It consists mostly of marshy savannah populated by palm trees. 184 species (148 genera and 67 families) are found here. The Euphorbiaceae, the Apocynaceae, the Moraceae, the Fabaceae and the Olacaceae are the park's dominant families.

### *1.1.7. Banco national park (*Parc national du Banco*)*

This national park is situated in the heart of the city of Abidjan, covering a surface of 3 474 hectares. It contains 146 wood vegetal species (36 families and 111 genera) and represents a now-rare example of a primary forest with mahogany, framires, avodires and niangons. The Meliaceae (13 % of identified species); the Caesalpiniaceae (12 %); the Euphorbiaceae, the Moraceae and the Annonaceae (6 % each) represent the dominant families (Sangne *et al*., 2018).

## 1.2. National parks, classified forests and rural forested areas in the Centre

### *1.2.1. The Abokouamékro fauna reserve (*La réserve de faune d'Abokouamékro*)*

This reserve was founded in 1988 covering a surface area of 20 430 hectares. Surveys have identified 323 species (220 genera and 77 families). The Fabaceae, the Poaceae, the Rubiaceae, the Apocynaceae, the Caesalpiniaceae and the Euphorbiaceae represent the most numerous families. Among the species found in the reserve, Dicotyledonous constitute 80 %, with 257 species, followed by Monocotyledons with 13 % (40 species) and Pteridophytes with3 % (10 species). Finally, two species indigenous to Côte d'Ivoire have been identified (*Baphiabancoensis*, *Uvaria tortilis*) and five species indigenous to the West African forested zone: *Anthocleista nobilis*, *Amorphophallus accrensis*, *Eugenia leonensis*, *Tiliacora dinklagei*, *Triclisia patens* (Kouadio *et al*., 2013).

### *1.2.2. Protected areas of Kokumbo (*Aires protégées de Kokumbo*)*

In this area, inventories have been made of 317 vegetal species divided into 244 genera and 77 families. Among these species, 166 have been identified on cocoa plantations and 275 in residual forests. In the latter areas, the plants most frequently found are the following: *Trichilia prieureana* (Meliaceae), *Celtis mildbraedii* (Ulmaceae), *Baphia nitida* (Fabaceae) and *Nesogordonia papaverifera* (Sterculiaceae). As far as the plantations are concerned, their most visible plants are *Musa paradisiaca* (Musaceae), *Elaeis guineensis* (Arecaceae), *Musa sapientum* (Musaceae), *Persea americana* (Lauraceae) and *Cola nitida* (Malvaceae) (Kpangui *et al*., 2015).

### *1.2.3. Marahoué national park (*Le parc national de la Marahoué*)*

Stretching out over 101 000 hectares, this park houses a total of 607 vegetal species (402 genera and 95 families). Among the most abundant families are Fabaceae (49 species), Rubiaceae (48 species), Euphorbiaceae and Poaceae (28 species each), Caesalpiniaceae (24 species), Apocynaceae (21 species), Moraceae (20 species), Asteraceae (17 species), Annonaceae and Mimosaceae (16 species each), Hippocrateaceae and Sterculiaceae (14 species each), Verbenaceae (13 species), Sapindaceae (12 species) and Meliaceae (11 species) (N'Da*et al*., 2008).

Among the park's flora, Dicotyledonous represent 85, 3 % (518 species) and Monocotyledons 15 % (85 species), while Pteridophytes are represented by only four species (0, 7 %).

The most abundant species is *Chromolaena odorata* (Asteraceae, 33 species). Among the other species found here, some are classified as rare: *Garcinia afzelii* (Clusiaceae), *Bersama abyssinica* (Meliantaceae), *Psilanthus mannii* (Rubiaceae), *Robynsia glabrata* (Rubiaceae), *Euadenia eminens* (Capparidaceae) and *Aphania sengalensis* (Sapindaceae).

### *1.2.4. Téné classified forest (*La forêt classée de la Téné*)*

This forest houses a rich collection of 471 species (312 genera and 78 families) of flora. The most abundant varieties are Rubiaceae (30 species and 21 genera), Poaceae (25 species and 19 genera), Fabaceae (23 species and 14 genera), Euphorbiaceae (23 species and 17 genera), Sterculiaceae (19 species and 10 genera), Apocynaceae (18 species and 12 genera) and Caesalpiniaceae (13 species and 11 genera). Among the species most frequently encountered one finds: *Griffonia simplicifolia*, *Mansonia altissima*, *Motandra guineensis*, *Nesogordonia papaverifera*, *Sterculia*

*rhinopetala*, *Marantochloa leucantha* and *Trachyphrymium braunianum* (Kouassi*et al*., 2015).

### *1.2.5. Upper Sassandra classified forest* (La forêt classée du Haut-Sassandra*)*

This forest extends across 102 400 hectares and is directly watered by the Sassandra river and its tributaries. The floral inventory contains 322 vegetal species (239 genera and 77 families), among which the most abundant are Rubiaceae (19 species), Euphorbiaceae (16 species), Fabaceae (14 species), Apocynaceae and Poaceae (12 species each), Caesalpiniaceae and Sterculiaceae (11 species each), Annonaceae (10 species), Hippocrateaceae and Sapindaceae (eight species). The inventory contains two species indigenous to Côte d'Ivoire: *Baphia bancoensis Aubrév* and *Chrysophyllum taiense Aubrév & Pellegr* (Kouassi, 2014).

## 1.3. National parks, classified forests and rural forested areas in the North

### *1.3.1. The Korhogoregion (*La région du Korhogo*)*

This region, which extends across some 4 hectares, is dominated by savannah and SOVs have been identified here in the rural forest areas. It houses 423 species (197 genera and 67 families). The most numerous genera are the following: Ficus (nine species); Combretum (five species); Terminalia (four species); Bridelia, Cassia, Clerodendron and Crotalaria (three species each). Families with the greatest number of species are the Rubiaceae (22 species), the Fabaceae (19 species), the Poaceae and the Euphorbiaceae (14 species each), the Caesalpiniaceae (13 species), the Combretaceae (12 species) and finally the Moraceae (10 species) (Tiébré *et al*., 2016a).

### *1.3.2. The Ziémougoulalocality (*La localité de Ziémougoula*)*

Sparse forests and savannahs make up the vegetation of this locality. SOVs have been identified here in the rural forest area. Study of the flora has yielded an inventory of 426 species (290 genera and 83 families), among which six are endangered, to wit: *Afzelia africana*, *Khaya senegalensis*, *Guarea thompsonii*, *Vitellaria paradoxa*, *Pterocarpus santalinoides* and *Milicia excelsa*.

## 1.4. National parks, classified forests and rural forested areas in the East

### *1.4.1. Comoé national park (*Le parc national de la Comoé*)*

With a surface area of 1 149 450 hectares, this park is the largest protected space in the country. In total, an inventory has been made of 1 001 vegetal species (562 genera and 131 families), of which the most abundant are the Poaceae due to its being a savannah-based plant (N'Guessan, 2009). As for the forested area in the southeast, it favours a profusion of Rubiaceae (Makanga, 2011; Aké-Assi, 2002).

### *1.4.2. The transition zone between forest and savannah (*La zone de transition entre forêt et savane*)*

The transition zone between forest and savannah is situated in the department of Tanda. SOVs have been identified here in the rural forest area and research has indicated the presence of 186 species (124 genera and 37 families), of which the most numerous are the Meliaceae (22 % of individual plants) and the Moraceae (17 %).

### *1.4.3. The Bokassô sacred forest (*La forêt sacrée Bokassô*)*

The floral inventory made of this forest has revealed the presence of 188 vegetal species (154 genera and 64 families), of which the most abundant are the Rubiaceae (13 species), the Fabaceae and the Moraceae (12 species each) (Adou Yao *et al*., 2013).

## 1.5. National parks, classified forests and rural forested areas in the West

### *1.5.1. The transition zone between forest and savannah (*La zone de transition entre forêt et savane*)*

In this region, SOVs have been inventoried in the rural forest area. Censuses done in this zone confirm the presence of 349 vegetal species (256 genera and 76 families), of which the most numerous families are the Poaceae (29 species), the Fabaceae (27 species), the Rubiaceae (24 species) and the Euphorbiacae (18 species) (Tiébré *et al*., 2016b). As for the most represented genera, these are: *Ficus* (nine species), *Vernonia* (six species), *Combretum* and *Sida* (five species each), *Cissus*, *Cola*, *Pennisetum* and *Setaria* (four species each). According to the IUCN list, some species found in this zone are classified as endangered, notably: *Afzelia africana*, *Albizia*

*ferruginea*, *Khaya grandifoliola* and *Mitragyna ledermannii* (UICN, 2015). Other species are on the verge of extinction: *Hibiscus comoensis*, *Lannea nigritana*, *Milicia excelsa* and *Uvaria tortilis* (Aké-Assi, 1998).

### *1.5.2. The northwest Sudanese zone (*La zone soudanienne nord-ouest*)*

In this region, the plants have been inventoried in the rural forest area. The flora of the Ziémougoula region includes 426 species (290 genera and 83 families). Six of these plants are classified as rare and endangered species, to wit: *Afzelia africana*, *Khaya senegalensis*, *Guarea thompsonii*, *Vitellaria paradoxa*, *Pterocarpus santalinoides* and finally *Milicia excels* (Ouattara*et al*., 2006).

### *1.5.3. Mont Péko national park (*Le parc national du Mont Péko*)*

Occupying a surface area of 34 000 hectares, this park is particularly renowned for its vegetation (mountain flowers and primary forests). It contains a floral inventory of 384 species divided into 88 families. The most abundant families are the Fabaceae (12 % of species), the Rubiaceae (8 %), the Malvaceae (6 %) and the Moraceae (5 %). A number of plants are included in the list of species facing extinction, such as Maytenus undata (Celastraceae).

# 2. Management of plant-based resources

The sustainable management of SOVs derived from cultivated plants requires a solid understanding of the functioning of cultural- and agricultural systems. With regard to SOVs derived from the wild, it is the social- and ritual practices surrounding their acquisition which are determinative.

## 2.1. The role of agricultural systems in the production of SOVs, and threats

Numerous ecological studies show the positive connection between the biological diversity of species and ecosystemic operation (Frank and Naughton, 199; Loreau *et al*., 2001): primary productivity, soil fertility and sustainability (capacity for resilience of the system following an

environmental perturbation (Giller *et al*., 1997; Altieri, 1999; Swift *et al*., 2004). Thus, according to Hobbs and Morton (1999), the stability and sustainability of polyspecific systems could be optimised by products with beneficial effects as observed in nature due to biodiversity. As it happens, mixed agriculture can have a positive effect on certain cultivated plant characteristics and their productivity, which is usually higher than that of monospecific cultivation (given equal sowing intensity) (Muschler, 2001; Bulson *et al*., 1997; Gooding *et al*., 2007). Some ancient plants species play a more protective role with regard to biodiversity and soil conservation.

In agrosystems (Altieri, 1999), the functions expected from a plurispecific covering are significant (fig. 3):

– attenuation of the variability of the production of biomass and thus reduction of the risk of a failed harvest;

– maintenance or restoration of the water cycle (minimisation of run-off and moisture evaporation due to good soil cover via vegetation (Swift *et al*., 2004);

– recycling of nutrients (especially for agroforestry systems due to deep-rootedness (Noordwijk *et al*., 1996);

– improvement of the carbon-containing capacity of the soil (Vandermeer *et al*., 1998; Scopel *et al*., 2005);

– reduction of the risk of proliferation of weeds and plant diseases due to better plant health (Trenbath, 1993; Hauggaard-Nielsen *et al*., 2001; Gurr *et al*., 2003). In mixed cultivation, the utilisation of "decoy" crops to attract destructive insects or the disease-bearing agents they spread aim at reducing damage caused to the principle crop (Shelton and Badenes-Perez, 2006).

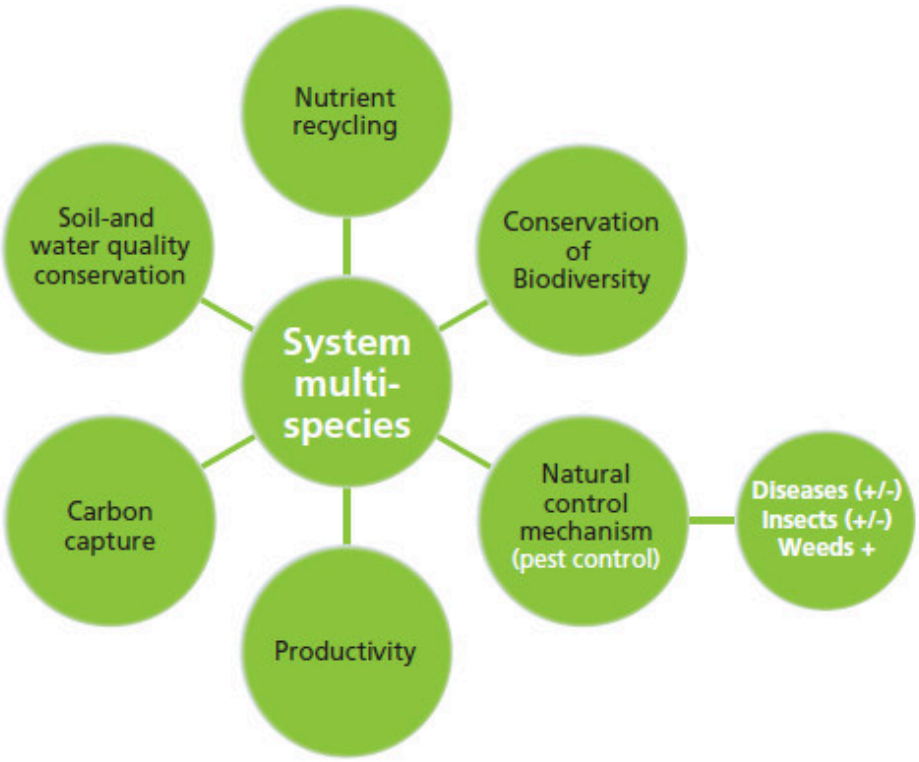



**Figure 3: Environmental functions served by plant-based species within a multi-species system.**

**Source: According to Maleyzieux *et al.* (2009)**

While sacred- or protected spaces do serve as protection for the diversity of plant resources, urbanisation – but also extensive agriculture, industrial production and industrialisation – constitute serious threats. The destruction of plant habitats by deforestation, overgrazing, brushfires and drought also reduce the abundance of many important species.

To this can be added the damaging effects of climate change, more and more visible in a number of areas and expected to increase in years to come. Over the course of the last 25 years, Côte d'Ivoire has lost a third of its forest biotope (World Bank, 2018).

Apart from this estimation made by the World Bank, the WHO has also demonstrated that climate change poses a significant new threat to public health as well. In this regard annual direct spending on health-related issues is estimated to reach 4 billion USD by 2030, rising in tandem with the increase in atmospheric pollution.

Depending on their availability, species are traditionally classified according to four categories (Malan, 2009):

– plants existing in abundance and easy to harvest;

– plants existing in abundance and difficult to harvest;

– rare plants;

– plants at risk.

This method of empirical classification aligns with scientific studies done on the abundance of SOVs and could serve as basis for a more in-depth quantification and better ecological management of plant habitats of species which are useful to human populations.

## 2.2. The role of sacred sites in the protection of SOVs

According to the directorate for sustainable development policies and strategies (Directorate-general for sustainable development, 2016), certain identified cultural practices could align well with the principles of sustainable development. These encompass three aspects, namely the environmental sphere, the social sphere and the economic sphere (table 3).

| **Practices** | **Region** | **Alignment with sustainable development** | | |
|---|---|---|---|---|
| | | **Environmental sphere** | **Social sphere** | **Economic sphere** |
| Sacred forests | All the regions of Côte d'Ivoire | Environmental conservation via protection of the forest canopy and of biodiversity | Protection of the cultural- and tourism heritage in relation to the rituals performed here<br><br>A temple used for training, for apprenticeship | Indirect impact on agricultural productivity via maintaining functioning of the microclimate (increasing rainfall)<br><br>Ecosystemic |

| | | | | |
|---|---|---|---|---|
| | | | , for initiation and for preserving socio-cultural knowledge | services |
| Idols (plant-based) | All the regions of Côte d'Ivoire | Protection and conservation of biodiversity | Contribution to social and psychological wellbeing, and to communal harmony | Not indicated |
| Sacred mountains | Some regions (the west, etc.) | Environmental conservation via biodiversity protection | Protection of the cultural- and tourism heritage in relation to the rituals carried out here (for obtaining political, social, military and religious power, etc.) | Direct impact on agricultural productivity via maintaining the microclimate (good rainfall) and thus increasing the income of the local populations |
| Fertility festival | In the south and particularly the east of Côte d'Ivoire | Thoughtful and ongoing management of natural resources (forests, etc.) | A space for the passing on of knowledge, know-how, life lessons, values and culture<br>A place for attaining social maturity | |
| Poro region | Senufo territory (Gur ethnocultural area in the north) | Conservation of patches of vegetation, protection of biodiversity, the role of | Cohesion among social groups | Tourist attraction, source of income |

| | | | | |
|---|---|---|---|---|
| | | regulating the local climate, teaching respect for nature, cultural practices respectful of the environment, plant-based healthcare, etc. | | |
| Letting land lie fallow | Entire Ivorian territory | Environmental conservation, sustainable management of biodiversity and natural resources, managing climate-induced risks | Maintaining cultural and social richness | Improving productivity associated with strengthening the viability of agricultural systems |
| Dipri festival | South of Côte d'Ivoire (Sikensi department) | Conservation of the sacred forest, environmental protection | Celebration of unity, solidarity and social cohesion | Tourist attraction |
| Yam festival | Man, Botro, Abengourou and surrounding villages, Brong kingdom, Doropo, Aboisso, Agboville, Sikensi, etc. | Protection of heritage and the environment (sacred forests) | Strengthening solidarity and social cohesion | Development of tourism and increasing the economic potential of implicated areas |

**Table 3: Alignment of different practices in Côte d'Ivoire with the principles of sustainable development.**

This governmental recognition is important since many traditional practices have been known to disappear due to social evolution. This fact renders studies of sacred woods, forests and mountains following a methodology adapted to their specificities all the more useful (Fournier and Sanou, 2013). These places of cultural significance and communication with supernatural entities, the ancestors, spirits and so forth express the spiritual values of a community. For example, one may note the sacred mountains located in the Man region, the sacred woods of the Poro and Tchologo regions, or the sacred forests of Zaipoply (Tai), Gbépleu (Man), Tabagne (Bondoukou), Waninou (Touba). The list of sacred forests (Ministry of environment, urban hygiene and sustainable development, 2016) does not include small sacred spaces, isolated copses or even sometimes a single sacred tree.

The sacred character of natural spaces indirectly constitutes a particular form of ecological management and protection or conservation of plant species (Huybens and Tchamba, 2011) due to the social cohesion it engenders. However, the protective role played by these sites should be viewed within a relative context, as they are often intruded upon by the inhabitants of neighbouring villages (Liberski-Bagnoud *et al*., 2010; Fournier, 2011).

Certain human activities are prohibited here (gathering of firewood, agricultural activity, picking plants, etc.), their practice punished by law, whereas ceremonies or initiatory rituals, funeral services, the gathering of vegetal matter for traditional healing are allowed.

The effects attributed to certain plants can play a role in the sustainable management of resources: for example, in the Ehotilé community trees are considered as indicator of the presence of honoured entities, guarantors of community well-being (Malan, 2009). Such is the case of, for example, the "spirit" tree (*Trichilia tessmannii*) among the Oubi, the Kapok tree (*Ceiba pentandra*), the baobab (*Adansonia digitata*) located in the North, or the iroko (*Milicia excelsa*) among the Baoulé. Globally religious beliefs are either attached to certain wood-based plant species represented by totems (connection between a species and a family, clan or tribe), or to certain individual plants, generally very large trees.

## 2.3. Prohibitions, traditional commandments and protection of plants

Religious beliefs inspire fear (of illness or bad fortune for the individual or the community) leading to the avoidance of certain species or

prohibition of their felling, thus to their indirect protection. In a number of regions penalties are inflicted in case of violation of the rules protecting plants put in place by the community, such as for shea, the néré plant or the baobab. Some tree species are prohibited from felling due to their medicinal powers or their use for religious purposes. Thus in Douagué there is a prohibition against cutting down the iroko (Huybens and Tchamba, 2011). Other species are allowed to be used for medicine but not as firewood for food preparation, such as *Combretum molle* (*kahadjaba*) found in the Senufo ethnocultural area, as this plant is reputed to cause conflict between those having eaten a meal cooked using its wood.

Apart from these prohibitions or commandments, some agroforestry uses allow for the preservation of species for the benefits derived from them: shade, support for other plants, medical care… Letting land lie fallow, practiced across the totality of the Ivorian territory, also allows for the maintenance and regulation of biodiversity richness (Serpantié, 2003).

A final benefit of SOV should be pointed out, viz. that of sacred days during which everyone is prohibited from going into the woods or engaging in agricultural activity. These days are called *mlantchin-Anaya* (Wednesday and Friday) in the Akan ethnocultural area (Directorate- general for sustainable development, 2016), *tchékpiè* among the Niarafolo in the Ferkessédougou region (personal communication), *soupè*, *zogbo* and *djinigo* among almost all the Koulango and the Abron. And just as there are prohibited days, there are also sacred days dedicated to harvesting (Koua *et al*., 2017).

In order for SOVs to hold any economic potential, both their availability and diversity are of utmost importance. However, the census of plant species useful for health has not yet been completed at this time. At the same time the accelerated destruction of the natural milieu reduces the possibility of discovering new species useful for phytotherapy. It would therefore be indispensible for the cataloguing of medicinal plants and ethnobotanical, ethnopharmacological and phytochemical research to continue and to intensify in Côte d'Ivoire, but also on the level of the African states and in conjunction with other international partners. Another important measure would be the cultivation of medicinal species in order to reduce their clearance from forests and ensure the preservation of the species (Akpagana and Boucher, 1995). Measures for protecting plants should be intensified toward sustainable development. They should integrate social and cultural uses made by local communities with the consent of the bearers of traditional knowledge.

# PART II

# OVERVIEW OF APPLICABLE REGULATIONS WITH REGARD TO HEALTHCARE CATEGORIES

Sommaire

The different sectors of exploitation encountered in the first chapter (medicine, cosmetics, well-being…) operate within a framework of in-depth legislation and regulation in different countries and institutions around the world, notably within the European Union and in China. For greater clarity, these will be examined hereafter according to the timeline of their taking effect. These legal aspects either have direct impact on SOVs or else will be presented because of having an indirect impact (e.g. environmental law relating to biodiversity conservation, intellectual property rights, or access to and sharing of derived benefits).

African states, and Côte d'Ivoirein particular, have not always officially recognised the non-religious uses of SOVs. Nevertheless, the growing interest in substances making up part of the traditional pharmacological stock is leading African states to integrate them into their systems of traditional healthcare, that is to say, to recognise their operation within a legal framework. The placing of products emerging from the traditional pharmacological stock on the market and the legal framework governing the operation of medication requires a detailed presentation and a comparison at different levels (African and global). Apart from the legal framework of the active elements enabling effective treatment of certain illnesses, the cosmetics-, food supplements- and additives sectors all operate according to specific legislation which will be examined one after another in the following section. Legal texts in Côte d"Ivoir follow a hierarchy mirroring those of its former colonising authority. Thus the Ivorian texts are similar to the type of hierarchy of norms such as those laid down by Hans Kelsen[39]. The regulations constituting the legal corpus relating to the pharmacological industry are contained in the texts of the national legal code, to which are added such community-based and international regulations as are applicable to Côte d'Ivoire. Regulatory texts contain both prescriptions specific to the production of pharmaceutical products and those of a general nature relating to medication. In addition, as businesses operating as part of the pharmaceutical industry also make up a branch of the general industrial landscape, regulations applicable to this sector apply to it as well. National and international legislation relating to resources (exploitation and management), conditions determining access and exploitation, rural land law and exploitation rights as well as the advancement of discussions between the European Union and Côte d'Ivoire – undertaken in 2013 as part of negotiations towards a voluntary partnership agreement on the application of forest-related regulations, management and trade in wood and wood-derived products (VPA-FLEGT) – are all elements to be taken into consideration. The aim is to combat the illegal exploitation of forests, with the various categories of classified forest and sacred forest

[39] Within the field of law, he is the father of the "pure theory of law". He is also the father of normativism and of the principal of a hierarchy of norms.

adding many additional rules and practices to be taken into account. Finally, environmental law represents a cross-cutting legal field affecting all these utilisation sectors of SOVs, and as such will be presented following the examination of the different sectoral legislative frameworks.

# Chapter I
# Legislation in the medical sector

Legislation operating in the medical sector governs the definition and the production of medication, as well as the activities of practitioners and doctors inCôte d'Ivoire.

## 1. Legislation surrounding medication

### 1.1. National legislation

In Côte d'Ivoire, the definition of medication inherited from the erstwhile colonial powers has evolved ever since the promulgation of law N°2015-533 of 20 July 2015, now classifying as such "all drugs, substances, composite substance or preparation represented as having curative or preventative properties with regard to human or animal ailments, as well as all products to be administered to human or animal with the aim of restoring, correcting or modifying their organic functioning" (article 3).Other products are also classified as medication, notably cosmetic and bodily hygiene products containing "poisonous substances" in doses or at concentration levels higher than those established as legal by the Ministry of health. Parts of plants or elements extracted from them acting as SOVs could be covered by this law.

The curative or preventative properties of SOVs vis-à-vis human or animal diseases are therefore what inscribe them in the category of medication. The same law (article 11) grants pharmacies the sole right of sale of medicinal plants belonging to a pharmacological stock recognised in Côte d'Ivoire or "listed on an official list of exceptions decided upon by decree of the ministerial cabinet and maintained by the ministry responsible for health" thus assuring that these products and the responsibility linked to their distribution can be duly tracked.

The approval of pharmaceutical products for human consumption depends on a formal authorisation granted by Côte d'Ivoire as well as on

compliance with regulation N°06/2010/CM/UEMOA, which governs a more extensive area of West Africa.

## 1.2. Classification of medication

The classification by the WHO of four categories of traditional medication, among them those derived from plants, seems useful insofar as it takes into account the cultural context within which these therapeutic approaches operate.

Category 1 groups together medication prepared as needed by the traditional practitioner according to traditional and standardised methods, and which have demonstrated their effectiveness and their safety for use after 20 years of employment. Their use is governed by regulations regarding the practice of traditional medicine and they do not require formal authorisation for introduction into the market. The SOVs prescribed by the practitioner can be fresh or dried and they are generally stored for only short periods of time.

Derived from popular employment, the medicines belonging to category 2 – commonly called "traditional medications improved" or TMI[40] (box 6) – are produced before being needed in an industrial or semi-industrial (thus standardised) manner, which ensures the stability of the product. They are furnished with a batch number. Like category 1 medication, the safety of their use is guaranteed by the length of time they have been in use. The commercial distribution of these medicines requires official authorisation and is done from pharmacies or herbalist practices.

TMIs are products which are more developed than those found in local traditional form, for example Attote to battle impotence or GP20 to treat sinusitis. A number of criteria must be met in order to earn recognition as a TMI[41]:

– a determined toxicity;

– confirmed pharmacological effectiveness;

– a confirmed quantitative analysis of the constituent elements;

– certified quality control.

[40] Sub-regional workshop on access to and sharing of benefits held in Abidjan from 24 to 28 October 2016, DJEKA Pharmaco and CNS-Sinusite.
[41] https://savoirs.cames.online/jspui/bitstream/20.500.12177/709/1/CS_05292.pdf [consulted in November 2020].

**Box 6**

**Traditional medications improved (TMI)**

"Traditional medications improved (TMA) are medications derived from the local traditional pharmaceutical stock with identified toxicity limits and pharmacological effects confirmed via scientific research, and with dosages properly quantified upon being introduced into the marketplace following quality control" (Mali, Ministry of health,MS/INRSP/DMT, 2004).

In order to promote the standardisation of traditional medications, the West African health organisation (OOAS) since 2013 has been developing a regulatory framework to operate on a West African level, to which each country in the region is expected to make input and to adopt. Thus, simultaneously, a fully aligned, standardised protocol governing traditional medications improved for all West African states was also conceived, based on a model proposed by the WHO.

The classification of traditional medications improved presented here was adopted at the first meeting of the WHO regional experts committee on traditional medicine held in Harare (Zimbabwe) in November 2001. It takes into account modes of preparation, therapeutic indicators and the degree of innovation applied to the medications in relation to methods applied in traditional medicine. It classifies traditional medications into four categories.

**Category 1 TMIs**

Medications belonging to category 1 are prepared by a traditional healer for a patient and exhibit the following characteristics:

– they are prepared on the spot;

– they are prepared using traditional, standard methods;

– they are prepared by the traditional healer for a specific patient;

– both their safety and their efficacy are guaranteed based on the experience of longtime use (more than 20 years);

– the raw materials used are well known to the traditional healer and can be fresh or dried;

– their period of preservation is relatively short.

**Category 2 TMIs**

Medications belonging to category 2 are derived from the common traditional pharmacological stock and have market-related applications. Ihey have the following characteristics:

– they are prepared in advance and packaged with a batch number;

– the raw materials used in their manufacture are very well known among the populace;

– their manufacture employs methods geared toward stability and standardisation;

– their production is done on a large- or semi-large (industrial) scale;

– their safety and efficacy are guaranteed by ethnomedical evidence arising from longstanding use, or by open clinical trials in cases where such are judged necessary by the governing authority;

– the active elements operating within them are derived directly from raw materials;

– the main chemical groups of their raw materials are known;

– their period of preservation is determined by stability testing.

**Category 3 TMIs**

Medications belonging to category 3 emerge from research institutes and manifest the following characteristics:

– they are prepared in advance and packaged with a batch number;

– their production is done on a large- or semi-large (industrial) scale;

– their preservation period is determined by stability testing;

– their active elements are standardised extracts;

– they take into account the biological properties of raw materials, novel therapeutic indicators, a galeric formulation with a specified dosage and knowledge of active biological molecules;

– they are standardised and produced according to fabrication best pracrices;

– their efficacy and safety have been established via preclinical- and clinical trials carried out according to standard protocols.

**Category 4 TMIs**

Finally, medications belonging to category 4 emerge from research institutes and display the following characteristic:

– hey are prepared in advance and packaged with a batch number;

– their production is done on a large- or semi-large (industrial) scale;

– their preservation period is determined by stability testing;

– their active elements are purified molecules;

– they take into account the biological properties of raw materials, novel therapeutic indicators, a galeric formulation with a specified dosage and knowledge of active biological molecules;

– they are standardised and produced according to fabrication best pracrices;

– their efficacy and safety have been determined via preclinical- and clinical trials carried out according to standard protocols.

Category 3 concerns medicines emerging from research in institutions. As in the case of category 2, they are produced ahead of need in an industrial or semi-industrial manner and packaged with a batch number. The active biological molecules are known, meaning that the active elements are standard extractions with specified doses. Official authorisation for commercial distribution follows examination of five areas of consideration: administrative, pharmaceutical, pharmacological, toxicological and clinical.

Category 4 distinguishes itself from category 3 by its utilisation of purified molecules to produce medicines which are generally fabricated in countries outside of Africa. As for category 2 and 3, official authorisation is required for category 4 medication.

The classification of medication shows that more and more traditional and artisanal knowledge and know-how are being used within the context of a desired industrialisation by international organisations in order to create ever more elaborate types of medication. These traditional medications should therefore be considered as potentially attaining growing importance in the future insofar as concerns the provision of African healthcare (Amari, 2009).

## 2. Legislation regarding the traditional pharmacological stock and traditional practitioners

A series of actions have been undertaken in Côte d'Ivoire or on a supranational scale in order to ensure benefit is derived from traditional medicine and the associated pharmacological stock: the West African economic and monetary union (UEMOA); the Economic community of Western African states (ECOWAS); the African organisation of intellectual property (AOIP). These initiatives have resulted in the adoption, over the

course of more than 30 years, of a series of legislative texts regarding the traditional pharmacological stock and traditional practitioners for human and animal healthcare. These texts integrate the provisions relative to SOVs without for all that being specific to them and recognising that plants can constitute the whole or part of a medicinal substance. That is why, as part of this chronological presentation, some legislative dispositions deal with medicines seeing as they can apply to SOVs. The international context, characterised by the desire of economic organisations to promote access to high-quality medication for their populations, is equally characterised by the alignment of pharmaceutical regulation as primary means of ensuring such access. The process of alignment of pharmaceutical regulation, conducted under the auspices of UEMOA, has enabled the promulgation of several binding resolutions bearing on its member states, and which are summarised in tables 4 and 5.

A bill adopted in 1987 deals with the creation of a national pharmacologicalstock in Côte d'Ivoire, followed in 1995 by the integration of traditional medicine into the national plan for healthcare development (PNDS). Shortly thereafter (1996), a workshop was organised in Aboisso aimed at creating a legal framework for the practice of traditional medicine in order to achieve its integration into healthcare programmes. Following the Aboisso workshop, presidential order N°3967 of 27 August 1997 authorised collaboration between modern and traditional medicine. Two years later, in 1999, the ministerial cabinet approved three pieces of legislation dealing with:

– authorisation for the practice of traditional medicine;

– creation of a national organisation of traditional practitioners;

– a code of conduct for practitioners of traditional medicine in Côte d'Ivoire.

Since its creation on 28 December 2001 (bill N°409), the National programme for the promotion of traditional medicine (PNPMT) contributes to the improvement of healthcare access for the population by extending the use of traditional medicine and associated medication.

At the level of AOIP, in 2002 the Libreville initiative led the ministries of health of member states to adopt two reference texts listing shared criteria in order better to address the needs of populations with regard to traditional medicine (better elaboration and better conditioning). These texts aim at enabling an alignment of procedures for identifying traditional health practitioners among the different countries, but they also harmonise the procedures for classifying medications derived from the traditional pharmacological stock by taking into account the WHO classification into four categories of medication. The criteria for classifying of the traditional pharmacological stock are the pharmaceutical quality, as well as the safety

and effectiveness of therapeutic treatment. For categories 1 and 2 the long term use of traditional medication may be considered as guarantee of their safety and their effectiveness alike. On the other hand, category 3 and 4 medications require verification via scientific experimentation.

In October 2010, in decision N°08/2010/CM/UEMOA on best practices for the fabrication of medications for human use in ECOWAS member countries, annex 3 deals with plants: specifications regarding raw material, selection and quality control of plants, organisation of locations and production itself, and quality control of the end product.

In 2014 the West African health organisation (WAHO/OOAS) reviewed the training curriculum for the practice of traditional medicine and produced a document on plant formulae as well as a manual on the plant-based treatment of 40 illnesses in West Africa (WAHO, 2015).

The following year, in 2015, the WAHO sought to institutionalise to a greater degree the place of traditional medicine within the national healthcare systems by bolstering the regulatory authorities of ECOWAS member states to harmonise their directives and norms for the evaluation and registration of traditional practitioners, as well as traditional medicinal products (WAHO, 2016).

Activities related to traditional medicine and the pharmacological stock are regulated in Côte d'Ivoire by the law of 20 July 2015 (N°2015-536) and the decree of 27 January 2016 (N°201-24), which instituted a code of ethics and conduct for the practitioners of traditional medicine.

The profession of practitioner of traditional medicine was finally legalised and defined (in terms of conditions for authorisation) in 2015 by law N°2015-536, which also applies to authorisation for the practice of traditional medicine for healthcare establishments. Article 1 of the law also stipulates that the medicines of the traditional pharmacological stock are defined as "all medication conceived of and developed by a practitioner of traditional medicine or a researcher based on knowledge and information derived from a traditional pharmacological stock. They are also medicinal end products and labelled as such containing vegetal, animal or mineral matter or their preparations and possessing therapeutic or prophylactic properties". The same law authorises the sale of therapeutic plants (tisanes, powders, extracts, essential oils…) in herbalist shops (article 17).

The role of the traditional practitioner was completed by decree N°2016-24 of 27 January 2016, which underscores their contribution to the protection, regeneration, development and promotion of flora and which affirms their conduct, to wit: the practitioner is not allowed to mix or combine natural substances prescribed by them with pharmaceutical products.

Regarding traditional medication, while the country does have procedures for the authorisation of medications, these do not relate specifically to the traditional pharmacological stock. As a result, the former national authority for pharmaceutical regulation (Directorate for medicines, medication and laboratories) created an authorisation procedure based on three considerations (administrative, pharmaceutical and toxico-clinical). The authorisation is granted for 3 years based on safety, quality and security, evaluated by a multidisciplinary committee of experts.

The administrative consideration focuses on unit of production and price-setting for the product. It also includes an ethnomedical report validated by a healthcare authority based on a protocol adhered to for at least 4 months (for category 2 medication) or agreement protocols for clinical trials between the producer and the research institute (for category 3 medication).

The pharmaceutical consideration includes the results of physiochemical, biological and microbiological trials, to which are added the bibliography of plants used and the description of the active substances and the stages of production. Finally, the results of tests done on the final product are integrated in order to evaluate its stability as well as its microbiological and organoleptic attributes.

The final consideration is concerned with toxico-clinical data related to traditional medication and draws on a report verifying the utilisation of the medication for 20 months in its current or traditional form, and another report on toxicity trials conducted on the plants used or on species from the same family. The toxicity- and clinical trials complete the 3rdconsideration for category 3 medications.

The difficulty for those seeking authorisation in providing the elements required leads to authorisation for the commercialisation of plant-based medication to involve exclusively imported products, and to only the private laboratory S-Terre[42] engaging in the reconditioning of phytomedications in Côte d'Ivoire.

[42] S.Terre is a phytotherapeutical laboratory in Côte d'Ivoire, the only wholesaler granted authorisation by the Directorate for medicines, medications and laboratories (DPML) and the products of which are sold exclusively in pharmacies.

| YEAR | NUMBER | CONTENT |
|---|---|---|
| 2005 | Bill n°02/2005/CM/UEMOA | Harmonisation of pharmaceutical regulation among UEMOA member states |
| 2008 | Directive n°06/2008/CM/UEMOA | Free circulation and establishment of pharmacists of Union origin within the UEMOA space |
| 2010 | Bill n°06/2010/CM/UEMOA + Annexes | Procedures for authorisation of pharmaceutical products for human use in UEMOA member states |
| | | Adoption of guidelines for authorisation of nutritional supplements in UEMOA member states |
| | Decision n°07/2010/CM/UEMOA + Annex | Adoption of guidelines for authorisation of cosmetic products in UEMOA member states |

**Table 4: Principal milestones in the harmonisation of pharmaceutical regulation within UEMOA[43].**

| YEAR | STRUCTURES AND MESURES |
|---|---|
| **BURKINA FASO** | |
| 1978 | Creation of the Institute for research of natural substances |

[43] Joint texts adopted by the UEMOA ministerial council appear on the organisation's website at the following address: http://www.uemoa.int/Pages/ACTES/Conseil des Ministres.aspx

| | |
|---|---|
| 1984 | Inauguration of the Directorate for the procurement and pharmacological cataloguing of traditional remedies |
| 1984-1989 | Putting in place of decentralised cells related to the traditional pharmacological stock and of associations of healthcare practitioners |
| 1994 | Legal recognition of traditional medicine and the pharmacological stock: law N° 23/94/ADP of 19 May |
| 2002 | Creation of the Directorate for traditional medicine and the pharmacological stock |
| 2004 | Launch of the Programme for the promotion of traditional medicine and the pharmacological stock (Yelkouni et Charasse-Pouélé, 2006) |
| **MALI** | |
| 1973 | Creation of the national institute for research onthe traditional pharmacological stock and medicine (INRPMT): ordinance N° 43 CMLN of 14 August |
| 1975 | Setting conditions for the operation of the INRPMT: decree N° 1409/MSP-AS/CAB of 29 May |
| | Setting of tariffs for the phytosanitary control of medicinal plants and authorisation for the INRPMT to open a herbal supply outlet: interministerial decree N° 1953MSP-AS –MF-MC (Ministry of public health, Ministry of social action, Ministry of finance, Ministry of commerce) of 18 August |
| 1981 | Institution of the Malian Office for medicine, absorbing the INRPMT: law N° 81-18/AN-RM of 16 February |
| | Recognition of the INRPMT as partner institution of the WHO |
| 1986 | Absorption of the Division for traditional medicine by the National institute for research on public health: ordinance N° 86-04/PRM of 13 February |
| 1994 | Setting conditions for the opening of private practices for consultation and traditional healthcare, for herbal outlets and for production units of TMI: decree N° 94-282/PRM of 15 August |
| 1995 | Setting of regulations for the organisation and |

| | |
|---|---|
| | functioning of private practices for consultation and traditional healing, for herbal outlets and for production units of TMI: decree N° 95-1319/MSS-PA of 22 June |
| 2009 | Putting in place of an oversight committee for the national programme for traditional medicine (Diallo, 2010) |
| **SENEGAL** | |
| 1966 | Prohibition on the exercise of traditional medicine: law N° 66-069 of 4 July |
| 2017 | Legalisation of the exercise of traditional medicine |
| 2021 | No standardised traditional medication |
| **GHANA** | |
| 1994 | Creation of the Directorate for traditional medicines and alternatives under the auspices of the Ministry of health |
| 2000 | Legalisation of the registration of traditional practitioners with the Council for the practice of traditional medicine: law N° 575 |
| 2002-2004 | Strategic plan for the development of traditional medicine |
| 2003 | Policy for the development of traditional medicine |
| 2005-2009 | Strategic plan for the development of traditional medicine |
| 2006 | Code of conduct<br>Standards for practice |
| 2008 | List of essential medicinal plants for primary healthcare |
| | Administrative directives for alternative and complementary medicine |
| | Directives for a framework for the protection of intellectual property rights related to indigenous knowledge linked to health and to medicinal resources and plants |

**Table 5: Organisation of traditional medicine and the pharmacological stock in countries bordering Côte d'Ivoire.**

# 3. Regulations relating to the fabrication of medication

A number of regulations deal with the authorisation of medication for human or animal use, produced locally or imported. These texts do not refer specifically to TMI, or in particular to the active base ingredients of SOVs, meaning that a specific set of regulations in this regard remains to be issued in Côte d'Ivoire.

Among the existing regulations governing the production of plant-based medication, UEMOA has issued decision N° 08/2010/CM/UEMOA on best practices for fabrication, which relates to the entirety of the production chain regardless of location of production (whether in the country where the product will be consumed or abroad). Firstly a selection of seeds is done in order to obtain quality SOVs. Their cultivation and harvest must result in a qualitative stability of the plants. This is verified by quality control, which enables assurance of the water content, the uniformity of a particular batch, the absence or presence of any contamination (by pesticides, mushrooms or microbes, parasites, toxic metals), of adulteration products or of any other foreign substance which would not belong in the final, desired product. The control is carried out via documentation related to fabrication, but also via comparative testing for conformity to reference samples. It is interesting to compare the measures of best practices for fabrication used by UEMOA and the WHO (table 6). The UEMOA commission's ministerial council on 4 July 2005 in Dakar adopted a resolution relating to the putting in place of a structure tasked with the standardisation of pharmaceutical regulations. Thus structure, named the Unit for medicines regulation harmonisation and cooperation (CHRCP), is coordinated by a steering committee which in 2008, within the framework of initiating its proposed activities and with the technical and financial support of the WHO, set about and approved the publication of a guide for best practices relating to medications.

Regarding the production of plant-based medication itself, the quality of the raw materials collected has to be respected in order to ensure the quality of the final product, notably via the storage of SOVs in areas adapted to the purpose in order to prevent the onset of mould and fermentation, and in order to protect them from animals or micro-organisms which could potentially damage them. The tracing of the procurement of the active elements and of the rest of the production process is documented in detail. Finally, as a last step, the quality control of the final products involves the examination of the chemical aspects of the medication, specifically with regard to the galenic form and to microbiological data.

Sommaire

| | UEMOA | WHO |
|---|---|---|
| **Characteristics of BPFs** | 6 chapters<br>3 annexes | 17 chapters<br>13 annexes |
| **Regulatory basis** | Decision N° 08/2010/CM/ UEMOA[44]+ annex | *WHO Technical Report series*, nº 943, annexe 3 |
| **Number of editions** | 1 in 2010 | 7 from 1969 to 2014 |
| **Year of publication** | 2010 | 2014 |
| **Domain, subjects** | -Fabrication of medications for human use | -Fabrication of medications for human use, active and excipient substances<br>-Pharmaceutical inspections |
| **Specific medications taken into account** | -Sterile pharmaceutical products<br>-Biological pharmaceutical products (identical content corresponding to WHO best practices paragraph)<br>-Plant-based pharmaceutical products | -Sterile, biological, plant-based and experimental pharmaceutical products<br>-Radiopharmaceutical products |
| **Quality management** | Chapter 1: Quality management<br>-Personnel | Chapter 1: Quality assurance<br>Chapter 2: Best practices of fabrication |

[44] Decision N°08/2010/CM/UEMOA decreeing the adoption of the guide of best practices for fabrication of pharmaceutical products for human use in UEMOA member states.

| | | |
|---|---|---|
| | -Pharmaceutical responsibility<br>-Documentation<br>-Verification of proceeds<br>-Reclamations and recalls<br>-Subcontracting<br>-Audits of suppliers and subcontractors<br>-Self-inspection and quality audits | Chapter 3: Sanitary and hygienic installations<br>Chapter 5: Reclamations<br>Chapter 6: Recalls<br>Chapter 7: Subcontractors<br>Chapter 8: Self-inspections and audits<br>Chapter 9: Personnel<br>Chapter 10: Training<br>Chapter 11: Personal hygiene<br>Chapter 15: Documentation |
| **Locations and materials** | Chapter 2: Locations and materials<br>-Locations, materials, qualification | Chapter 4: Qualification and verification<br>Chapter 12: Locations<br>Chapter 13: Material |
| **Components and products** | Chapter 3: Components and products<br>-Raw material; articles for conditioning; bulk intermediary products; en products; rejected, returned, recalled products; recovered, reworked, retracted products | Chapter 14: Material |
| **Fabrication** | Chapter 4: Fabrication<br>Information on | Chapter 16: Best practices related to production |

| | | |
|---|---|---|
| | fabrication of batches, prevention of cross-contamination | Chapter 17: Best practices related to quality control |
| **Conditioning** | Chapter 5: Conditioning<br>-Instruction; information and operation | Chapter 14: Material |
| **Quality control** | Chapter 6: Quality control<br>-Specifications and testing methods<br>-Sampling; operation of control; programme for overseeing stability<br>-Utilisation of provider analysis certificates | Chapter 16: Best practices related to production<br>Chapter 17: Best practices related to quality control |

**Table 6: Comparison between best practices for fabrication (BPF) used by UEMOA and the WHO.**

Another regulatory text deals with the free circulation of plants and vegetal products corresponding to the shared security and quality standards in all UEMOA member states. This is regulation N° 007/2007/CM/UEMOA regarding the sanitary security of plants, animals and foodstuffs, which establishes the mutual recognition of products among member states. The term "vegetal substance" is not defined in this text, as opposed to "plants and vegetal products", which are living plants and parts thereof, including seeds and genetic material.

The same regulation entrusts the organisation of cooperation among UEMOA member states, as well as the alignment of shared food security policies to a subcommittee charged with the sanitary security of plants, which committee is itself part of the regional committee for the sanitary

security of plants, animals and foodstuffs. The subcommittee notably provides technical advice to UEMOA in order to carry out its work.

# Chapter II
# Legislation related to other sectors in which SOVs are employed

## 1. Cosmetics

In 1993, a number of Ivorian interministerial decrees (N° 27, 28, 29, 30 and 31/MSPS/MIC of 9 February) dealt with the prohibition of the use of certainsubstances in cosmetic products for bodily hygiene, with rules around best practices and the responsibility of producers, with conditioning and, finally, with centres receiving the formulae of cosmetic products.

In 2010, a decision of UEMOA (N° 07/2010/CM/UEMOA) for the alignment of cosmetics in its member states enabled the definition of criteria for these products according to their type, their area of application on the body and their functioning. Regarding the ingredients used, reference is made to precautions vis-à-vis allergenic products but, astonishingly, lightening products are not mentioned even though their use in Africa is extensive. The evaluation of the quality of cosmetic products by a commission of experts before commercialisation is affirmed in the text. The shared regulations also contain obligations of declaration for the establishment producing the cosmetics, of respect for the rules of BPF and the rules of labelling. Finally, a person responsible for each cosmetic product is designated for commercialisation and oversight of the product.

In 2015, an Ivorian decree (N° 2015-288 of 15 April) regarding sanitary security linked to cosmetic and hygiene products was promulgated. It established a non-exhaustive list of prohibited lightening products containing hydroquinone with more than 2% of mercury and its derivatives, corticoids and corticosteroids, as well as derivatives of vitamin A. Even though this decree prohibits artisanal mixtures of cosmetic products integrating SOVs, they remain exempt from quality control conducted by the LNSP (national laboratory for public health). Existing regulations governing cosmetic products in Côte d'Ivoire ensure security of their use for the population. Even so, a more intensive control of the supply chain and the application of punishment in case of infraction of the regulations would constitute two advances toward the improvement of security in the cosmetic sector.

Sommaire

## 2. Food supplements

Particularly sought-after in parapharmacy, food supplements operate on the border between food and medication.

In Côte d'Ivoire, legislation governing these products is promulgated in 2010 in the form of a decision by UEMOA (N° 06/2010/CM/UEMOA) on the authorisation of nutritional supplements taken orally.

These are classified into seven categories: vitamins, mineral salts, fatty acids, amino acids, probiotics and prebiotics, plants and plant preparations and, finally, other nutritional supplements. Regarding plants or parts of plants, the list includes plants traditionally considered as food and excludes those with pharmacological properties aimed at exclusively therapeutic use.

The operation of authorisation for these products is informed by a multidisciplinary technical commission. It consists of an administrative part and a technical part bearing on the applicant, analytical information, a summary of the product's characteristics and labelling. It deals with the ingredients, with their composition (relevance of the qualitative and quantitative composition of the product), with the conditioning material, with labelling information and information relating to the fabricant. The process is similar to the authorisation for market entry of medications.

The operative legislation for nutritional complements offers consumers security of use. Nevertheless, it could be strengthened by authorised sections on nutrition and health, specific rules on labelling, particularly for edible plant-based nutritional supplements as a means of standardising the use of these products.

## 3. Additives

Decision N° 06/2010/CM/UEMOA regarding food supplements defines food additives as "any substance not normally consumed as alimentary commodity per se, and which is not normally utilised as ingredient characteristic of an alimentary commodity, regardless of whether or not it has a nutritional value and the intentional addition of which to an alimentary commodity for a technological or organoleptic purpose at any stage of fabrication, transformation, preparation, processing, conditioning, packaging, transport or storage of such commodity results, or may result (directly or indirectly) in its incorporation or that of its derivatives into the

commodity or could in some other way affect the characteristics of said commodity. The term does not apply to either contaminants or substances added to alimentary commodities for the purpose of maintaining or improving their nutritional properties". Quality control of additives is carried out by the LNSP (national pharmaceutical policy, 2015).

Under current Ivorian regulation, no text applies specifically to SOVs used as alimentary, pharmaceutical or cosmetic additives, and provisions taken in this regard could be useful. Only regulation N° 07/2007/CM/UEMOA deals with the health security of plants, animals and foodstuffs.

## 4. Applicable environmental law

The production of cultivated plants as sample of wild-growing resources poses the possibility of perturbation of the natural landscape and leads to taking account of the environmental dimension of these human engagements. Both common law and environmental law are implicated in these questions.

Common law is made up of a collection of traditional normative mechanisms operating within indigenous communities, to which are added the legal rules of common law. As for environmental law, one of its aspects concerns threats, the most significant one being pollution. At a national level in Côte d'Ivoire, the law of 3 October 1996 (N° 96-766) instituted an environmental code followed by a decree governing application on 24 October 2012 (N° 2012-1047) which retains the principle of polluter-payer used by the Organisation of economic cooperation and development (OECD). The environmental code engages with a number of questions related to SOVs. For instance, it requires the prior authorisation of the introduction, importation and exportation of all plant species (article 16). It regulates pollution by prohibiting the dumping of all substances posing a potential danger of destruction to the flora contained in maritime- and lagoon zones (article 76). Finally, it addresses the issue of protected plants by prohibiting their destruction and damage, as well as their removal either wholly or in part (article 87).

Apart from pollution, another danger posed to SOVs concerns the use of pesticides. As it happens, their potential damage to flora has led to them being strictly controlled. Thus, in 2009, in order to protect both the environment and the health of the population, regulation N° 04/2009/CM/UEMOA deals with the authorisation of pesticides, their

commercialisation and their control in UEMOA member states. Insofar as it serves to protect the environment, this regulation therefore also relates to SOVs.

Although the legislation aims at removing potential threats to the environment, it also seeks to protect the existing landscape. To achieve success in this regard and to encourage innovation, the official recognition of traditional medicine and its pharmacological stock should include the rights of holders of traditional knowledge, particularly regarding SOVs.

The development of forms of intellectual property adapted for the protection of knowledge associated with plants and traditional medication improved is currently the subject of debate in different international fora, in particular within the WOIP's (World organisation for intellectual property) intergovernmental committee on intellectual property relating to genetic resources, traditional knowledge and folklore, created in 2000.

Within this framework it is advised to create registers and databases relating to genetic resources and traditional knowledge not kept secret. Such registers are meant to guarantee the protection of traditional knowledge from a "defensive" point of view, i.e. prevented the keepers of such knowledge from being cheated through the patent application process. Thus the prior registration of knowledge can be taken account when considering the application of specific techniques as part of the patent application examination procedure – in this way it will be impossible to obtain patents for already-registered applications.

For purposes of comparison within the subregion, one may note that the assurance of benefit derived from Ghanaian phytotherapy in 2015 was the subject of a study for development conducted within the framework of the action plan of the WOIP (Essegbey and Awuni, 2015).

On 19 December 2008 ECOWAS promulgated the additional Act A/SA.4/12/08, which constituted the adoption of its environmental policy. This policy, similar to that of UEMOA, aims at assuring a natural, healthy and productive milieu for the improvement of conditions of life for the populations of the subregion. This desire results from the recognition of degradation and a reduction in the vegetal resources necessary for the fabrication of traditional African medication.

The desire for environmental protection expressed by the Ivorian state manifested itself in 2016 in its Constitution, which affirms that "the protection of the environment and the promotion of the quality of life is a duty of the community and of every physical or corporate person. The state undertakes to protect its maritime spaces, its watercourses, its natural parks […] from all forms of degradation. The state and its public collectivities are taking the necessary measures to safeguard its fauna and flora […]"

(article 40). SOVs are therefore officially protected by the foundational law of Côte d'Ivoire.

Apart from the legislative framework, the state also created a national environmental agency (ANDE) to contain the impact of human activity on the natural landscape and to carry out environmental impact studies based on expert input. As for the Ivorian antipollution centre (Ciapol), it came into being in order to effectuate the analytic evaluation, the monitoring and the management of environmental data. A third Ivorian institution is linked to SOVs: the Ivorian office of parks and reserves, of which one of the tasks is the management of flora in national parks and reserves.

The ratification, by Côte d'Ivoire, of international conventions strengthens the protective effect of regulations and national institutions that deal with the environment. Thus the country is one of the 190 signatories to the United Nations convention on biological diversity (1992) to combat the degradation of ecosystems and the loss of biodiversity, and which works for the sustainable and equitable use of genetic resources. On a continental scale, by ratifying the African convention on the protection of nature and natural resources (originally signed on 27 February 2004, ratified on 23 October 2013 and coming into force for Côte d'Ivoire on 23 July 2016), the country undertook to take measures to protect flora, to optimise its utilisation, as well as is sustainable development.

In Ivorian environmental law, forested areas are treated separately. They are governed by a 2019 law which defines them as "the totality of state forests, territorial collectives, physical and corporate persons as stipulated in private law". According to this forest code (article 16), the utilisation of genetic resources and the benefits of biotechnology are regulated by the state.

## 5. The Nagoya Protocol and benefit-sharing

A legal framework has proven itself indispensible in order to organise the development of the use of plant-based traditional medication improved. Such a framework could notably promote collaboration among practitioners of modern- and traditional medicine, which for the present consists of the simple rotation of patients between one and the other, as was revealed by an investigation undertaken in Abidjan in 2011-2012.Sometimes the value of collaboration is unclear for traditional

practitioners, as they fear revealing their knowledge and thus losing their source of income.

The value of knowledge of the traditional pharmacological stock should nevertheless be recognised. It should be able to benefit from a specific system of protection, both on the international and the national market. This protection must allow the legitimate holders of knowledge to benefit from the sharing of such benefits as may emerge from the exploitation of this knowledge. The potential for exploitation of knowledge is very important within the framework of therapeutic schemas, as much within rural zones as in urban ones.

The Nagoya Protocol (come into force on 29 October 2010, signed by Côte d'Ivoire on 25 January 2012 and ratified on 24 September 2013) aims at a just and equitable sharing of benefits linked to the exploitation of genetic resources and/or to traditional knowledge associated with them – notably via adequate access and appropriate transfer of applicable technologies – in order to contribute to the conservation of biological diversity and the sustainable use of its constituent elements.

In 2014 Côte d'Ivoire proclaimed a national strategy for access to genetic resources and the sharing of benefits (Ministry of environment, urban sanitation and sustainable development, 2014).

An updated legal framework was approved between 19 and 21 October 2020 by the legal departments of the relevant ministries and by the members of the ad hoc Nagoya Protocol committee put in place on 29 November 2019.

Apart from the presentation of legislation and regulation by sector (medical, cosmetic…), it is useful to invert our point of view and to consider the perspective of a company seeking to develop its activities in Côte d'Ivoire. It would have to take into account the totality of the regulations touching on greatly varied domains: urbanisation and expansion, commerce, environment, intellectual property, working conditions and legal questions. Lacking a text regulating the standardisation of medications derived from the traditional pharmacological stock, the WOIP's reference document can be used for this purpose instead, as can decree no 05/13-UEAC-OCEAC-CM-SE-2 relating to procedures for the standardisation of medications for human use within the Central African economic and monetary community (Cémac) which in its presentation of different types of medication takes into account those deriving from a traditional healthcare-related heritage by providing a template for the various requirements to be met, based on the category of medication concerned, when an application for official approval of such a medication is filed. The following table (table 7) aims at serving as recapulative tool of the regulatory texts applicable to businesses operating in Côte d'Ivoire.

| Domain | Activity/ Subject | Texts | Institutions affected | Attributions/Interest of the field of intervention |
|---|---|---|---|---|
| **NATIONAL DISPOSITIONS RELATED TO INDUSTRIAL ACTIVITY** | | | | |
| **Health** | Pharmacological stock | Law n° 2015-536 of 20 July 2015 relating to the use and organisation of medication and the traditional pharmacological stock | | |
| **Urbanisation and expansion** | Urban and rural expansion | Code for urban and rural expansion | Ministry of urbanisation | Applicables rules for the designation of terrain for the location of businesses |
| | | Law n° 98-750 of 23 December 1998 relating to rural expansion, amended by laws n° 2004-412 of 14 August 2004, n° 2013-655 of 13 September 2013 and n° 2019-868 of | | |

| | | | | |
|---|---|---|---|---|
| | | 14 October 2019 | | |
| **Commerce** | Creation and expansion of activities | Ordonnance n° 2012-487 of 07/06/2015 (Code for investment) | Centre for the promotion of investment in Côte d'Ivoire (Cepici) | Regimen of benefits and general rules applicable to direct investment, national and foreign, carried out in Côte d'Ivoire<br>Centralisation of administrative procedures relative to the creation of economic activities in Côte d'Ivoire (single service desk) |
| | Exploitation | Decree n° 2014-556 of1/10/2014 (organisation by the Ministry of industry) | Ministry of industry, Directorate-general for industrial activity | Oversight of local industrial development |
| | Foreign Commerce | Interministerial decree n° 235 MCAPPME/MPMEF of 27/06/2013 (Guce - Single service counter for foreign commerce) | Guce | Documentary control of products imported into Côte d'Ivoire by computer system |
| | Competition | Law n° 2013-865 of 27/12/1991 (competition) | Ministry of commerce | Regulatory limits for organising free competition, price fixing, and the control of anti compétitive activities of |

Sommaire

| | | | | |
|---|---|---|---|---|
| | | | | businesses |
| **Environment** | Protection of the environment | Law n° 88-651 of 07/07/1988 (protection of public Health and the environment against toxic and nuclear industrial waste, and hazardous substances) | Ministry of environment<br>Penal juridictions | Prevention of acts and attempted acts relative to traffic in toxic and nuclear industrial waste and substances hazardous to the environment and the health of populations |
| | | Law n° 96-766 of 03/10/1996 (Environmental code)<br>Decree n° 96-984 of 08/11/1996 (rules and procedures applicable to studies relative to the environmental impact of development projects) | ANDE | Implementation of technical tools for the evaluation and control of the environmental impact of economic activities, before implantation or in the process of exploitation:<br>- environmental impact studies<br>- determination of environmental impact<br>- audits of environmental management plan |
| | | Law n° 98-755 of 23/12/1998 (Water code) | Ministry of environment | General principales applicable to the management of water resources |

| | | | | |
|---|---|---|---|---|
| | | Law n° 2002-102 of 11 February 2002 relating to the creation, management and funding of national parks and natural reserves | | |
| | | Law n° 2013-444 of 19 June 2013 authorising the President of the Republic to ratify the Nagoya Protocol on access to genetic resources and the just and equitable sharing of benefits derived from their use, in relation to the Convention on biological diversity, adopted in Nagoya on 29 October 2010 | | |
| | | Law n° 2014-390 of 20 June 2014 regarding | | |

| | | | | |
|---|---|---|---|---|
| | | a position on sustainable development | | |
| | | Law n° 2016-554 of 26 July 2016 relating to fishery and aquaculture | | |
| | | Law n° 2019-675 of 23 July 2019 enabling the Forestry code | | |
| | | Decree n° 94-614 enabling ratification of the Convention on biological diversity | | |
| **Aspects of intellectual property and quality** | Research and development | Decree n° 2005-112 of 24 February 2005 enabling the creation, organisation and operation of a public administrative entity (EPA) called the Ivorian office of intellectual property | OIPI | Identification of a national institution and rules for a centralised application for protection with the OIPI<br><br>Possibility of patenting discoveries and innovations |

Sommaire

| | | | | |
|---|---|---|---|---|
| | | (OIPI), amended by decree n° 2015-241 of 8 April 2015 setting out the compositional elements, the organisation and theoperation of the OIPI | | |
| | Patenting | Agreement of 24 February 1999 amending the Bangui Agreement of 2 March 1977 instituting an African organisation for intellectual property (AOIP) | AOIP/OIPI | |
| | Fight against counterfitting | Law n° 2013-865 of 23/12/2013 (fight against counterfitting and pirating, protection of intellectual property rights) | Customs administration<br>National committee for the fight against counterfitting (CNLC) | Affirmation of the fight against all forms of counterfitting<br>Seizure modalities of customs administration and areas of intervention of institutions involved in the fight<br>Definition of customs sanctions and |

| | | | | |
|---|---|---|---|---|
| | | | | restriction mesures of customs procedures |
| | Quality | Law n° 2013-866 of 23/12/ 2013 (normalisation and promotion of quality) | Côte d'Ivoire normalisation (Codinorm) | Definition of the legal framework of normalisation and promotion of quality conforming to the UEMOA alignments scheme for activities related to accreditation, certification, normalisation and metrology |
| **Economy** | Taxability of companies | Law n° 63-524 of 26/12/1963 (General tax code) | Directorate- general for taxation (DGI) | Schedule of imposition of industrial and commercial benefits<br>Collection of taxes on business activities |
| | | Law n° 64-291 of01/08/1964 (Customs code) | Directorate- general for customs | Definition of general conditions for the application of customs collection |
| | | Law n° 2004-52 of 30/08/2004 (schedule of the free trade zone for biotechnology and ICT, information and communication | VITIB.SA | Creation of an incubation zone, technology transfer, promotion, training and benefitting from tax exemption for the development of technological innovation and investment |

| | | | | |
|---|---|---|---|---|
| | | technology) | | |
| | | Organic law n° 2014-336 of 5 June 2014 relating to financial legislation | | |
| **RELATED DISPOSITIONS** | | | | |
| **Socio-professional considerations** | Working conditions | Law n° 2015-532 of 20/07/ 2015 (Labour code) | Ministry of employment | National schedule applicable to relations between employers and workers |
| | | Joint interprofessional convention of 19/07/1977 | Patronage and employee union representatives | Agreements between employers and workers regarding general working conditions and the application of workers' social benefits |
| **Justice** | Recourse in case of dispute | Organic law n° 2014-424 of 14/07/2014 (creation, organisation and operation of the jurisdictions of commerce) | Tribunals for commerce | Legal recourse in case of dispute between parties in commercial matters |
| **Decentralisation** | | Law n° 2003-208 of | | |

| | | | | |
|---|---|---|---|---|
| | | 7 July 2003 enabling transfer and devolution of governmental functions to territorial collectives | | |

**Table 7: Legal economic dispositions applicable to all individual businesses in Côte d'Ivoire**

# PART III

# THE SOV VALUE CHAIN AND ECONOMIC OUTLOOK

Sommaire

Knowledge collected by research institutions, as much as by the heritage of secular traditions is put into practice in different types of know-how in Côte d'Ivoire. These will be elaborated upon in the 1st chapter with regard to their agricultural-, pharmacological- or veterinary-, then cosmetic-, aspects. This know-how is possessed by SOV actors, who exploit them at different stages in the production chain. These professional or informal categories will therefore be presented in the 2nd chapter with the focus on certain professions. Finally, the SOV economic development perspective will lead us in the 3rd chapter to consider questions regarding an exploitation strategy for Ivorian plant-based resources.

Sommaire

# Chapter I
# Techniques, practices and know-how related to SOVs

Scientific and traditional knowledge regarding plants can be implemented in different areas, such as agricultural cultivation, therapeutic practices related to human and animal health and the technical processes used in the cosmetic and hygiene sectors.

## 1. Growing- and traditional techniques

Plant cultivation constitutes an alternative to their gathering in the wild by the Ivorian population in order to meet their food-related-, medicinal-, aromatic- or cosmetic needs, and is carried out in a number of ways: stripping the trunk of its bark, directly or by cutting down the trees, e.g. for the akpi (*Ricinodendron heudelotii*); gathering, on foot or by cutting down the trees (fruit…); the systematic severing of vines, such as is the case for Landolphia owariensis or Piper quineense (pear tree). Gathering imposes a risk to natural resources, which adds to that posed by the extension of agricultural activity, by cattle farming and by the uncontrolled exploitation of wood resources. Some practices, such as bark-stripping, increase the risk of infection by micro-organisms or damage caused by bird or insects (Ouattara, 2006) which in turn threatens the sustainability of the resource in question. Certain ritual practices are also associated with the gathering of plants by traditional healers (libations, sacrifices, words…). For the sake of protecting plant species in the wild, the domestication of plants and the putting in place of cultural practices respectful of the natural environment appear as of primary importance for Côte d'Ivoire.

### 1.1. Multiplication of noteworthy vegetal species

Techniques for the multiplication of noteworthy vegetal species are sowing, layering, cutting of stems and roots, and finally suckering.

Sowing enables the interruption of the vegetative dormancy period of the seeds of every vegetal species. The germination capacity depends on the physiological properties of each species. The germination of hard seeds can be attained firstly by the abrasive treatment (mechanic or chemical) of the seed pods: for example, agitation of *Melitotus albus* in a sealed space for 10 minutes enables 91% germination, as opposed to only 0,5 % for untreated seeds (Hamly, 1932). Manual abrasion with sandpaper or mechanical scarification by centrifuge also operates in favour of germination, but it can reduce the half-life of seeds and create dysfunctions in vegetal development (Hamly, 1932). Treatment with concentrated sulphuric

acid is also effective on legumes (80% average rate of germination), as is a solution of pure or 95% ethylene alcohol for Papilionaces (Verschaffelt, 1912).

Another multiplication technique is via layering. It consists of turning the young ground-level shoots and low or upward-trending branches of trees or bushes towards the ground and maintaining them in that position, then covering them with soil in order to achieve the formation of new roots, which ultimately allows for the separation of the layering from the mother plant.

Cutting for its part consists of separating a portion of the stem (15 cm long and 0,5 to 2 cm in diameter) or parts of roots (15 to 20 cm long and with a diameter of 2 to 4 cm) from the mother plant in order to induce the formation of new roots or shoots after have covered them with soil.

Finally, suckering is a natural method of vegetative multiplication through applying stress on the mother plant. The success of this technique depends on the species under consideration, their growth method and pedoclimatic conditions. Following the superficial cutting of the roots (1 to 4 cm in diameter), the production of suckers is simulated with the development of hanging shoots from adventitious buds to obtain individualised plants capable of serving as part of reforestation operations.

## 1.2. Cultural agro-ecological techniques

### *1.2.1. Stability of multispecific cultural systems*

In the face of monospecific cultural systems, which today are criticised for their negative effects on the environment (soil erosion, overexploitation of water resources, massive use of pesticides and chemical fertilizer, pollution of the phreatic water table, etc.), multispecific cultures are now considered as more productive, more stable and more resilient for natural landscapes.

In this context, some commentators have proposed that traditional species serve as models for the conception of innovative cultural systems (Gliessman, 2001; Altieri, 2002), such as the reproduction of prairie cover for adaptation to climatic variations and other natural perturbations (parasitic invasion…) (Jackson, 2002). Ewel (1999), for his part, suggests copying the operation of forest formation after having demonstrated the role of perennial wood species in the sustainability of humid tropical zone ecosystems.

### *1.2.2. Connection between soil fertility and telluric microbial communities*

Two associations have proven very beneficial to soil fertility, namely holobiont and mycorrhizal symbiosis.

A holobiont is created from a plant and the micro-organisms it houses, and which develop mutually (Selosse, 2016). Endophytic micro-organisms housed in grain in particular play an essential role in germination by improving the nutrition, with regard to minerals, of seedlings, and that by producing growth hormones (Xu *et al.*, 2014) or by combating vegetal disease agents (Sundaramoorthy and Balabaska, 2013).

Scientific studies for the moment have not extensively explored the organs implicated in vegetal reproduction and the transmission of micro-organisms from one plant generation to another. As a result, these organs could potentially constitute reservoirs of microbial diversity favourable to the growth of the host plant (Truyen *et al.*, 2015).

Another reciprocally beneficial association is that between vegetal roots and certain ground mushrooms, notably mycorrhizal arbuscular mushrooms (MAM) or those belonging to the phylum glomeromycetes (Schüßler *et al*., 2001). This mycorrhizal symbiosis serves as central actor in soil fertility, the spatio-temporal evolution of vegetal formations in terms of diversity, productivity (due to the importance of mushrooms in the acquisition of nutrients by plants) and resilience (via the role of mushrooms in lending resistance to plants to stress or their tolerance of pollutants (Smith et Read, 2008).

In order to exploit the benefits of mycorhizal symbiosis, it is possible either to introduce in bulk a strain of chosen MAM, or to facilitate the multiplication of MAM by the introduction of species such as legumes, called hypermycotrophes (i.e. with a high mycorrizhal dependence).

These techniques for reproducing the functioning of ecosystems via holobiont or mycorrhizal symbiosis could represent for Côte d'Ivoire an effective strategy for developing soil fertility in an effective way which is also respectful of the natural milieu. Related to techniques for vegetal multiplication, and evaluated on a case-by-case basis according to local vegetal species, these techniques would enable putting in place effective and sustainable cultural systems currently mostly under-utilised on a global scale. A number of prospective future approaches can be defined:

– creation of multispecific covering by integrating into vegetal selections the parameter of symbiosis between plant and micro-organisms;

– utilisation of microbial resources in service of multispecific cultural itineraries due to the diffusion of scientific knowledge;

– effective exploitation of microbial biofertilisers through the creation of a best practices charter.

# 2. Therapeutic practices in traditional medicine

Other practices linked to SOVs apply to the means of fabrication of remedies, to their administration and protective care (see electronic version, I, 4.3.2., 4.4.2., 4.4.4. and annex 7).

## 2.1. Plant preparation and conservation

Plant preparation can be done within a private family setting, or otherwise is reserved for the holders of ancestral knowledge only. The selection of vegetal species and their number depend on the curative effects desired as well as on cultural traditions related to representations of the world (Yoro, 2014; Sanogo, 2014).

The traditional healer uses a pot made of baked clay brought by the patient, or else a calabash in cases where a purification or enchantment is required. The plant parts (leaves, bark, roots, flowers, fruit…) are then prepared via decoction, steeping, infusion, crushing, kneading, etc. (see reference in electronic version, I, annexe 7).

Traditional plant-based treatments are presented and preserved in the form of pellets (clay or china clay additions to vegetal substances), calcine, pomades, amulets, incense, soaps. Thus the fabrication of *soumbara* (or *soumbala*) from the nere fruit (*Parkia bigliobosa*) enables one to obtain dried pellets for preservation: the seeds are separated from the pulp and dried, washed, boiled in water, passed through a mortarboard to remove the pods, washed

again, then left to ferment for a few days. Conservation is generally done by drying in the sun or by the heat of a fire.

### 2.2. Means of administering treatments

The administering of treatments operates according to many variations derived from social representation. They can be preceded by a prayer or incantation, take place on specific days or times of day, in certain places and according to a certain disposition of the patient (bathing at a crossroads for example, or facing the sunrise) (Koné, 1998; Yao, 2012); finally, they vary according to sex and the symbolism attached to numbers: the posology is attached to unequal numbers for men and equal numbers for women.

Prescriptions often include prohibitions (dietary, sexual, menstrual impurity) during treatment (Adjet *et al*., 2016; Kouassi, 2019). Sometimes, in cases of serious illness, the patient may be required to visit the practitioner regularly for a continuous monitoring of his health.

## 3. Procedures related to cosmetics and hygiene

Species used notably for skin- and hair care rely on ancestral know-how related to the extraction of fatty tissue for bodily care and the production of potash for making soap.

### 3.1. Extraction of plant-based fatty tissue

The procedure for extracting fatty tissue starts with cashews or seeds obtained from African crabwood (*Carapa procera*) and the Shea tree (*Vitellaria paradoxa*) (Ouattara *et al*., 2017). For the African crabwood, the fruit is boiled as preliminary measure, then dried in the sun and cut up in order to extract the cashews. As for shea, it is grounded up before or after roasting (which improves the quality of the oil). The paste obtained is diluted in water, then brought to boil and finally cooled down. The fatty tissue is retrieved from the surface of the mixture, purified by ebullition and then ultimately imbued with fragrance from aromatic plants.

With the African oil palm, another plant from which fatty tissue is obtained, two oils are obtained: palm oil (or "red oil") extracted from the fibrous pulp surrounding the fruit, and palmist oil, which proceeds from the cashew and extracted by crushing of the fruit. The cashews obtained are soaked in water for a few days to soften them and facilitate their crushing.

## 3.2. Fabrication of traditional soap

The primary plants used for making potash are *Cobia pentandra* (Kapok tree) and *Cussonia arborea* (Ouattara *et al*., 2017). The potash is obtained from vegetal ash (the entire plant, trunks, branches, fruit shell, etc.) made into a solution, then filtered and evaporated. Traditional soap can then be manufactured from the mixture of potash and fatty tissue. A number of procedures for this exist: the fatty tissue is heated, then a potash solution or powder is added (for example in the departments of Dabakala and Katiola), or indeed the inverse. The preparation is homogenised by mixture in order to obtain a foamy paste which becomes solid when cooled.

# Chapter II
# SOV-related role-players

## 1. Social organisation and transmission of traditional knowledge

### 1.1. Organisation of traditional healers

The PNPMT lists a minimum of 17 000 practitioners of traditional medicine operating under different designations. Around 80% of them make use of plants for producing their medications, which are used to treat both physical and psychological ailments.

The primary actors in the field of traditional medicine are legally classified by the law of 20 July 2015 (law N°2015-536) according to a number of categories (fig. 4): traditional midwife, chiropractor, herbalist, medico-druggist (who prepares and sells raw material for therapeutic use), naturotherapist (who only uses natural substances for healing), phytotherapist (who heals using the properties of medicinal plants), psychotherapist (who treats mental disorders with medicinal plants and via supernatural or magical powers), bonesetter and finally ritualist (who uses primarily religious or non-religious rituals as treatment). The proportion of different traditional practitioners varies from one administrative region to another (fig. 5).

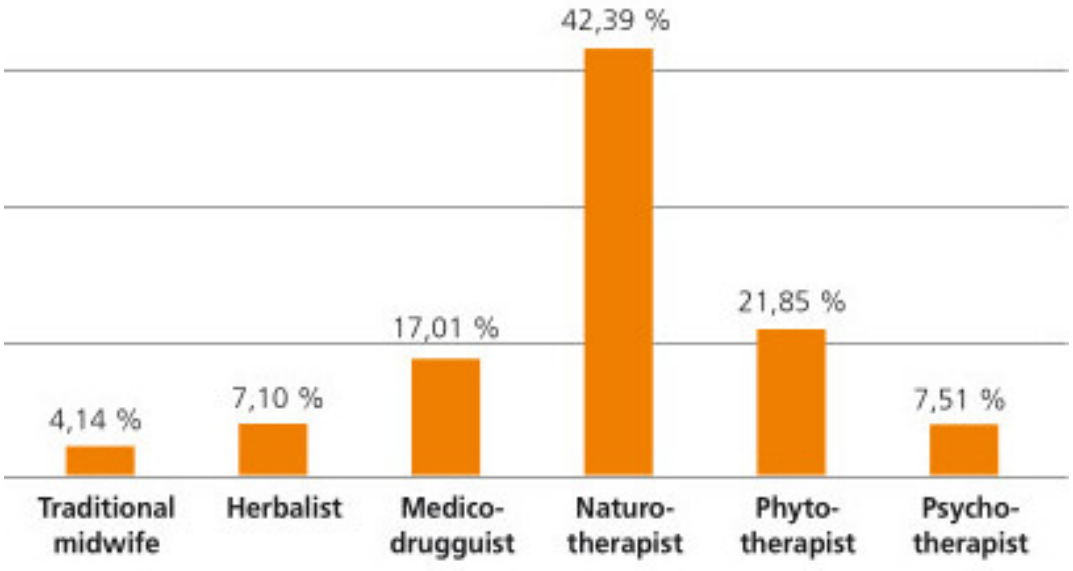



**Figure 4: Proportion of practitioners of traditional medicine by speciality in Côte d'Ivoire (2018).**
**Source: PNPMT**

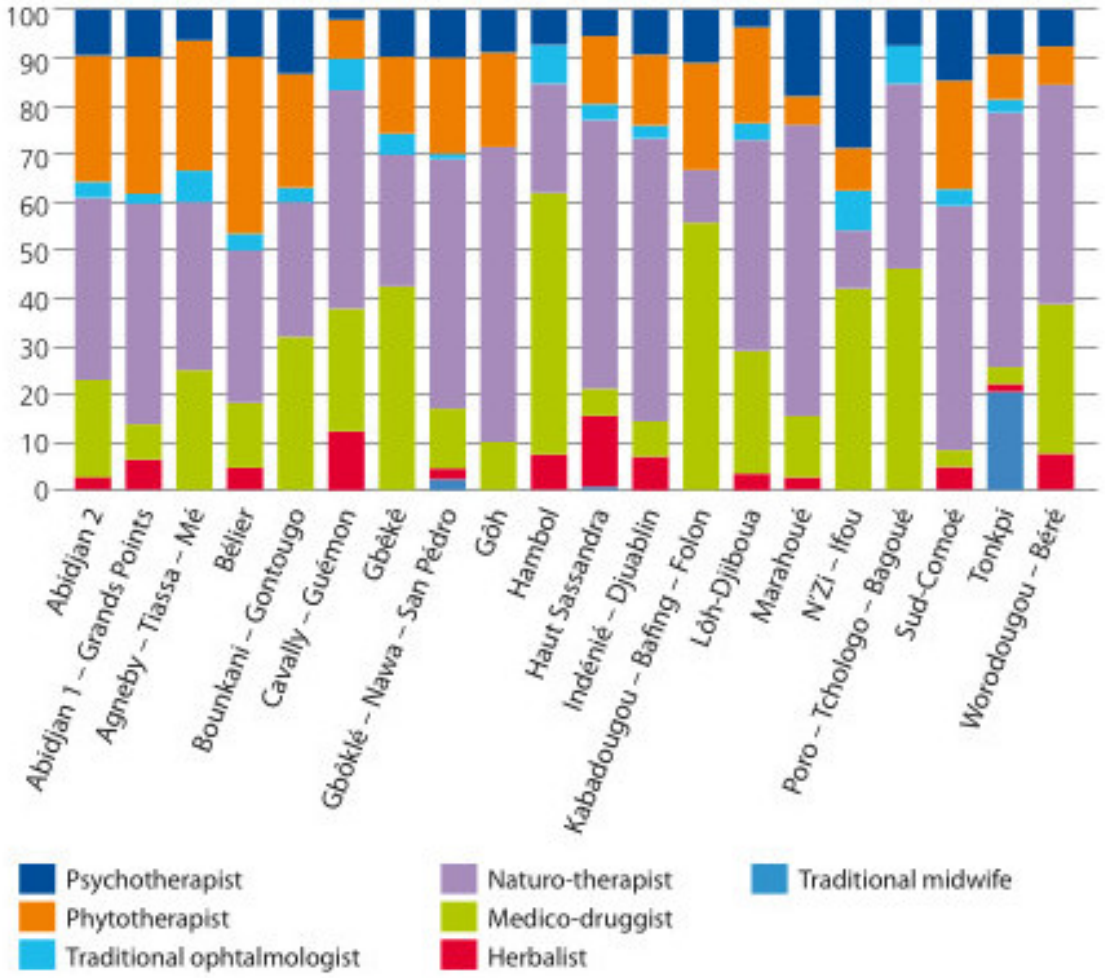



**Figure 5: Distribution of practitioners of traditional medicine by administrative region in Côte d'Ivoire.**
**Source: PNPMT**

Other appellations currently in use include: diviner, diviner-healer, healer and totemist (boxes 7, 8 and 9). Thus, among the Ehotilé, the function of priest practising divination rituals (Komian) is inseparable from the role of healer, and the members of this group occupy a strategic place in the community. As it is, they are considered as interpreters of intermediary genies operating between the visible and invisible worlds (Duchesne, 1996, quoted by Malan, 2009) and use plants for their therapeutic care.

**Box 7**

**Traditional therapists in the Baoulé community**

Among the Baoulé, an ethnic group belonging to the Akan cultural space, there exist some twenty specific organisational structures in the form of ethnic sub-groups, arranged around the concept of the "canton". These often distinguish themselves by their accents or other linguistic intonations, as well as by additional cultural specificities. Baoulé ethnic sub-groups are divided into a southern- (the Agba of the Dimbokro and Bocanda region) and a northern group (the Satiklans of Botro and the Godè of Béoumi).

As traditional health practitioners, they have two principal functions (healer and diviner) as well as a third combining the other two ("diviner-healer"). The diviner practices divination in order to determine the causes of an illness or death. He also predicts the future with the help of genies or the ancestors. For his part, the healer possesses a certain mystical power or the power of vision, through which he protects his patients against evil forces or sorcery. Finally, the diviner-healer diagnoses the illness and proposes a treatment conducive to healing, often while in a trance (Yao, 2012).

**Box 8**

**Traditional healers among the Krou**

Under the appellation "traditional healer" (Tchéro 2013) are grouped together all healers treating patients through empiric means such as herbs and therapeutic gestures. Thus among the Krou it distinguishes three categories of traditional therapists. The healer represents the central function of the healthcare system due to accumulated knowledge about nature. The diviner defines his role by the employment of divination and for a time acted as colleague to the healer, who relied on him for the selection of medicinal plants. Finally, the totemist was invested with a beneficial power (as opposed to malevolent) allowing him to treat the most serious cases via substitution sacrifice (an animal dying in place of the afflicted person).

**Box 9**

**The *komian*, the diviner of Côte d'Ivoire**

Among some people, such as the Ehotilé (a people inhabiting the extreme southeast of Côte d'Ivoire) and indeed all the Akan people, the role of *komian* (a priest practicing divination rituals) is indistinguishable from that of the healer. *Komians* possess a determining social status and occupy a strategic position in the social life of this particular population. Among the Anyi they are held up as interpreters of a type of genie known as a "bosson" (which acts as intermediary between the visible and invisible worlds) (Duchesne, 1996) and as such represent the society's protectors. Komians often acquire their knowledge via inheritance or else directly from the bossons (as part of their initiation). Owing to this traditional religion, the Ehotilé largely dominates the social system. The population's

healthcare management operates according to diverse social practices, which manifest themselves in the use of plants and the invocation of genies according to the diagnosis of the illness made by the healer and according to the religion of the patient (Ainyakou and Mandyan, 2015).

The equivalent among the northern Gur people is the *sandobélé* (priests) and the *djinan* (genies), of which the roles and practices are similar.

## 1.2. Transmission of knowledge and obstacles in traditional medicine

The traditional medication sector is associated with a significant variety of possessors of collective knowledge (Amari, 2009). In some cases the transmission of knowledge and know-how related to traditional medicine is extremely codified and takes place in public medical establishments or jointly between health establishments and specialised families or bloodlines.

Other role-players also engage in the transmission of SOV-related knowledge, notably the family which may pass on a secret related to the practice of traditional medicine from generation to generation. Since the transmission of this knowledge is done orally, it usually remains undocumented, which enables the secret to be maintained. Of course, this mode of transmission can impose certain constraints, such as in the case of the death of a practitioner before the transmission of the knowledge in question, and also within the framework of pursuing a standardisation process for medications containing SOVs.

Speaking more broadly, besides families, castes, native communities and bloodlines, but also villages or cantons, are recognised for specialising in the treatment of certain health problems. Their possession of knowledge thus displays an informal character as a result of accumulation by experience.

The acquisition of local knowledge often occurs orally, through inheritance, via initiations or apprenticeships which globally follow the same patterns from one group to another, albeit with some community-based particularities. The process of acquisition is often long and progressive. The apprentice is only allowed to begin gathering plants once the initiator (father or master) considers him ready.

As examples of initiatory rituals one may refer to the *Dipri*, a traditional celebratory ritual for the New Year and to the yam festival of the Abidji people (a Kwa group), in the department of Sikensi. In the forest the holders of traditional knowledge pierce their stomachs and then treat their wounds by substances including plants. Scarring is instantaneous (Directorate-general for sustainable development, 2016). Another ritual is that of the *Valè Pouè* among the Abouré, for the emergence of the midwife: hygiene and purification is accomplished through plant-scented palm oil (Directorate-general for sustainable development, 2016). In the religion of the Ehotilé, the Nyango cult plant a tree whenever a woman gives birth to her eighth, ninth and tenth child, or to twins; three species are used as *Nyango*: *Baphia nitida*, *Jatropha curcas* and *Newbouldia laevis* (Malan, 2009).

Sometimes one encounters difficulties in transmission from one generation to the next because of the jealous way in which ancestral secrets are guarded by their holders, or as a result of deception. The study conducted by the PNPMT (Kroa *et al*., 2014) enables us to discern that a crisis of confidence among traditional practitioners is the primary cause of their refusal to transmit their knowledge. Insofar as all knowledge plays an identitarian role, making knowledge available to all and sundry poses a problem. The strongest identitarian value of plants lie in their use as basis for the fabrication of poisons, used for hunting

weapons or weapons of war, and which is only transmitted within the relevant group (Fiéloux, 1984).

# 2. Focus on career paths linked to SOVs

## 2.1. University courses offered related to SOVs

Of prime importance is being able to recognise plants in order to avoid marking errors in identification. This is a long-term process of knowledge acquisition. Apart from the different means of transmission of traditional knowledge, training in the proper identification of SOVs can also be acquired in an institutional setting.

A number of training courses have been put in place in Ivorian public universities and prominent colleges aimed at the exploitation of and derivation of value from SOVs. Training courses offered by universities in the field of SOVs are orientation more towards research than ensuring a career outcome, as opposed to the course offered by the INPHB, which produces technicians and engineers for the agricultural sectors and the agrofood business. Thus, at Yamoussoukro the specialist higher education establishment for agronomy (ESA), an integral part of the INPHB, trains high-level engineers and technicians notably in agronomy, agroeconomy, pedology, crop protection and forestry.

In 2011, a department for training in traditional medicine was created as part of the medical sciences faculty of Abidjan. It has been in operation since 2013. In 2014, more than 1 500 practitioners of traditional medicine were trained in anatomy, conventional hygiene, sustainable techniques for the gathering and storage of medicinal plants, as well as in priority illnesses and programmes. The decree of 27 January 2016 (N° 2016-24) on the obligations related to traditional medicines encourages practitioners to undergo training. At the Félix Houphouët Boigny University (UFHB), three faculties offer university courses related to SOVs. In the training- and research unit (UFR) for pharmaceutical sciences, certain specialised courses, such as a Masters in the exploitation of natural substances are offered. The UFR for biosciences for its part offers four courses on the exploitation of SOVs. Finally, the UFR for the sciences and structure of materials and technology has a Masters course devoted to the chemistry of natural substances.

Other Ivorian universities also offer training linked to plants, namely the Nagui Abrogoua University (UNA), with two Masters courses (botany and physiotherapy; chemistry and physico-chemistry of natural substances); the Jean Lorougnon Guédé University (UJLoG) with two Masters courses (biodiversity; bioresources and agronomy); and finally the Péléforo Gon Coulibaly University (UPGC) of Korhogo with notably a Masters in agrophysiology.

For that matter, one centre for biodiversity and another for technological innovation have also been created, which contributes to the objective of the protection of species and plant research.

## 2.2. The pharmaceutical production and control industry

This area is regulated as much from the point of view of medicinal production as access to the profession of pharmacist (see electronic version, III, 4.3. and 6.4.). Conditions

for access to becoming a professional pharmacist are defined by decree N° 173/MSP/DSPH of 18 April 1986.

Concerning production, the rules for the opening and closing of establishments of pharmaceutical production as well as modifications to their organisation are framed by the decree of 18 April 1986 (N° 173 MSP/DSPH). Until 2015, this text served as reference for industrial pharmaceutical production in Côte d'Ivoire.

The law of 20 July 2015 (N° 2015-533) reaffirms the role of a responsible pharmacist, traceability of products and sanitary vigilance. In order to respond to the significant financial requirements of the sector, the proprietors of establishments of pharmaceutical industry for the most part were not pharmacists. This regulation therefore allowed for the development of the pharmaceutical approach in the country, up to that point limited by its economic aspects.

The quality of medicinal products (imported or local) remains a priority in national pharmaceutical policy, which has led to control of refinement units (such as the S-Terre laboratory), which in any case require a fabrication best practices certificate. Nevertheless, certain units of artisanal production of SOV refinement are not subject to inspection and it would be useful to strengthen the framing of these structures. The decision N° 08/2010/CM/UEMOA of October 2010 regarding the practice of fabrication in member states detail the measures to be taken in order to ensure the quality of fabrication of medicines and other pharmaceutical products. The Ivorian pharamceutical regulation authority (AIRP) issues production authorisations to artisanal units specialising in plant-based medications. This authorisation depends on the applicant meeting a minimum qualification level, as well as on the effective application of best practices for fabrication.

The law of 3 August 2017 (N° 2017-541) regarding the regulation of the pharmaceutical sector lends the AIRP the status of independent administrative authority and ensures Côte d'Ivoire is aligned to international standards. A system of quality management has been put in place by the pharmaceutical regulatory authority in order to improve performance in the field and to earn recognition of its abilities in the international sphere. This approach could be usefully expanded and harmonised on a pan-African and subregional scale to support international cooperation.

## 2.3. Commercialisation of plants and phytomedications

Every state has put in place specific rules for the commercialisation and control of pharmaceutical products (box 10). In traditional medicine, women are the primary actors in the processing, conservation and commercialisation of plants and bark (Koua *et al*., 2017). Among them one finds dealers in medicinal plants or herbalists, retailers, wholesalers, collectors. Robust organisation and a functional network of village women and women having moved to the cities have created conditions for the field to flourish.

**Box 10**

**Control and market placement of phytomedications in countries bordering Côte d'Ivoire**

**Senegal**

The Senegalese state wanted to put in place the control of plants used and management of vegetal resources; mastery of the transformation of vegetal resources into viable scientific medicines; a procedure for obtaining authorisation for commercial exploitation of the TMI; oversight of practitioners (respect for a code of ethics, suppression of charlatanism, putting in place of a national commission for the identification of qualified professionals, registration).

In Senegal, five tisanes are prepared by the faculty of medicine and pharmacy studies: an anti-diarrhetic (Mbaltisane©, made from *Euphorbia hirta*), a laxative (Laxatisane, from Cassia italica), an antispasmodic (Mbanta©, made with *Cassia occidentalis*), a hepatoprotector (Bakis©, using the roots of *Tinospora bakis*) and finally an anticough remedy (Elooko©, from leaves of *Guiera senegalensis*).

**Burkina Faso**

Regarding official authorisation, in Burkina Faso only four TMIs have received authorisation for commercial exploitation in the country, namely a cough syrup (Douba syrup) made from an extract of bark from *Entada africana*; an anti-asthma remedy (Kunan© potion) made from *Sclerocarya birrea*; an anti-icteric and antimalarial (Saye© tisane) made from a mixture of roots from *Cochlospermum planchonii*, from leaves from *Cassia alata* and from *Phyllanthus amarus*; and finally an antimalarial tisane (N'Dribala© tisane) made from roots of *Cohlospermum planchonii*[45].

**Mali**

In Mali, while a number of medications are currently in the process of being formulated and thus not yet authorised, we nevertheless count seven TMIs having obtained authorisation for commercial exploitation from the Department of traditional medicine (DMT): an antimalarial (Malarial-5©, combining *Lippia chevalieri*, *Cassia occidentalis* and *Spilanthes oleracea*), a laxative (Laxacassia©, made with the leaves of *Cassia italica*), a tisane against ambien dysentery and diarrhoea (Dysenterial©, made from *Euphorbia hirta*), an antigasterite and antiulcer remedy (Gastrosédal©, containing *Vernonia kotschyana* among its ingredients), a choreletic (Hepatisane©), an anti-cough remedy (Balembo© syrup, prepared from *Crossopterix febrifuga*), a pomade against coetaneous infections (Psorospermine©, using *Psorospermum guineense*).

**Ghana**

The voluntary nature of policy in Ghana regarding the exploitation of medicine and the traditional pharmacological stock manifests itself in the removal of barriers related to quality control and the efficacy of phytotherapy. The law regarding the practice of traditional medicine (2000) explicitly recognises that traditional medicine not only treats physical illnesses but also psychological and social ones. In 2008, the Ministry of health inscribed a series of medicinal plants on the list of essential medication. In Ghana the Moringa constitutes an example of a SOV used for its medicinal use (antioxidant made from nutrients in the

45 https://www.jle.com/en/MedSanteTrop/2006/66.6/606609%20%20Place%20des%20m%C3%A9dicaments%20traditionnels%20en%20Afrique%20(mPousset)%20.pdf [consulted in November 2020]

leaves), but also as food (leaves, under the Minga Foods© label) and beauty products (oil derived from seeds). The totality of the plant is used, and even waste produced by processing of the plant serves as organic fertiliser or for water purification[46].

Phytotherapists are the only ones authorised to prepare and sell TMIs. Among the training modules for practitioners, one concerns the obtaining of authorisation for the commercialisation of TMIs derived from the African pharmacological stock (PPN, 2015).

Since October 2010 the authorisation of pharmaceutical products in UEMOA member states is framed by regulation N° 06/2010/CM/UEMOA. The authorisation for commercial exploitation of phytomedication is awarded by the AIRP following the deposition of a technical dossier examined by a parapharmacy commission in order to evaluate the qualitative and quantitative composition of the product based on a certificate of analysis from the national laboratory for the control of medications.

The decree of 12 December 2018 determining the functioning of the AIRP previews a national commission for medication and other pharmaceutical products. In parallel, in a draft regulatory text is also previewed the creation of a national commission to evaluate phytomedication dossiers and those related to pharmaceutical products. The alignment of these two texts will certainly allow optimisation of the organisation of examination and oversight of these products.

[46] https://www.lemonde.fr/afrique/article/2017/07/31/au-ghana-la-success-story-du-moringa_5167057_3212.html [consulted in November 2020]

# Chapter III
# Prospects for economic exploitation of SOVs

The Convention on biological diversity (1992), ratified by Côte d'Ivoire in 1995, as well as the Nagoya Protocol (2010), has proven that an awareness of the economic exploitation of SOVs could favourably influence the conservation of the most threatened ecosystems, particularly forests. These two texts encourage the putting in place of a mechanism for access to, and sharing of, benefits in order to favour research and development and to establish a balance of benefits between the countries of origin of resources and the holders of knowledge (Laird, 1993; Laird and ten Kate, 2002). Such a mechanism does not yet exist in Côte d'Ivoire. As a result, economic exploitation takes different forms here depending on the role-players involved and aimed at different objectives: public healthcare, nutrition, food sovereignty, conservation of ecosystems and biodiversity, protection of local knowledge, etc.).

The General confederation of businesses of Côte d'Ivoire, the Chamber of agriculture and the Chamber of commerce and industry still make use of approaches to the exploitation of natural substances with little visibility with regard to acquisition and the possibilities of developing innovative products.

Economic exploitation enables the development of new industries (innovation of products or production processes) or the qualitative improvement of familiar products. Nevertheless, proof of the therapeutic, cosmetic or other qualities is not sufficient to conclude the possibility of economic exploitation, which depends on a number of distinct factors (availability of the resource, social, institutional environment, market needs, legal, etc.).

Exploring the potential for the economic exploitation of SOVs of which those properties which could be of industrial interest have been demonstrated is the approach promoted by the biocommerce initiative (BioTrade initiative) of the United Nations Conference on Trade and Development (UNCTAD). The objectives of this approach are the improvement of the value chain and opening commercial avenues, all while retaining conformity to the Sustainable Development Goals or other international environmental agreements[47]. The sharing of benefits should be of concern to all of the parties involved who care about the development of new products or domains.

Detailed case studies enable us to make an assessment of the current state of the SOV value chain in Côte d'Ivoire. While waiting for these to be put into practice, it is useful to consider questions which would help in defining a relevant strategy for Côte d'Ivoire.

## 1. Obstacles to, and objectives of, economic exploitation

[47] https://unctad.org/en/Pages/DITC/Trade-and-Environment/BioTrade.aspx [consulted in November 2020]

Sommaire

Despite the wealth of knowledge about SOVs, many obstacles to economic exploitation exist within the field of healthcare products. A major one, linked specifically to the exportation market, is the absence of a specific legal framework for access to and sharing of benefits relating to genetic resources and associated traditional knowledge in Côte d'Ivoire in this regard, even though such a framework would provide the advantage of resulting in precise prescriptions with regard to recommended resources and uses, as well as recommendations regarding the recognition of local knowledge and its holders, thus ultimately allowing for the putting in place of value chains.

The objectives of the exploitation of SOVs could be multiple: the improvement of public health for urban and rural populations, conservation of biodiversity (cultural development of wild plants traditionally gathered, putting in place of agricultural activities with significant value addition, etc.), promotion of local knowledge related to the pharmacological stock, support to businesses relying on natural ingredients… As some objectives cannot be pursued in tandem, certain priorities would have to be identified.

The major principles which could inspire Côte d'Ivoire with regard to the access to and sharing of benefits derive from the Initiative for strengthening capacity on access and sharing of benefits, piloted by GIZ (Gesellschaft für internationale zusammenarbeit), the African Union's model text, the principles developed by businesses using natural ingredients (Union for ethical biotrade, UEBT), as well as on the BioTrade initiative already mentioned (table 8).

| FINANCIAL BENEFITS | NON-FINANCIAL BENEFITS |
|---|---|
| Fees paid to national authorities for the right to collect specimen samples | Access to credit for local actors and producers |
| Fees for permits or concessions and other administrative fees paid to national authorities | Possibility of taking part in value chains, to identify commercial avenues and to take advantage of them |
| Purchase of harvested products, materials, specimens or biodiversity samples paid to the community (may be subjected to fair pricing criteria) | Training and strengthening of capacity to improve the methods of production, storage, conservation, quality control, etc. |
| Payments agreed to with communities, cooperatives or associations for commercialisation of products obtained from biodiversity | Utilisation of systems of certification and fair trade |
| Sums transferred to local and national preservation funds | Social recognition |
| Exclusivity contracts signed with a community, cooperative or association | Definition of border regulations and territorial rights |
| | Economies of scale or production targeting niche markets to a greater extent |

| | |
|---|---|
| | Constitution of associations and corporate person sin order to participate in sales- and commercialisation activities in a more balanced way |
| | Access to useful commercial information |
| | Job creation and improvement of working conditions |
| | Intangible intellectual property rights (collective markings, geographic indications…) |

**Table 8: Financial- and non-financial benefits of biocommerce related to SOVs**

**Source: According to CNUCED, 2017, p. 43**

## 2. Beneficiaries of exploitation and discount benefits

The economic potential of SOVs can lead to gains for certain role-players or sectors, but also to losses for others. The potential beneficiaries of the economic exploitation of SOVs are many and vary according to the type of resources and the exploitation sectors in question: economic role-players in the field, institutions of basic or applied research, practitioners of traditional medicine and other holders of local knowledge linked to plants, the entirety of the population. Benefits can be direct or indirect and of varied in nature – public health or job creation for example – and operate at different levels, e.g. national, regional or international. As in the case of objectives, it is therefore important clearly to identify and target the direct or indirect beneficiaries of exploitation projects in order correctly to evaluate the strategy to be implemented.

## 3. The value chain from the perspective of sustainable development

Value chains consist of more-or-less the same stages with regard to one product to another: collection or cultivation, sale of raw materials by exporters, then by importers, wholesalers, intermediaries, brokers and wholesalers; transportation; processing, ultimately exportation. For all of these stages economic studies are currently lacking, and the undertaking of which would be important in the years to come.

Developing one stage or another of the value chain depends on the chosen objectives and the targeted beneficiaries. Other objectives can be pursued with an eye towards economic exploitation, such as conservation and biodiversity, and the recognition and promotion of local knowledge: according to the importance accorded to these factors, local or imported plants are favoured, as are common or rare species, and cultivated or wild ones.

Legal questions are mixed into these considerations, since property rights determine the conditions governing access to with regard to plants in the wild. At the same time, the exploitation of SOV value chains raises questions regarding the holders of associated knowledge, notably in cases where a plant is common to a number of geographic zones or countries, since the recognition of rights in such cases proves even more complicated. All along the value chain attention has to be paid to questions of intellectual property and to protected trademarks or patent pending procedures.

A comparatively less risky option could be the market placement of natural ingredients for pharmaceutical purposes, for cosmetics, for perfumes, etc. as entry point for the eventual marketing of SOVs themselves. In such a case, diversification and exploitation bears on agricultural and agroforestry production. The expected benefits depend notably on existing competition with regard to products, production costs, vegetal quality or global prices.

From the perspective of sustainable development, the reproduction of a resource, its renewal and the maintenance of its natural milieu are indispensible. Businesses should not be based on the marketing of endangered resources until conditions for the sustainable exploitation of these resources have been met.

# 4. Markets

African markets for natural substances are not well known. At the same time, the extent of exportation and international markets with regard to natural cosmetic, food-related and phytotherapeutic ingredients is not well known either. Among export product, a few products used in phytotherapy have seen an increase in demand (*Prunus Africana*, *Harpagophytum procumbens*), as have some used in perfume production (bergamot, box 11), in cosmetics (shea, box 12), and used as food supplements (Hoodia gordonii). Globally, all markets for natural ingredients have seen a significant expansion. Thus global commerce in aromatic and medicinal plants has almost tripled in value between 2008 and 2018, causing concern for the straining of resources. Food supplements have also seen very significant development, such as plant-based natural flavorants originating in West Africa, for example monellin (extracted from *Dioscoreophyllum cumminisii*), thaumatin (extracted from *Thaumatococcus daniellii*), miraculin (extracted from *Richardella dulcifera*) or brazzelin (extracted from *Pentadiplandra brazzeana*).The market for beauty products in Africa is expected to double in the coming decade, with a projected growth rate on the order of 5% to 10% (UEBT, 2017). In this cosmetics sector certifications have seen a significant market progression (organic, fair, derived from sustainable cultivation…).

## Box 11

## Bergamot essential oil production in Côte d'Ivoire
## The Coci example

Widely cultivated in Calabria (southern Italy) for more than 600 years, bergamot (*Citrus aurantium spp. Bergamia, Rutaceae*) is a small citrus resembling a lemon with a thick, greenish-yellow peel. Once ripened, it can reach 80 to 200 g in weight.

### Essential oil, a bergamot flagship product

Bergamot is cultivated in a number of African countries, among which Côte d'Ivoire, which is the second largest producer of bergamot[48] essential oil, far behind Calabria (boasting 80% of global production). Harvesting is done between November and January, by hand given the fragility of the fruit.

Rarely used as food (excepting for a few speciality purposes such as Bergamot from Nancy candy and as food aromatic), it is more frequently used as essential oil, which possesses calming-, antispectic- and antispasmodic properties and benefits, as well as serving as effective remedy for insomnia. It is also used in the manufacture of perfume (as a component of eau de Cologne and numerous deodorants for men), but additionally in cosmetics and aromatherapy.

### Exploitation now operating on a large scale

The history of bergamot essential oil in Côte d'Ivoire goes back to the 1950s in the Sassandra region. When the opening of the port of Abidjan in 1951 dealt a death blow to the local sweet banana industry, formerly the most prosperous of the local industries, local growers (African and European) converted their operations into the cultivation of citrus instead under the leadership of Louis von Blom who, anticipating the coming transformation in the sector, in 1943 had introduced the *Eureka* lemon, grafted onto the sour orange. His example, followed by other European large-scale planters, and then by a growing number of African small cultivators, led to the rapid growth of a dynamic citrus industry. From 1953 onward the European pioneers ascended to the level of large-scale cultivation by purchasing materials necessary for the extraction of essential oils, while the African cultivators banded together in cooperatives concentrating on the cultivation of the fresh fruit instead. The number of growers increased from 10 to 186 between 1960 and 1975, and the cultivated land area from 500 to 2 000 ha between 1965 and 1970. Production increased from 5 000 to 9 000 tonnes of citrus between 1966 and 1968.

In 1969, six European growers (von Blon, Cousin, Delafosse, Gazelle, Roucou and René Pierre) were dealing in more than 10 000 tonnes of fruits and also trading in fruit following the extraction of oil, these remnants usually discarded. In view of the growth of the citrus agricultural industry and the desire expressed by the producers also to engage in their own processing, the government responded by creating an agro-industrial complex called the "Côte d'Ivoire consortium of citrus and perfume plants" (Coci), a company sporting government participation as majority investor. In April 1994 the majority shareholder stake in Coci passed to Coopagrum, uniting 470 growers operating plantations of various sizes making up a total surface area of 4 551 ha.

From lemons, bergamot, sour oranges and limes, Coci produced essential oils, lemon juice and citrus pomace (dried citrus peel) which are exported to France, Germany, the United States and the United Kingdom.

[48] https://www.tourismeci.org/secteurp.htm [consulted in December 2020].

Coci essential oils were prized on the international market because of their clear qualities and their purity (no trace of organochlorines or pesticides, which is essential for the fabrication of medications and food products). Chemical analyses of samples from various locations carried out by the French overseas fruit research institute in the 1960s revealed an abundance of limonene, linalool and linalyl acetate. Essential oils from Côte d'Ivoire are characterised by their relative richness in free alcohols.

**Market fluctuations**

Global production of bergamot essential oil, which in 1990-1991 reached between 80 and 100 tonnes per year, was divided exclusively between Côte d'Ivoire and Italy. With regenerated areas also beginning to yield produce over the course of the following years, Coci's production increased rapidly, reaching 1 500 tonnes in 1997.

The market has seen significant fluctuations due to the development of synthetic products, cheap alternatives to medium-range products, and due to the demonstrated phototoxic properties of bergapten – although a solution to this problem was discovered in the 1990s.

Outside of Italy, the production by manufacturers of bergamot essential oil (Morocco, Argentina, Brazil, Guinea and Côte d'Ivoire) currently represents only 15% of the global market[49].

Coci saw successive restructurings and finally closed its doors shortly after the year 2000. The production of bergamot essential oil, ever since wholly entrusted to the free market, is currently practiced by a few small industrial entities scattered across the country.

Finally, the question of markets raises a number of strategic problems. Thus, the existence of an already-existing dynamic market with a strong demand is not necessarily a slowing-down factor to the development of an Ivorian offer in the same sector, such as Prunus africana. For currently-featured plants the market may already exist, which enables a return of experience but also allows for the envisioning of future competition. Being intimately familiar with consumer expectations (texture of products desired, their appearance, their conditioning, etc.) and the applicable regulations is an essential condition for knowledge of the targeted market.

Ultimately, two very different strategies emerge: innovation within the sectors or participation in existing sectors which feature high demand and established distribution networks. To these strategies are added the question of envisioned market scale (regional, national or international): depending on the product, the strategies don't have the same relevance at different scales and quotas, restrictions and non-tariff-related measures should be taken into consideration (UNCTAD 2018a, 2018b, 2018c, 2018d). Finally, the problem of public or private investment, or public-private partnership, has to be considered. The appropriate level both for strategy and action has to be precisely determined for each substance to be exploited.

In order to synthesise the choices necessary for a SOV strategy in Côte d'Ivoire, state authorities could elaborate a number of scenarios based on some SOV products available in the country in order to create a projection of their evolution in order finally to come to a

[49] https://www.passeportsante.net/fr/Solutions/HuilesEssentielles/Fiche.aspx?doc=huile-essentielle-bergamote[consulted in December 2020].

perspective orientated according to environmental, social, economic, industrial and scientific implications with regard to the various options envisaged.

**Box 12**

**Potential and challenges for the construction of a shea industry in Côte d'Ivoire**

**Properties, uses and economic significance of shea**

Shea (*Vitellaria paradoxa*), formerly known as Butyrospermum parkii, produces a nut containing an almond used for food-related-, medicinal and cosmetic purposes, as well as for manufacturing soap. Its greatly varied composition of saturated and unsaturated fatty acids, as well as of insaponifiables, reveals interesting properties with regard to nutraceuticals. Currently shea butter is used in the manufacture of moisturising body lotions (up to 15% to 20% of content), of liquid gels for showering or shampoos (up to 15% to 20% of content), of soaps (up to 70% to80% of content), of lip balms and numerous other personal care products. It is particularly used in a range of food products, from chocolate to margarine, and including confectionary.

According to the Global shea alliance (AGK) the shea value chain provides direct or indirect employment to around 16 million Africans. Raw shae is produced in West Africa (table 9) where a dozen countries participate in its exploitation. Global demand for shea exceeds 5 million tonnes.

The total value of shea butter exports has increased from 1.5 million to 52 million USD between 2000 and 2012. With regard to shea almonds, the average rate of annual increase in exportations from the region for the period 2002-2012 reached 26.9%. The Netherlands is the largest importer of shea butter from West Africa, followed by Denmark, France and China. Currently it is estimated that the chocolate industry accounts for 90% of purchases of shea in nut form.

| Country | Estimate of total production (in tonnes) | Estimate of annual collected quantity | Consumption (estimate) | Total quantity exported | Quantity of almonds exported | Quantity of shea butter exported |
|---|---|---|---|---|---|---|
| Significant exporters in West Africa: Burkina Faso, Benin, Mali, Ghana, Togo, Côte d'Ivoire, Nigeria | 1 130 00 | 585 000 | 321 900 | 263 100 | 217 000 | 46 100 |
| Small exporters in West Africa: Gambia, Guinea (Conakry), Guinea-Bissau, Niger, Senegal, Sierra Leone, Cameroon, Chad | 81 200 | 17 600 | 13 590 | 4 010 | 2 950 | 1 060 |
| Other producing countries: Ethiopia, Sudan, Uganda, CAR, RoC | 191 000 | 19 350 | 19 050 | 300 | 0 | 300 |
| Total | 1 402 200 | 621 950 | 354 540 | 267 410 | 219 950 | 47 460 |

**Table 9: Estimate of African shea production.**

**Source: Holtzman, 2004**

## Revenue generated in Côte d'Ivoire

Sporting an annual production of 40 000 tonnes of nuts and processing between 10% and 30% of fruit, Côte d'Ivoire occupies the fifth place worldwide in this regard[50].

On a socio-economic level trade in shea almonds and butter constitutes a significant source of income for the rural women who are the main role-players and the first link in the industry value chain (table 10). Over the course of the harvesting season, stretching every

[50] Documentary devoted to the shea industry in West Africa:
https://www.youtube.com/watch?v=O5fWMXHGLzc&t=426s
https://www.youtube.com/watch?v=DhWeOWiQMl8&t=405s

year from June to October, the gathering of fruit growing wild in batches in Côte d'Ivoire's "shea parks" provides a woman engaged in the production of shea butter with an income estimated at between 85 000 and 100 000 CFAF. During the same time period, the total amount resulting from the sale of shea pulp and butter undertaken by a female trader in urban marketplaces is calculated at 2 300 000 CFAF. Similarly, shea product wholesalers can aspire to a profit of between 4 and 10 million CFAF per season. Within this sector, 90% of the role-players are women, their number estimated at around 12 000[51].

| Regions | Processing capacity (in tonnes) | Almond production (in tonnes) |
|---|---|---|
| **Hambol** | 972 | 1 350 |
| **Tchogolo** | 10 044 | 13 500 |
| **Poro** | 14 580 | 17 550 |
| **Bagoué** | 2 268 | 9 450 |
| **Kabadougou** | 648 | 1 350 |
| **Bounkani** | 3 564 | 90 450 |

**Table 10: Shea almond- and butter production capacity.**

**Source: BNCIK**

## Industry operations

On a national level four major groups of role-players or professional agricultural organisations engage in the day-to-day operations of the industry across the Ivorian territory:

–the Shea industry of Côte d'Ivoire (Fika-CI) was created on 12 May 2012 in Abidjan. Its status as legal entity is based on law no 60-315 of 21 September 1960, relating to associations;

–the national office for the creation of an inter-professional union of shea producers (BNCIK) was put in place on the premises of the Ministry of agriculture in March 2014 by role-players in the Côte d'Ivoire shea industry[52];

– the Ivorian shea network (Rika) is made up of around 1 120 members and is located in the Korhogo region;

– the economic interest group GIE-Enzepie is made up of producers and processors of agricultural products, including shea.

On an international level two global entities sporting local representation in Côte d'Ivoire and affecting the shea industry are the Global shea alliance (AGK) and UN Women.

Since 2019 the production of shea in Côte d'Ivoire has been certified as organic, which should ease its access to European markets and enable more elevated pricing.

[51] https://ojs.ugent.be/AF/article/view/5050 [date of consultation: February 2021].
[52] www.http://psndea.ci [date of consultation: February 2021].

As far as concerns its significance for the empowerment of women in shea-producing regions, the Inter-professional fund for agricultural research and counsel (Firca) since 2014 has undertaken to contribute to the raising up of a shea industry that is better structured and more dynamic. In 2017 UN Women has matched step with this ambition via its programme for women in agriculture and sustainable development (AgriFED).

**Challenges surrounding approaches underway**

The challenges are:

– for production: ensuring the maintaining of existing wooded parks and facilitating access to, and control of, land by women. Achieving the cultivation of species and creating wooded parks to ensure the sustainability of cultivation;

– for processing: achieving the modernisation of the entire processing chain in order to reduce the hardships imposed on women by their labour. Increasing the yields obtained from processing and ensuring better storage and packaging of products;

– for commercialisation: developing a professional pathway to commercialisation on national, regional and international level. Creating a "*Made in Côte d'Ivoire*" brand to add value to national products.

– for structuring: placing the industry on a more professional footing and ensuring its control by women;

– for mobilising resources: mobilising resources from technical and financial partners; mobilising resources within the shea industry and ensuring proper management.

**Production zones**

Shea grows naturally between latitude 7°45' and 10°45' North, in an area where annual rainfall varies between 600 and 1 500 mm.

Shea-producing regions in Côte d'Ivoire are characterised by an abundance of plantations stretching on as far as the eye can see in the country's north. A dozen regions are implicated: Bafing (Touba), Bagoué (Boundiali, Tengréla), Béré (Mankono), Bounkani (Bouna), Gontougo (Bondoukou), Hambol (Katiola, Dabakala), Kabadougou (Odienné), Poro (Korhogo), Tchologo (Ferkessédougou) and Worodougou (Séguéla) (map 2).


**Map 2: Map of the geographic location of shea-producing regions.**

**Source: geography unit of the directorate of archives of the Ministry of foreign affairs, 2004**

# Conclusion

Our collective evaluation has highlighted the essential role of SOVs from simultaneously a public health, collective identity,a s well as economic and sustainable development perspective in Côte d'Ivoire.

In terms of public health, scientific and ethnobotanical knowledge regarding plants have been shown to be extensive and diverse, at the same time with regard to diseases they could treat and their multiple uses in traditional medicine. The latter has proven itself important to make up for the lack of access to Western medicine outside of urban areas (having direct recourse to plants or else indirectly via the intervention of a traditional healer). The Covid-19 healthcare crisis, associated with a marked enthusiasm among the population in favour of natural treatments should necessarily signal to the Ivorian health system the value in a more structured integration of SOVs as part of hospital procedures and primary health care. Thus the strengthening of local capacities with regard to SOVs (cultivation of plants and phytomedicines) in order to meet national demand in the healthcare sector would lend Côte d'Ivoire greater resilience by reducing as much as possible its dependence on foreign aid in this regard.

SOVs also make up an integral part of the richness of the Ivorian identity, due to the extraordinary biodiversity of its natural landscapes, particularly visible in national parks and classified forests or in other protected zones. Their identitarian significance manifests itself in the number and social importance of traditional practitioners, as well as in the totality of the rituals and ceremonies utilising SOVs as part of the spiritual and social life of the country's communities.

Finally, as a result of their abundance, as well as their variety, Ivorian SOVs constitute a foundational element of the national economy, operating both informally and formally. Whether one is talking about plants picked in the wild or cultivated ones, the question of respecting the environment arises in terms of the preservation of the landscape and the protection of biodiversity alike. In wild forest areas the methods of gathering, as well as the amounts collected raise the question of environmental management; in the context of monospecific crops the fragility of such crops in the face of disasters, the reduction of soil fertility and recourse to chemical inputs leads to questions around systems of sustainable agriculture as much as to those dealing with economic viability.

With regard to both sectoral and local strategies, the cultivation and exploitation of SOVs (organisation of production, intellectual property protection, structuration of the industry, environmental protection…) should be developed in harmonious conjunction with the habits and customs of populations. The regulatory and legislative framework is in the process of being standardised on a national and international level, which facilitates commercial exchanges and the sharing of successful experiences and lessons learned (see electronic version, annex 1).

# PART IV

# RECOMMENDATIONS

The 17 recommendations which follow devolve logically from the developments presented in the assessment, and can be expressed according to the following four-fold thematic division:

– the environment and preservation of biodiversity;

– multidisciplinary research, innovation, employment sectors, training towards professional qualifications and certification;

– application- and derivation of benefits sectors;

– economic development.

Apart from a great deal of data gathered and analysed, these recommendations are also in part based on the WHO strategy for traditional medicine as outlined in its 2014-2023 plan[53], as well as on the WHO African regional committee strategy regarding the strengthening of the role of traditional medicine in healthcare systems: a strategy for the African region[54]. Nonetheless, our recommendations are aimed at providing insights more specifically dedicated to Côte d'Ivoire.

While interconnected, these recommendations should be approached in a systematic way in order to ensure benefit is derived from Ivorian plant-based substances in a sustainable manner. They are primarily destined for the administrative and political authorities operating within the relevant sectors, and more widely for all the public- and private sector role-players, as well as those associated with them, concerned with the management and beneficial exploitation of SOVs in Côte d'Ivoire.

# 1. The environment and biodiversity preservation

**R.1. Ensuring the sustainability of the provision of resources by promoting the protection, domestication, selection, improvement and adaptation of varieties to conditions of production and local use.**

The sources used for obtaining plant-based resources should be subjected to some form of organisation or operated according to a simple management plan in order to ensure the sustainability of the resource's biological ecology, as well as of its economic- and social sustainability.

The floral heritage of African countries has often been subjected to local overexploitation, as well as to a veritable pillaging by the industries situated in northern hemisphere countries, rendering its conservation difficult. This heritage will require the making of a considerable effort to ensure it is inventoried, as well as the putting in place of a

[53] OMS, *la stratégie de l'OMS pour la médecine traditionnelle pour 2014-2023*, 2013, p1-p76. ISBN 978 92 4 250609 9. https://www.who.int/publications/list/traditional_medicine_strategy/fr/

[54] Comité régional de l'Afrique, 63. (2013). Renforcement du rôle de la médecine traditionnelle dans les systèmes de santé : UNE stratégie pour la Région africaine (Document AFR/RC63/6). OMS. Bureau régional de l'Afrique. https://apps.who.int/iris/handle/10665/96491"

conservation policy. This effort should be supported by northern hemisphere countries on the basis of standard agreements ensuring an equitable division of both responsibilities and results, in all cases respecting the terms of the Nagoya Protocol. This effort also cannot be properly undertaken without the strengthening of research capacities in southern hemisphere countries.

From this perspective it is necessary for southern and northern countries alike to adopt whatever procedures would be required to ensure that the intensive gathering of specific Ivorian plants does not compromise their very existence, does not disturb any ecological balance and does not lead to the erosion of any ecosystems. As a result, it seems necessary to facilitate the harvesting of such plants by rural communities, and notably the most disadvantaged among them, thus creating a two-fold benefit of combatting poverty while also conserving plant-based biological diversity. Furthermore, territorial organisational plans should include the creation of areas that are both protected and devoted to species or plant-based elements of particular interest.

It is within this context that the expert committee recommends the expansion of agricultural diversity within small-scale, family-based cultivation practices in Côte d'Ivoire via the adoption of a few flagship species including, for example:

– Ocimum gratissimum (more commonly known as clove basil). A plant from the Lamiaceae family already domesticated and used in traditional Ivorian medicine in the form of essential oils for its numerous healing properties (notably for combating cytotoxins, as antioxidant and anti-fungal agent). It is also known for acting as organic pesticide;

– Lippia multiflora (more commonly known as the Gambian tea bush). Present in Côte d'Ivoire, used in the production of essential oil. Its cultivation in Côte d'Ivoire is not currently practiced at a high level, though it is increasingly traded, possessing biomedical and food-related benefits as determined through numerous scientific studies.

**R.2. Strengthening protection of sacred woods and forests in the face of threats posed by urbanisation and large-scale agriculture.**

"A reminder that, of 16 million hectares of forest existing at the beginning of the 20th century, the residual forest surface area in 2015 represented only 3.4 million hectares, i.e. an average rate of decrease of more than 200 000 ha per year. At this pace the Ivorian forests will have disappeared in about ten years" (Ministry of water and forestry, 2018). Among the threats responsible for this deforestation both large-scale farming and urbanisation have been identified.

The Côte d'Ivoire national forestry- and fauna census (IFFN), underway since 2019, will enable an assessment of the situation and the determination of strategies and objectives to ensure better exploitation and a planned management of biodiversity and the national heritage.

The 2019-2030 strategic plan put in place by the Ministry of water and forestry (MEF)[55] aims at strengthening interactivity, and overcome contradictions, among its development goals in order to ensure the putting into practice of a planned policy for the conservation, repopulation and extension of forests in Côte d'Ivoire.

[55] Reference document: Decennial emergency plan for putting in place astrategy for the conservation, repopulation and extension of forests in Côte d'Ivoire: Conservation, repopulation and extension of rural-area forests – Support for the creation of forests for use and for the placing on a professional footing of the wood-energy industry.

It is important that such a specific approach improves the framework for the sustainable exploitation of non-wood-based forest materials as well as reinforces the forest-based usage rights of local communities, all while promoting the conservation of natural forests in the appropriate areas among both individuals and communities.

In order to ensure optimal interministerial coordination with an eye towards the putting into practice of the various national plans related to this type of organisation, administrative entities and intersectoral committees should be strengthened in a way that blends all applicable elements together.

### R.3. Creating a reference guide specific to SOVs.

It is recommended that a specific reference guide be created, and regularly updated, in which is indicated the specific links between SOVs and sector-specific regulations aiming at a strategic utilisation for the protection of public health, as well as the protection of the environment and biological diversity. The economic role-players in industries served by SOVs should be made aware of the creation and availability of this SOV-specific reference guide and to the challenges surrounding the vulnerability of natural resources, as well as to legal implications related to the quality and safety of products emanating from the industry.

A process aimed at the linking of already-existing, albeit fragmented, initiatives should be prioritised. The creation of bridges between these diverse initiatives, such as the setting up of a network of herbaria to ensure the cataloguing of all plants in Côte d'Ivoire, should be considered. Cooperation among the various Ivorian role-players operating in the sector, e.g. the National centre for floristry and its botanical gardens in Cocody or the Aké-Assi research centre, should be promoted. In this regard it would be useful to create an interinstitutional pilot group made up of such institutions, under the auspices of the Ivorian government, to take stock of current conditions and to initiate the beginning of such a network.

This reference guide could be rounded out by the creation of an entire series: wooded parks, in vitro conservation (vitroplants), cryoconservation, *ex situ* conservation, duplication of catalogues, augmenting catalogues with SOVs derived from novel exploration within Côte d'Ivoire and the subregion, etc. This series could be national or regional according to the areas of development and exploration in question.

## 2. Multidisciplinary research, innovation, employment sectors, training towards professional qualifications and certification

### R.4. Creating a sharing- and operational platform related to medicinal plants.

Among its other functions, this platform would also enable the promotion of the place of traditional medicines among other healthcare options. This would be achieved via close cooperation between the Ministry of health – notably the national programme for the promotion of traditional medicine, which deals with specific issues related to biodiversity – the Ministry of higher education and scientific research and the Ministry of water and forestry, as well as academic institutions and practitioners of traditional medicine in order to

formulate national policies around traditional medicine and to come up with initiatives and flagship programmes within this sector.

A useful initiative would be the adoption of a national list of medicinal plants possessing possible therapeutic- or economic benefits[56]. Such a list could be divided into two groups according to the pharmacological catalogue of other countries, such as France:

– list "A" noting plants that are traditionally used;

– list "B", plants traditionally used in processed form of which the negative side-effects outweigh any expected therapeutic benefits[57].

This platform should focus particularly on applied research into traditional medicine and on the different aspects of research into medicinal plants: identification and classification of plants; phytochemistry; pharmacology and clinical trials aimed at therapeutic application; study of psychosocial and cultural aspects as well as behavioural patterns; personal development and technical training of healthcare units and, above all, designing effective instructional methods; the role of traditional medicine in medical research related to illnesses identified as "priority"; promotion of research activities related to the integration of different medical systems.

The expert committee also recommends setting up a naturotherapy clinic as part of the University hospital centre (CHU) in Cocody. The proximity of this centre to the training and research centre (UFR) for medical sciences, the UFR for pharmaceutical and biological sciences and the UFR for biosciences will encourage collaboration between researchers and the practitioners of traditional medicine who will be running the clinic.

**R.5. Creating a national institute for research into complementary medicine and the traditional pharmacological stock, as well as for raising awareness among the youth[58].**

In order to gain maximum benefit from research and innovation done in relation to SOVs, notably in the healthcare and wellness sector, the creation of a national institute for research into the pharmacological stock and traditional medicine – equipped with the latest instruments for research into bioactive substances – is recommended.

Such an institute, bringing together researchers in different disciplines related to pharmacological- and healthcare sciences would promote integrated and participative research toward the development of traditional medicines improved (TMI) derived from plants and from traditional local recipes, the standardisation of products and the means of monitoring medicinal plants. It could also ensure the evaluation of the national floral stock and the creation of means of integrating traditional practices into the system of primary healthcare.

The creation of a designated research fund and/or annual calls for thematic projects on the part of the Fund for science, technology and innovation (Fonsti) aimed at advancing the use of pertinent SOVs is indispensible for supporting and stimulating research activities related to plant-based substances in Côte d'Ivoire.

[56] Close to 200 different medicinal plants have been listed as used by healers operating between Tai and Abidjan by Weiss (1997).See also: Cellule d'aménagement du parc national de Taï, 2000; Minesudd, 2016.
[57] This terminology enables some exploitation even though lacking scientific proof (list A) or, on the other hand, provides fair warning of possible undesirable effects.
[58] Such a project, initiated by the Ministry of health, public hygiene and universal healthcare cover is currently underway under the auspices of the PNPMT.

From the point of view of developing research on SOVs, training the younger generation (especially students in schools and universities) to recognise the plants growing in their natural surroundings could be enhanced (via field trips of a botanical- and ethnobotanical nature, virtual outings, etc.).

In this regard it seems relevant to raise the awareness of university- and high school students in a more systematic way with regard to knowledge and recognition of the plants inhabiting Côte d'Ivoire's regions via visits to botanical gardens and herbaria as part of their courses as well as, ultimately, through the actual creation of herbaria.

Enhancing both the attractiveness and interest raised by the subject matter could further be accomplished by the staging of free exhibits in botanical gardens featuring the different Ivorian SOVs with simple and easily-understood presentations of their biological features, their therapeutic and biological benefits, their social and cultural uses, their vulnerabilities…

**R.6. Prioritising and supporting the putting in place of specific training courses, the completion of which would entail the awarding of formal qualifications and diplomas, with regard to the entire gamut of SOV-related sectors.**

Aimed at developing and putting in place specific training courses for all role-players in the SOV industry, notably relating to best production practices and the putting together of applications seeking authorisation for the introduction into the market of traditional medications improved. The Ivorian pharmaceutical regulatory authority (AIRP), created in February 2020, grants authorisation to small-scale entities engaged in the production of plant-based pharmaceuticals, the application for which requires that the applicant (pharmacist, traditional healer, pharmacists-in-charge…) possess specific qualifications and competencies related to production best practices. In this regard the enhancement of studies related to the Ivorian pharmacological stock within the UFR for pharmacy is recommended. Conceivably extra credit could be awarded for recognised and integrated knowledge gained from professional experience towards the awarding of a diploma as part of the certification system.

Training courses aimed at the eventual awarding of formal qualifications and structured in module form (e.g. according to the European credits transfer scale – or ECTS – format) properly adapted to their targeted market, joining together practical coursework, supervised coursework and lectures, should be encouraged and supported. The strengthening of teaching methods adapted to the local context, the refurbishment or even brand-new outfitting of teaching laboratories in training units (with for example subscriptions to plant-based taxonomic data bases, microscopes, etc.) is also required.

One may note that a number of training courses already exist, from curricula devoted to the chemistry of natural substances to pharmacology and phytotherapy, as well as agriculture. These courses are on offer within different training and research centres (UFR) attached to various universities and other educational institutions in Côte d'Ivoire. It is recommended that these training courses, whether aimed at the obtaining of formal qualifications and structured in module form or adapted for short-course format, be offered within the framework of these research and training centres and thus made available to all those engaged in professions related to SOVs (e.g. traditional healers, farmers, etc.). An important point to note is that notably teaching modules dealing with best practices in the

production of especially plant-based medications[59] capable of promoting the quality of medications for sale should be enhanced and elaborated. In this regard traditional healers constitute a priority target group to be engaged via these training courses.

Beyond the necessity of strengthening Ivorian capacity in the field of SOVs, it is essential to create and enhance links among the academic-, financial-, socio-economic- and innovation sectors (see recommendation 11).

**R.7. Creating a registry of local names and their meanings as used in the various regions of Côte d'Ivoire, while also undertaking more exhaustive ethno-taxonomic studies.**

According to the systems of international classification the names of certain plants have a tendency of changing based on the evolution of scientific knowledge available about them at any given time. Thus a number of criteria are relied upon in deciding on the taxonomic term used to designate a particular plant. In this regard indigenous knowledge could constitute an indispensible aid to the various identification-, classification- and popularisation strategies for plants derived from this process. At the same time, a register of names in local languages could serve as reference guide in case of confusion arising between two different types of classification.

Currently some piecemeal work on this subject has been done, but it is necessary to combine these efforts with an eye to standardisation and to facilitate their processing into a single, commonly-usable system of classification of scientific names.

Eventually, apart from the scientific names of plants, it will also be important to indicate their local names. This second step will be essential for the effective dissemination and appropriation of this knowledge among the entirety of the Ivorian people, as well as of such practices as may be related to them.

Such an initiative could be undertaken under the auspices of the Directorate-general of the Ministry of higher education and scientific research (MESRS) as part of the national programme for the promotion of traditional medicine, and by local governing structures able to do so (see recommendation 4: creating a sharing- and operational platform in relation to medicinal plants).

**R.8. Making an inventory of SOVs used as part of the traditions and customs of Côte d'Ivoire, notably in traditional ceremonies, initiation rituals, etc.**

Such a tool could ensure better monitoring of areas home to particular natural resources, as well as of their abundance. In addition, identifying the possessors of knowledge could raise their profile and better define their status, notably with a view toward improving their practices in terms of safety, protection and drawing maximum benefit from the financial returns associated with these practices.

At a governmental level a number of initiatives for undertaking such an inventory have seen the light. In 2016 the directorate-general for sustainable development of the Ministry for the environment and sustainable development carried out an initial, non-exhaustive cataloguing of traditional practices and customs in Côte d'Ivoire (Ministry for the

[59] For more information and also for purposes of drawing inspiration, one may download the production best practices guide of the national agency for the safety of medication- and healthcare products (ANSM), notably annex VII: https:/ansm.sante.fr/documents/reference/bonnes-pratiques-de-fabrication-de-medicaments-a-usage-humain

environment and sustainable development, 2016). Such an initiative could be refined and completed in order to include additional regions of the country, the effort notably undertaken in collaboration with other ministerial entities (e.g. the PNPMT, the MESRS, the MEF).

**R.9. Raising the profile of local knowledge representative of the regions of Côte d'Ivoire via various forms of recognition.**

Côte d'Ivoire is known for its rich cultural heritage, and each region is marked by numerous representations of this heritage, or by specific cultures. The originality of traditional knowledge could be highlighted by public recognition bestowed in the form of the awarding of an annual prize. Products representing regional selections could be displayed as part of a national competition and promoted via the awarding of a prize.

Recognition as part of either the material or immaterial cultural heritage could be one of the ways of raising the profile of the winners of these types of competitions as much as possible. Implemented in conjunctions with other recommendations, this recognition could have positive impact in terms of economic development, but also in terms of preserving the cultural heritage of Côte d'Ivoire, such as through the protection of wooded areas and sacred forests (recommendation 2).

The promotion of this knowledge and the plant-based substances used as part of cultural practices could also be prioritised during certain key traditional gatherings (poro, tchologo, fertility festival, etc.). This could be accompanied by a widespread raising of awareness of the many uses of SOVs, including of their vulnerabilities in the face of global transformation. The youth constitutes a segment of society that should be particularly targeted in this regard.

**R.10. Strengthening the shepherding of innovation in relation to SOVs across the entire industry spectrum**

A number of different initiatives operate at different levels aimed at raising the profile of plant-based substances. The outcomes of these initiatives reveal that a dispersion of effort is leading to a depletion of energy and competence in this regard. SOVs represent an innovation niche-area which deserves to be better brought to light and the government, via a mobilisation of the various role-players in the innovation system within the academic-, economic-, financial- and entrepreneurial sectors should make more of an effort to promote its potential and to shepherd pilot projects emerging from all segments of the innovation chain, up to the point of commercialisation.

With an eye towards lending such support, the action plan of the World organisation for intellectual property (WOIP) – which deals with the adoption and putting into place of new and improved products and procedures – could serve as reference guide. As it stands there already exists a WOIP action plan specifically devoted to the development of phytotherapy. Furthermore, certain spaces and forums dedicated[60] to innovation could include a section devoted to SOVs.

In order to promote linkages between training, research and socioeconomic role-players, the initiate aimed at the creation of an institute for research into and application of practices related to traditional medicine and the pharmacological stock, undertaken by the PNPMT, should incorporate a profile-raising component. To this end it could also be

[60] Such as the promotion of Ivorian research week (Sepri).

supported by skills made available by other ministries or other duly equipped and specialised entities operating in the area of processing technology and the value-derivation and commercialisation of SOV-based healthcare products.

A regular (annual or biannual) workshop aimed at raising the profile of these products, combined with scientific colloquia devoted to plant-based substances in Côte d'Ivoire, could also prove a useful undertaking.

# 3. Application and value-derivation sectors engaged with SOV-related practices

### R.11. Putting in place a centralised registration system for products introduced into the market

The use of SOVs as cosmetic products requires the putting in place of a centralised registration system for such products when they are introduced into the market (in adapted imitation of the European model), as is also the case for the regulation of plant-based food additives. The centralisation of regulatory texts (national, regional) into a single database would facilitate their consultation and dissemination, and would go a long way toward ensure the protection of the population's health[61].

Registration via the instructive model put in place by the European Union[62] appears to us suitable for the Ivorian context and also has the advantage of expanding the knowledge of its users regarding the cosmetic SOV market, notably insofar as concerns the comprehensivity, simplicity and transparency of data, which will greatly facilitate the task of monitoring the market.

Creating such a system would be an ambitious undertaking and would require the verification of existing agreements and data, and would also necessitate the long-term allocation of sufficient financial means in order to ensure the sustainability of such a monitoring tool (creation, software maintenance, promotions, etc.). Support from international partners via the World health organisation or the European council could prove very valuable for achieving the creation and maintenance of such a registration system.

### R.12. Regulating the standardisation of TMIs

In the absence of legislation regarding the standardisation of traditional medications improved it is necessary, for the protection of public health, to install a regulatory framework to manage this activity, based on traditional use of medications and with measures in place to guide those seeking authorisation for the market introduction of medicines derived from the

[61] As an example, see the European Union's page devoted to the centralisation of regulatory texts: https://ec.europa.eu/growth/sectors/cosmetics/legislation_fr

[62] Since 2013, registration of cosmetic products before their introduction into the market has been done at a European level via a notification portal for cosmetic products (Cosmetic product notification portal, CPNP). A service offered free of charge, it also provides a FAQ which could serve as inspiration for Côte d'Ivoire: https://r2dmgx4irzpou4rayqiayhwmkm-adv7ofecxzh2qqi-webgate-ec-europa-eu.translate.goog/cpnp/faq/?event=faq.show

traditional pharmacological stock. TMIs should also be listed along with other essential medications.

As an example, the contents of such a regulatory framework (sections and main content) as well as guidelines could be based on those of the National medicine- and healthcare products safety agency (ANSM), which is the relevant entity with regard to this subject in France[63].

In order to facilitate the process for small TMI producers, forms to be filled out would be drawn up according to the latest "question-and-response" formats, thus to facilitate interaction with the administrative authorities and to simplify the process of standardisation (in such a way avoiding recurring errors, ensuring better understanding of regulations, etc.). For cases where standardisation is not achieved during the first round of application, the putting in place – as part of the overseeing authority – of an advisory- and guidance unit would be indispensible in order to avoid fake TMIs being introduced into the market, and to ensure the improvement of product quality.

It seems equally essential to draw inspiration in this regard from benefit-derivation- and regulatory models for TMIs having been successfully developed in West Africa. To this end, and as noted previously, Mali has developed a framework for deriving benefit from, and codification of, TMIs which has proved itself successful.

### R.13. Putting in place a regularly-updated national database of the availability of resources

This would amount to creating an inventory of areas within which industries which utilise plant-based substances operate, as well as making an evaluation of the availability of resources upon which they depend and of the knowledge and techniques upon which they rely (all the while also keeping in mind issues related to the protection of and access to such resources, knowledge and techniques).

Ambitious in scope, such an instrument could over time come to act as early warning system for regulating the production of SOVs based on the state of resource availability and their ecosystems. In this regard an incremental approach seems most appropriate in order to be able to create and enhance such a model at an acceptable cost. Thus at first the instrument could focus on a limited number of key products, such as savannah tea, before integrating other SOVs.

Identifying information sources which can be used to populate the database is an important stage in the creation process, requiring procedures for making such information available and for its proper use. Apart from the allocation of sufficient financial resources, the proper mobilisation of role-players – first and foremost universities – is essential. The government, via an interministerial effort involving mainly the Ministry of water and forests, the Ministry of health and the ministry of higher education and scientific research could shepherd the creation of such an instrument by prioritising the mobilisation and coordination of the appropriate role-players. Of course the sharing- and work platform related to medicinal plants (recommendation R4) and the National institute for research into complimentary medicine and the traditional pharmacological stock (recommendation R5) should also be involved.

[63] https://ansm.sante.fr/documents/reference/#; https://ansm.sante.fr/vos-demarches/industriel

**R.14. Incorporating useful traditional medical practices into the provision of medical care, notably with regard to primary healthcare.**

The WHO looks favourably on, and in some cases encourages, the incorporation of traditional medical practices into primary healthcare provision. However, too often – and in varying degrees according to location – the conditions within which collaboration between traditional healers and modern approaches take place are complex, even problematic.

As a result, based on the outcome of research and the social- and sociological realities, a real-world framework should be created for promoting harmonious cooperation between, and effective implementation of, such potential as is inherent in traditional practices (recommendations 8-9). This could be done by, among other things, the compilation of simple and succinct procedural manuals to be used by healthcare providers based on their level of engagement within the field of primary healthcare. Over the past few years use of the Artemisinin extract from Artemesia annua (Asteraceae) has served as a good example of success in this regard in a number of countries. For example, the French supreme healthcare authority (HAS) has published and made available short-form best practices recommendations and guides which could serve as model for the creation of other, similar documents[64].

A few pilot projects based in areas of shared access to the two types of medical practice could also be initiated in order to strengthen the links between them and to promote a shared approach to primary healthcare.

# 4. Economic development

**R.15. Raising awareness among role-players involved in deriving benefit from plant-based substances of the implementation of the Nagoya Protocol, of intellectual property, and of conditions governing the protection and the derivation of benefit from innovation (patents, trademarks and PGI).**

Côte d'Ivoire has a number of legal frameworks for supporting the inclusive development of, and the sustainable derivation of benefit from, SOVs, including of course the Nagoya Protocol (law no 2013-444) or current forestry-related legislation (law no 2019-675 of 23 July 2019 incorporating the forestry code) which, among other things, aim at promoting the active participation of local populations in the sustainable management of forest resources. These foundational frameworks are further elaborated upon by mechanisms and programmes aimed at their application, e/g/ a currently-operational mechanism dealing with the reduction in emissions due to deforestation and forest degradation (REDD), or the strengthening of laws governing forestry, management and trade (FLEGT) which includes the means of ensuring that benefits derived from the exploitation of forest resources are shared with an eye to the fulfilment of societal responsibility.

Apart from these procedures, it is also necessary to strengthen the more systematic application of these foundational frameworks, notably those devoted to the sharing of benefits with regard to intellectual property. This should be combined with an awareness-raising programme and the training of SOV role-players, specifically with regard to the

[64] As example:
https://www.has-sante.fr/jcms/fc_2875171/fr/resultat-de-recherche?FACET_THEME=c_64654%2Fc_64656

implementation of the Nagoya Protocol.

At the same time, it might be useful to raise the awareness of role-players in the field of research engaged in the study of how to derive useful benefit from plant-based substances, of the issue of intellectual property and of conditions governing the protection of, and the derivation of benefit from, innovation (patents, trademarks and indications of protected geographic origin or PGI).

**R.16. Undertaking studies on the macroeconomic impact of SOVs in terms of financial resources, employment creation and land management.**

The results of such studies could eventually enable the creation of an observatory to monitor the economic and social impact of SOVs and of such elements as play a determinative role in their development. For example, the Ivorian economic and social research centre (Cires[65]) could serve as a model in this regard. The proposed observatory of the macroeconomic impact of SOVs will need to be furnished with a sufficiently-large and sustainable budget. It could notably be established as an office in the presidency or the vice-presidency in order to supply real-time information on the state of biodiversity-, on the economic potential or impact-, or on the dimension of gender with regard to the development of SOV-related industries. Such an institutional placement would enable better coordination and greater efficiency with regard to government action related to SOVs.

**R.17. Ensuring periodic monitoring of activities related to SOVs undertaken in Côte d'Ivoire using specific performance indicators.**

The example of a table presented in annex 9, based on a WHO reference model, could be used for an annual evaluation of the performance of multisectoral initiatives undertaken towards the promotion of SOVs and traditional medicine.

[65] Cires was created in 1971 via a presidential decree (16 March 1971) to be a research centre devoted to development via awareness-raising research activities and engagement with both public- and private- role-players operating within the Ivorian economic sphere. For more information: https://www.cires-ci.com/index.php

# Selected bibliography

ADJANOHOUN E., AKÉ-ASSI L., 1979 – *Contribution au recensement des plantes médicinales de la Côte d'Ivoire*. National Flora Centre, Abidjan, 359 p.

ADJET A. A., KOUAMÉ D., FOKOU G., 2016 – Phytothérapie et lutte contre l'ulcère de Buruli dans le district sanitaire de Yamoussoukro (Côte d'Ivoire): identification, description, fonction symbolique des plantes et recettes utilisées. *Médecine et Santé tropicales*, 26 (4): 408-413. DOI: 10.1684/mst.2016.0630

ADOU L. M. D., KONÉ M. W., IPOU IPOU J., N'GUESSAN E. K., 2016 – Ethnobotanique et analyse phytochimique qualitative de *Pteridium aquilinum* (L.) Kühn (Dennstaedtiaceae), une Ptéridophyte utilisée comme plante médicinale en Côte d'Ivoire. International Journal of Biological and Chemical Sciences, 10 (4): 1783-1792.

ADOU YAO C. Y., N'GUESSAN K. E., 2005 – Diversité botanique dans le Sud du Parc National de Taï, Côte d'Ivoire. *Afrique Science*, 1 (2): 295-313.

ADOU YAO C. Y., KPANGUI K. B., KOUAO K. J., ADOU L. M. D., VROH B. T. A., N'GUESSAN K. E., 2013 – Diversité floristique et valeur de la forêt sacrée Bokasso (Est de la Côte d'Ivoire) pour la conservation. *VertigO – La revue électronique en sciences de l'environnement*, 13 (1): 1-15.

AHOUA A. R. C., KONÉ M. W., KONAN A. G., TRA BI F. H., BONFOH B., 2012 – Antioxidant activity of eight plants consumed by great apes in Côte d'Ivoire. *African Journal of Biotechnology*, 11 (54): 11732-11740.

AHOUA A. R. C., KONAN A. G., BONFOH B. et KONÉ M. W., 2015 – Antimicrobial potential of 27 plants consumed by chimpanzees (*Pan troglodytesverus* Blumenbach) in Ivory Coast. *Complementary and Alternative Medicine* 15: 383.

AINYAKOU T. G., MANDYAN N., 2015 – Position sociale des Kômians en contexte de modernité dans la société Agni Sanwi (de Maféré), Côte d'Ivoire. *Revue ivoirienne d'anthropologie et de sociologie Kasa Bya Kasa*, 30*: 190-203*.

AKÉ C. B., KONÉ M. W., KAMANZI A. K., AKÉ M., 2006 – Évaluation de quelques propriétés biologiques de produits de cueillette non ligneux vendus sur les marchés d'Abidjan et ses environs. *Pharmacopée et médecine traditionnelle africaines*, XIV: 1-17.

AKÉ-ASSI L., 1984 – *Flore de la Côte d'Ivoire: étude descriptive et biogéographique, avec quelques notes ethnobotaniques*. Doctoral thesis, University of Abidjan, 3 t., 1076 p.

AKÉ-ASSI L., 1998 – Impact de l'exploitation forestière et du développement agricole sur la conservation de la biodiversité biologique en Côte d'Ivoire. *Le Flamboyant*,46: 20-21.

AKÉ-ASSI L., 2001 – *Flore de la Côte d'Ivoire. 1, Catalogue, systématique, biogéographique et écologie*. Geneva, Conservatory and Botanical Garden, Boisseria, 57, 396 p.

AKÉ-ASSI L., 2002 – *Flore de la Côte d'Ivoire. 2, Catalogue, systématique, biogéographique et écologie*. Geneva, Conservatory and Botanical garden, Boisseria, 58, 441 p.

AKÉ-ASSI L., 2011 – *Abrégé de médecine et de pharmacopées africaines: quelques plantes employées traditionnellement dans la couverture des soins de santé primaire*. Abidjan, NEI-CEDA Publishers, 157 p.

AKÉ-ASSI L., GUINKO S., 1991 – *Plantes utilisées dans la médecine traditionnelle en Afrique de l'Ouest*. Basel, Roche Publishers., 151 p.

AKÉ-ASSI Y. A., 1992 – *Contribution au recensement des espèces végétales utilisées traditionnellement sur le plan zootechnique et vétérinaire en Afrique de l'Ouest*. Doctoral thesis, Claude Bernard-Lyon University I, 234 p.

AKPAGANA K., BOUCHER P., 1995 – La disparition des espèces végétales et la pharmacopée traditionnelle en Afrique tropicale. *Pharm. Méd. trad. Afro.*: 63-66.

ALTIERI M. A., 1999 – The ecological role of biodiversity in agroecosystems. *Agr.Ecosyst.Environ.*, 74: 19-31.

ALTIERI M. A., 2002 – Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agr.Ecosyst.Environ.*, 93: 1-24.

AMARI A. S., 2009 – *Enjeux et démarche méthodologique de réglementation des médicaments issus de la pharmacopée traditionnelle africaine: le cas de la Côte d'Ivoire*. Doctoral thesis, University of Strasbourg, 272 p.

AMBÉ G.-A., MALAISSE F., 2000 – Les plantes utilisées dans la médecine et la pharmacopée traditionnelles d'une population malinke en Côte d'Ivoire, *Revue Méd. Pharm. Afr.*, 14: 121-130.

ANGIOSPERM PHYLOGENY GROUP [APG], 1998 – An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden*, 85: 531-553.

ANGIOSPERM PHYLOGENY GROUP [APG] II, 2003 – An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of The Linnean Society*, 141: 399-436.

ANGIOSPERM PHYLOGENY GROUP [APG] III, 2009 – An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of The Linnean Society*, 161: 105-121.

ANGIOSPERM PHYLOGENY GROUP [APG] IV, 2016 – An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of The Linnean Society*, 181: 1-20.

ANONYMOUS, 2017 – *Évolution de la filière café-cacao de 2012 à 2017*.4th edition of the"Journées nationales du cacao et du chocolat", Abidjan, 29 September-1 October 2017 at the Caistab Plateau, 60 p.

ATTIOUA B., WENIGER B., CHABERT P., 2007 – Antiplasmodial Activity of Constituents Isolated from *Croton lobatus*. *Pharmaceutical Biology*, 45 (4): 263-266.

ATTIOUA B., YEO D., LAGNIKA L., HARISOLO R., ANTHEAUME C., WENIGER B., KAISER M., LOBSTEIN A., VONTHRON-SÉNÉCHEAU C., 2012 – In vitro antileishmanial, antiplasmodial and cytotoxic activities of a new ventiloquinone and five known triterpenes from *Parinari excelsa*. *Pharmaceutical Biology*, 50 (7): 801-806.

AZIZAH O., AMIN I., NAWALYAH A. G., ILHAM A., 2007 – Antioxidant capacity and phenolic content of cocoa beans. *Food Chemistry*, 100: 1523-1530.

AZOKOU A., ACHI Y. L., KONÉ M. W., 2016 – Lutte contre les tiques du bétail en Côte d'Ivoire par des méthodes traditionnelles. *Livestock Research for Rural Development*, 28 (04): 52.

BAGUIA-BROUNE F. D. M., N'GAMAN-KOUASSI K. C. C., MAMYRBEKOVA-BÉKRO J. A., VIRIEUX D., BÉKRO Y.-A., 2018 – Saponines des racines de *Securidaca longipedunculata*

(Polygalaceae) : quantification et évaluation anti-oxydante. *RevueNature et Technologie. Catégorie B: Sciences agronomiques et biologiques*, 19: 25-30.

BOLOU G. E. K., BAGRÉ I., OUATTARA K., DJAMAN A. J., 2011 – Evaluation of the Antibacterial Activity of 14 Medicinal Plants in Côte d'Ivoire. *Tropical Journal of Pharmaceutical Research*, 10 (3): 335-340.

BOUA B. B., BÉKRO Y.-A., MAMYRBÉKOVA-BÉKRO J. A., COULIBALY W. K., ÉHILÉ E. E., 2008a – Assessment of Sexual Stimulant Potential of Total Flavonoids Extracted from Leaves of *Palisota Hirsuta* Thunb. K. Schum (Commelinaceae). *European Journal of Scientific Research*, 22 (4): 533-538.

BOUA B. B., BÉKRO Y.-A., MAMYRBÉKOVA-BÉKRO J. A., N'GAMAN K. C., DOGBO D. O., ÉHILÉ E. E., 2008b – Screening phytochimique et potentiel pharmacologique des feuilles de *Palisota hirsuta* (thunb.) K. Schum. (Commelinaceae) utilisées en Côte d'Ivoire dans le traitement traditionnel de la dysfonction érectile.*Rev.Ivoir. Sci. Technol.*, 11: 231-246.

BOUA B. B., KOUASSI K. C., MAMYRBÉKOVA-BÉKRO J. A., KOUAMÉ B. A., BÉKRO Y.-A., 2013 – Études chimique et pharmacologique de deux plantes utilisées dans le traitement traditionnel de l'hypertension artérielle à Assoumoukro (Côte d'Ivoire). *European Journal of Scientific Research*, 97 (3): 448-462.

BOUQUET A, DEBRAY M., 1974 – *Plantes médicinales de la Côte d'Ivoire*. Paris, Orstom, coll. "Travaux et documents", 32, 232 p.

BOYD R., FOURNIER A., NIGNAN S., 2014 – Une base de données informatisée transdisciplinaire de la flore: un outil pour l'étude du lien nature-société. *In* Fabre G., Fournier A., Sanogo L. (eds), *Regards scientifiques croisés sur le changement global et le développement. Langue, environnement, culture*, Proceeds from the international Ouagadougou colloquium (8-10 March 2012), Sciencesconf.org, 165-200, hal-00939893f

BULSON H. A. J., SNAYDON R. W., STOPES C. E., 1997 – Effects of plant density on intercropped wheat and field beans in an organic farming system. *J. Agr. Sci.*, 128: 59-71.

CHENU J, AKÉ-ASSI L., 1987 – *Plantes médicinales tropicales et ivoiriennes*. Abidjan, Dareni Publishers, 1272 p.

CROIX VERTE, 1998 – *Forêts sacrées, patrimoine écologique vital de Côte d'Ivoire*. CRDI-PACIPE, 169 p.

CRONQUIST A., 1981 – *An Integrated System of Classification of Flowering Plants*. New York, Columbia University Press, 1262 p.

DILLINGER T. L., BARRIGA P., ESCÁRCEGA S., JIMENEZ M. SALAZAR L. D., GRIVETTI L. E., 2000 – Food of the gods: cure for humanity? A cultural history of the medicinal and ritual use of chocolate.*Journal of Nutrition*,130 (8S): 2057S-2072S.

DIOMANDÉ A., YAO K., SYLLA Y., TRA BI F. H., BAKAYOKO A., KONÉ M. W., 2018 – Pouvoir antioxydant et teneurs en composés phénoliques de deux espèces du genre Albertisia : *Albertisia cordifolia* (Mangenot et J. Miège) Forman et *Albertisia scandens* (Mangenot et J. Miège) Forman (Menispermaceae). *European Scientific Journal*, 14 (30): 1857-7881.

DIALLO D., 2010 – *État de la recherche en médecine traditionnelle au Mali de 1960 à nos jours* [online]: http://mail.cnom.sante.gov.ml/docs/pdf/Microsoft%20PowerPoint%20-%20Pr%C3%A9sentation%20CNOP%20Cinquantenaire.pdf

DIRECTORATE-GENERAL FOR SUSTAINABLE DEVELOPMENT, 2016 – *Us et coutumes conformes au développement durable*, 56 p.

DUCHESNE V. 1996 – *Le cercle de Kaolin, Boson et initiés en terre Anyi, Côte d'Ivoire*. Paris, Acts of the Institute of Ethnology, 32, 371 p.

EHOUMAN E., KONÉ M. W., TRA BI F. H., BAKAYOKO A., 2015 – Iron Reducing and Radical Scavenging Activities of 13 Medicinal plants from Côte d'Ivoire. *Pharmacognosy Journal*, 7 (5): 266-270.

ELUFIOYE T. O., OLADELE A. T., CYRIL-OLUTAYO C. M., AGBEDAHUNSI J. M., ADESANYA S. A., 2012 – Ethnomedicinal study and screening of plants used for memory enhancement and antiaging in Sagamu, Nigeria. *European Journal of Medicinal Plants*,2 (3): 262-275.

*ESSEGBEY G. O.*, Awuni S., 2015 - *OMPI Magazine* [online]:https://www.wipo.int/export/sites/www/wipo_magazine/fr/pdf/2015/wipo_pub_121_2015_01.pdf

ETEKPO S. D., N'GAMAN-KOUASSI C. C., MAMYRBEKOVA-BÉKRO J. A., BÉKRO Y.-A., 2018 – Antioxidant profiles of alcoholic tinctures from *Heterotis rotundifolia* (sm.) Jacq.-fél. (Melastomacaceae) by dpph radical trapping.*European Journal of Biomedical and Pharmaceutical sciences*, 5 (10): 39-45.

EWEL J. J., 1999 – Natural systems as models for the design of sustainable systems of land use, *Agroforest.Syst*., 45: 1-21.

FIÉLOUX M., 1980 – Les Sentiers de la nuit. Les migrations rurales Lobi de la Haute-Volta vers la Côte-d'Ivoire.Paris, Orstom (IRD), 200 p.: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_5/pt5/travaux_d/10005.pdf

GLOBAL ENVIRONMENT FUND, 2019 – *Bulletin d'information*, 9.

FOURNIER A., 2011 – Consequences of wooded shrine rituals on vegetation conservation in West Africa: a case study from the Bwaba cultural area (West Burkina Faso). *Biodiversity and Conservation*, 20: 1895-1910 [online]: DOI 10.1007/s10531-011-0065-5

FRANK D. A., MCNAUGHTON S. J., 1991 – Stability increases with diversity in plant communities: empirical evidence from the 1998 Yellowstone drought. *Oikos*, 62: 360-362.

GILLER K. E., BEARE M. H., LAVELLE P., IZAC M. N., SWIFT M. J., 1997 – Agricultural intensification, soil biodiversity and agroecosystem function. *Appl. Soil Ecol*., 6: 3-16.

GLIESSMANN S. R., 2001 – *Agroecosystem sustainability: developing practical strategies*. Boca Raton, CRC Press, 224 p.

GOODING M. J., KASYANOVA E., RUSKE R., HAUGGAARD-NIELSEN H., JENSEN E. S., DAHLMANN C., VON FRAGSTEN P., DIBET A., CORRE-HELLOU G., CROZAT Y., PRISTERI A., ROMEO M., MONTI M., LAUNAY M., 2007 – Intercropping with pulses to concentrate nitrogen and sulphur in wheat. *J. Agr. Sci*., 145: 469-479.

GUESSAN B. G. L., KADJA A. B., COTTET K., LECOUVEY M., MAMYRBÉKOVA-BÉKRO J. A., BÉKRO Y.-A., 2018 – Bio-guided anti-cariogenic and phytochemical valorization of Guiera senegalensis and *Pseudocedrela kotschyi* stem extracts. *Journal of Medicinal Plants Research*, 12 (28): 500-507.

GURR G. M., WRATTEN S. D., LUNA J. M., 2003 – Multi-function agricultural biodiversity: pest management and other benefits. *Basic Appl. Ecol*., 4: 107-116.

HAMLY D. H., 1932: Softening of seeds of *Melilotus alba*. *Botanical Gazette*, XCIII: 345-375.

HAUGGAARD-NIELSEN H., AMBUS P., JENSEN E. S., 2001 – Interspecific competition, N use and interference with weeds in pea-barley intercropping.*Field Crop. Res*., 70: 101-109.

HAXAIRE C., 1985 – « Vie et mort dans la représentation gouro des fluides du corps ». In *Le corps humain: nature, culture, surnaturel*. Paris, CTHS: 333-343.

HAXAIRE C., 1994a – Dégradation de la forêt, disparition des plantes utiles et nouvelles stratégies chez les Gouro de la République de Côte-d'Ivoire. *Journal d'agriculture traditionnelle et de botanique appliquée*, 36 (1): 57-73.

HAXAIRE C., 1994b – La femme adultère et le palmier: esquisse pour une anthropologie du remède. *Écologie humaine*, XII (1): 3-28.

HOBBS R. J., MORTON S. R., 1999 – Moving from descriptive to predictive ecology, *Agroforest. Syst.*, 45: 43-55.

HOFFMANN O., 1987 – *Les plantes en pays lobi (Burkina et Côte d'Ivoire): lexique des noms lobi-latin et latin-lobi*. Maisons-Alfort, IEMVT, 155 p.: https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers14-07/24668.pdf

HOLTZMAN J., 2004 – *La chaîne de valeur du beurre de karité, Synthèse d'étude et recommandations pour WATH*. WATH Technical Report, 1, 30 p.

HUYBENS N., TCHAMBA M., 2011 – Culture et spiritualité: la forêt écosystème culturel et symbolique. In *Les services culturels, sociaux et spirituels de la forêt*, Organisation internationale de la francophonie.

JACKSON W., 2002 – Natural systems agriculture: a truly radical alternative. *Agr.Ecosyst.Environ.*, 88: 111-117.

JUHÉ-BEAULATON D. (éd.) 2010 – *Forêts sacrées et sanctuaires boisés. Des créations culturelles et biologiques (Burkina Faso, Togo, Bénin)*. Paris, Karthala, 288 p.

KABRAN G. R. M., MAMYRBEKOVA-BÉKRO J. A., PIRAT J. L., LECOUVEY M, SAINTE-CATHÉRINE O., SOMMERER N., VERBAERE A., MEUDEC E., BÉKRO Y.-A., 2017 – UPLC-MS Quantification and Anticancer Potential of *Ximenia Americana* Hydro-Acetonic Crude Extract Leaves. *Der Chemica Sinica*, 8 (1):70-74.

KAMANZI K. A., SCHMID C., BRUN R., KONÉ M. W., TRAORÉ D., 2004 – Antitrypanosomal and antiplasmodial activity of medicinal plants from Côte d'Ivoire. *Journal of Ethnopharmacology*, 90: 221-227.

KAMANZI K. A., KONÉ M. W., TRA BI F. H., 2010 – Plantes à usages ethnobotaniques. *In* Konaté S., Kampmann D. (eds), *Atlas de la biodiversité de l'Afrique de l'Ouest. Tome III: Côte d'Ivoire*. Abidjan & Frankfurt/Main: 320-323.

KONAN M. K., KOFFI E. N., CISSE I., ADIMA A. A., BÉKRO Y.-A., 2016 – Phytochemical, nutritional and antioxidant capacity of five Ivorian edible leaves aqueous extracts. *Journal of Applied Pharmaceutical Science*, 6 (9): 082-086.

KONAN K. V., MAMYRBÉKOVA-BÉKRO J. A., GUIFFREY P., VIRIEUX D., PIRAT J. L., BÉKRO Y.-A., 2017 – Composition organique et activité anti-radicalaire de *Bombax costatum* de Côte d'Ivoire. *Série Pharm. Méd. Trad. Afr.*, 18 (2): 21-27.

KONÉ M. W., 1998 – *Évaluation de l'activité antibactérienne des plantes utilisées en médecine traditionnelle dans la région de Ferkessédougou, Côte d'Ivoire*.Masters dissertation, University of Cocody, 76 p.

KONÉ M. W., KAMANZI ATINDEHOU K., TRAORÉ D., 2002 – Plantes et médecine traditionnelle dans la région de Ferkessédougou (Côte d'Ivoire). *Annales de botanique de l'Afrique de l'Ouest*, 2: 13-23.

KONÉ M. W., KAMANZI ATINDEHOU K., TRAORÉ D., 2008 – Use of ethnoveterinary medicinal plants in Northern Côte d'Ivoire (West Africa). *South African Journal of Botany*, 74 (1): 76-84.

KOUA K. A., ADIKO F., N'GORAN G., 2017 – Processus de maintien des tradipraticiennes dans la dynamique de l'offre médicale de tradition Africaine en Côte d'Ivoire.*Revue des sciences sociales (RSS-PASRES)*: 61-73.

KOUADIO F., KANKO C., JUGE M., GRIMAUD N., JEAN A., N'GUESSAN Y. T., PETIT J. Y., 2000 – Analgesic and Anti-inflammatory Activities of an Extract from *Parkia biglobosa* used in Traditional Medicine in the Ivory Coast. *Phytother. Res.*, 14: 635-637.

KOUADIO K. B., N'DA D. H., VROH BI TRA A., ZOBI I. C., N'GUESSAN K. É., 2013 – Dynamique de la végétation et fréquence des feux de brousse dans la réserve de faune d'Abokouamékro (Centre, Côte d'Ivoire). *European Scientific Journal*, 9 (35): 179-192.

KOUAKOU J.-L., GONEDELE BI S., BITTY E.A., KOUAKOU C., YAO A. K., KASSE K. B. *et al.*, 2020 – Ivory Coast without ivory: Massive extinction of African forest elephants in Côte d'Ivoire. PLoS ONE 15(10): e0232993. https://doi.org/10.1371/journal. pone.0232993

KOUASSI A. K., 2014 – *Diversité floristique de la forêt classée du haut-Sassandra (Centre-Ouest de la Côte d'Ivoire) en période post-conflits armés*. Masters dissertation, Jean Lorougnon-Guédé University, 35 p.

KOUASSI K. É., SANGNE Y. C., KOUASSI K. H., 2015 – Richesse et diversité floristique dans les biotopes environnants la forêt classée de la Téné dans le département d'Oumé en Côte d'Ivoire. *Journal of Animal et Plant Sciences*, 24 (1): 3700-3713.

KOUASSI K. C., SOROKINA E. A., MAMYRBÉKOVA-BÉKRO J. A., BÉKRO Y.-A., 2016 – UV-Visible spectrophotometric detection of Solanum aethiopicumhexanic and n-butanolic excerpts and their anticancer activity monitored by flow cytometry and microscopy. *Journal of Biomedical and Pharmaceutical Research*, 5 (3): 28-39.

KOUASSI K. A., YAO K., KONÉ M. W., 2017 – Enquête ethnobotanique et évaluation de la composition minérale de plantes médicinales utilisées dans le Centre de la Côte d'Ivoire dans le traitement de l'ostéoporose et des maladies apparentées. *Afrique science*,13 (1): 197-208.

KOUASSI K. S., 2019 – Les rites dans la transmission et la pérennisation des savoir-faire céramiques chez les Gwa d'Oguédoumé (sud côtier de la Côte d'Ivoire). *E-Phaïstos* [Online]: http:// journals.openedition.org/ephaistos/4555 ; DOI: 10.4000/ephaistos.4555 [consulted on 20 April 2019].

KOULIBALY A., MONIAN M., ACKAH J. A. A. B., KONÉ M. W., TRAORÉ K., 2016 – Étude ethnobotanique des plantes médicinales : cas des affections les plus fréquentes d'une région agricole Daloa (Centre Ouest, Côte d'Ivoire). *Journal of Animal & Plant Sciences*, 31 (2): 5021-5032.

KPANGUIKOUASSI B., VROH BI TRA A., GONÉ BI ZORO B., ADOU YAO C. Y., 2015 – Diversité floristique et structurale des cacaoyères du « V baoulé » : cas de la sous-préfecture de Kokumbo (Centre, Côte d'Ivoire). *European Scientific Journal*, 11 (36): 40-60.

KROA E., DIABY B., NIARÉ A., TRAORÉ Y., AHOUSSOU E. M., YAO G. H. A. *et al.*, 2014 – Analyse de la collaboration entre médecines traditionnelle et moderne dans la région du Sud Bandama (Côte d'Ivoire). *Revue Cames, Série Pharmacopée et médecine traditionnelle africaines*, 17 (1): 21-27.

LAGOU S. M. L, TRA BI F. H., YAO K., BAKAYOKO A., KONÉ M. W., 2016 – Fistules obstétricales dans le district d'Abidjan, Côte d'Ivoire: niveau de connaissance et plantes

utilisées traditionnellement dans le traitement. International Journal of Biological and Chemical Sciences, 10 (3): 1273-1285.

LIBERSKI-BAGNOUD D., FOURNIER A., NIGNAN S., 2010 – « Les "bois sacrés", faits et illusions à propos des sanctuaires boisés des Kasena (Burkina Faso) ». *In*Juhé-Beaulaton D. (ed.): 57-88.

LOREAU M., NAEM S., INCHAUSTI P., BENGTSSON J, GRIME J. P., HOOPER D. U., HUSTON M. A., TAFFAELLI D., SCHMID B., TILMAN D., WARDLE D. A., 2001 – Biodiversity and ecosystem functioning: current knowledge and future challenges. *Science*,294: 804-808.

LOROUGNON G., 1993 – *La médecine traditionnelle africaine: plantes et pharmacopée chez les Bété de la région de Daloa (Côte d'Ivoire)*. Abidjan, University of Abidjan.

MAGIELSE J., ARCORACI T., BREYNAERT A., VAN DOOREN I., KANYANGA C., FRANSEN E. *et al*., 2013 – Antihepatotoxic activity of a quantified Desmodium adscendens decoction and D-pinitol against chemically-induced liver damage in rats. *Journal of Ethnopharmacoly*, 7, 146 (1): 250-256.

MAKANGA J. D. M., 2011 – Mosaïque forêt-savane et exploitation des ressources forestières du Gabon. *Geo-Eco-Trop*, 35: 41-50.

MALAN D. F., 2009 – Religion traditionnelle et gestion durable des ressources floristiques en Côte d'Ivoire: le cas des Éhotilé, riverains du parc national des îles Éhotilé. *VertigO – la revue électronique en sciences de l'environnement*, 9 (2) [Online]: DOI: 10.4000/vertigo.8661

MALAN D. F., AKÉ ASSI L., TRA BI F. H., NEUBA D., 2007 – Diversité floristique du parc national des îles Éhotilé (littoral est de la Côte d'Ivoire). *Bois et forêts des tropiques*, 292 (2): 49-58.

MALAN D. J., NEUBA D. F. R., KOUAKOU K. L., 2015 – Medicinal plants and traditional healing practices among the Ehotile people, around the Aby lagoon (East coast of Côte d'Ivoire).*Journal of Ethnobiology and Ethnomedicine*, 11: 21 [online]: DOI : 10.1186/s13002-015-0004-8

MALÉZIEUX E., CROZAT Y., DUPRAZ C., LAURANS M., MAKOWSKI D., OZIER-LAFONTAINE H., RAPIDEL B., DE TOURDONNET S., VALANTIN-MORISON M., 2009 – Mixing plant species in cropping systems: concepts, tools and models.A review.*Agron. Sustain. Dev*., 29: 43-62.

MAMYRBÉKOVA-BÉKRO J. A., BAMBA S., AKAFFOU S., BÉKRO Y.-A., 2009 – Charactérisation de la matière grasse extraite des amandes de *Afzelia africana* (Fabaceae-Caesalpinioideae) de Côte d'Ivoire. *Rev. Ivoir. Sci. Technol*., 13: 191-198.

MCPHERSON M. A., NIESWIADOMY M. L., 2000 – African elephants: The effect of property rights and political stability. *Contemporary Economic Policy*, 18 (1): 14-26.

MENDELSOHN R., BALICK M. J., 1997 – Valuing undiscovered pharmaceuticals in tropical forests. *Economic Botany*,51: 328.

MINESUDD, 2016 – *Stratégie et plan d'action pour la diversité biologique nationale 2016-2020*, 183 p.

MINISTRY OF ENVIRONMENT, 1999 – *Diversité biologique de la Côte d'Ivoire*.Compiled report, 273 p.

MINISTRY OF ENVIRONMENTAND SUSTAINABLE DEVELOPMENT, 2016 – *Us et Coutumes conformes au développement durable*: 1-57.

MINISTRY OF ENVIRONMENT, URBAN HYGIENE AND SUSTAINABLE DEVELOPMENT, 2016 – *Stratégie et plan d'action pour la diversité biologique nationale 2016-2020*, 183 p.

MINISTRY OF HEALTH AND PUBLIC HYGIENE, 2018 – *Pharmacopée ivoirienne*. Abidjan, National legal documentation centre(CNDJ), 206 p.

MINISTRY OF WATER AND FORESTS, 2018 – *Stratégie nationale de préservation, de réhabilitation et d'extension des forêts*: 7.

MONYN E. D., BAKAYOKO A., TRA BI F. H., YAO K., KONÉ M. W., 2016 – Niveau de connaissance et composition minérale de *Hydrocotyle bonariensis* Lam. (Araliaceae), une plante utilisée dans les ménages du district d'Abidjan (Côte d'Ivoire). International Journal of Biological and Chemical Sciences, 10 (5): 2046-2061.

MOUSSA D., KONAN K. M., KOFFI N. E., MAMYRBEKOVA-BÉKRO J. A., BÉKRO Y.-A., 2018 – Phytochemical screening and antioxidant profile of leave decoctions of five wild edible plants from Côte d'Ivoire. *Journal of Materials and Environmental Sciences*, 9 (2): 724-729.

MUSCHLER R. G., 2001 – Shade improves coffee quality in a sub-optimal coffee-zone of Costa Rica. *Agroforest. Syst.*, 85: 131-139.

N'DA D. H., ADOU Y. C., N'GUESSAN K. E., KONÉ M., SAGNE Y. C., 2008 – Analyse de la diversité floristique du parc national de la Marahoué, Centre-Ouest de la Côte d'Ivoire. *Afrique Science*, (3): 552-579.

N'DJA J. K., YETCHAWA T., ZO-BI I. C., 2017 – Diversité floristique et infiltration humaine de la forêt classée de la Besso (Côte d'Ivoire). *Journal of Applied Biosciences*,114: 11299-11308.

N'GUESSAN K. E., 2009 – Projet d'élaboration d'une base de données numérique sur la flore et la végétation du parc national de la Comoé, au Nord-Est de la Côte d'Ivoire, 37 p.: https://ci.chm-cbd.net/biodiversity/fauneflore/flore/flore-terrestre/projet-delaboration-dune-base-de-donnees

N'GUESSAN J. D., BIDIE A. P., LENTA B. N., WENIGER B., ANDRE P., GUEDE-GUINA F., 2007 – In vitro assays for bioactivity-guided isolation of antisalmonella and antioxidant compounds in Thonningia sanguinea flowers. *African Journal of Biotechnology*, 6 (14): 1685-1689.

N'GUESSAN K., TRA BI F. H., KONÉ M. W., 2009 – Étude ethnopharmacologique de plantes antipaludiques utilisées en médecine traditionnelle chez les Abbey et Krobou d'Agboville (Côte d'Ivoire). *Ethnopharmacologia*,44: 42-50.

N'GUESSAN A. H. O., DÉLIKO C. E. D., MAMYRBÉKOVA-BÉKRO J. A., BÉKRO Y.-A., 2011a – Teneurs en composés phénoliques de 10 plantes médicinales employées dans la tradithérapie de l'hypertension artérielle, une pathologie émergente en Côte d'Ivoire. *Revue de génie industriel*, 6: 55-61.

N'GUESSAN H. A., DAGO C. E. D., MAMYRBÉKOVA-BÉKRO J. A., BÉKRO Y.-A., 2011b – CCM d'extraits sélectifs de 10 plantes utilisées dans le traitement traditionnel de l'hypertension artérielle en Côte d'Ivoire. *European Journal of Scientific Research*,66 (4): 575-585.

N'GUESSAN E. A., N'DJA A. K., 2018 – Analyse de la diversité floristique de la forêt classée d'Agbo I (Côte d'Ivoire). *European Scientific Journal*, 14 (9): 346-357.

NEUWINGER H. D., 1996 – African ethnobotany – Poisons and drugs – Chemistry – Pharmacology -Toxicology. London-New York-Glasgow-Tokyo-Melbourne-Madras-Weinheim, Chapman & Hall, 941 p.

OBOUAYEBA A. P., DJYH N. B., DIABATE S., DJAMAN A. J., N'GUESSAN J. D., KONE M., KOUAKOU T. H., 2014 – Phytochemical and Antioxidant Activity of Roselle (Hibiscus Sabdariffa L.) Petal Extracts. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 5: 1453-1465.

ODUGBEMI T. O., ODUNAYO R., AKINSULIRE I., AIBINU E., FABEKU P. O., 2007 – Medicinal plants useful for malaria therapy in Okeigbo, Ondo state, Southwest Nigeria. *AfricanJournal of Traditional Complimentary and Alternative Medicine*, 4 (2): 191-198.

OMS, 2002 – *Stratégie de l'OMS pour la médecine traditionnelle pour 2002-2005*, 78 p.

OOAS, 2015 – *Rapport d'activité 2014*.

OUATTARA D., 2006. Contribution à l'inventaire des plantes médicinales significatives utilisées dans la région de Divo (sud forestier de la Côte d'Ivoire) et à la diagnose du poivrier de Guinée : *Xylopia aethiopica* (Dunal) A. Rich. (Annonaceae), Doctoral thesis, University of Cocody, 184 p.

OUATTARA D., KOUAME D., TIÉBRÉ M.-S., CISSE A., N'GUESSAN K. É., 2016 – Diversité floristique et usages des plantes dans la zone soudanienne du Nord-Ouest de la Côte d'Ivoire. *Journal of Animal & Plant Sciences*, 31 (1): 4815-4830.

OUATTARA L. H., KABRAN G. R. M., KADJA A. B., TANO M. B., MAMYRBEKOVA-BÉKRO J. A., BÉKRO Y.-A., 2016 – Étude phytochimique et activité anti-oxydante d'extraits de plantes de Côte d'Ivoire utilisées dans le traitement traditionnel des hémorroïdes. *International Journal of Innovation and Applied Studies*, 15 (4): 881-893.

OUATTARA D., COULIBALY S., KOUDEGNAN C. M., KAMANZI K., 2017 – Fabrication de savons traditionnels à base de plantes en zone de savane soudanienne de Côte d'Ivoire : état de la connaissance par les populations locales de Dabakala et de Katiola. *REB-PASRES*, 2 (1): 25-37.

PENALI L., MULHOLLAND D. A., TANO K. D., CHEPLOGOI P. K., RANDRIANARIVELOJOSIA M., 2007 – Low antiplasmodial activity of alkaloids and amides from the stem bark of *Zanthoxylum* rubescens (rutaceae). *Parasite*, 14: 161-164.

PETERS C. P., GENTRY A. H., MENDELSOHN R. O., 1989 – Valuation of an Amazonian rainforest. *Nature*,339 : 655-365.

PIBA S. C., 2016 – *Diversité floristique et potentiel en espèces sources de produits forestiers non ligneux de la forêt classée de Yapo-Abbé: contribution pour un aménagement durable*. Doctoral thesis, University of Nangui-Abrogoua, 253 p.

PIBA S. C., TRA BI F. H., KONAN D., BITIGNON B. G. A., BAKAYOKO A., 2015 – Inventaire et disponibilité des plantes médicinales dans la forêt classée de Yapo-Abbé, en Côte d'Ivoire. *European Scientific Journal*, 11 (24):161-181.

POGCI (Official portal of the government of Côte d'Ivoire), 2019 – *Filière cola: la Côte d'Ivoire, 1er producteur et exportateur mondial* [online]: http://www.gouv.ci/_actualite-article.php?d=6&recordID=9867&p=15 [consulted on 29 January/2020].

SANGNE YAO C., KOUAKOU KOUASSI A., BAMBA I., KPANGUIKOUASSI B., BARIMAYAO S. S., 2018 – Diversité structurale d'une aire protégée urbaine : cas du parc national du Banco (Côte d'Ivoire). *International Journal of Innovation and Applied Studies*, 24 (4): 1761-1772.

SANOGO, 2006a – *Développement, environnement et santé, rôle des plantes médicinales en médecines traditionnelles*: https://www.sifee.org/static/uploaded/Files/ressources/contenu-ecole/bamako/jour-4/2_Sanogo.pdf [consulted in novembre 2020].

SANOGO R. 2006b – *Le rôle des plantes médicinales. Développement, environnement et santé*. 10th IEPF and SIFEE summer school (6-10 juin), Bamako, Mali.

SANOGO S., 2014. *Connaissances locales et modes d'utilisation des plantes médicinales dans le traitement du paludisme et de la fièvre jaune dans la région des cascades. Cas du village de Diarrabakoko*. Masters dissertation, University of Ouagadougou, 117 p.

SANOGO Y., GUESSENND N. K., TRA BI H. F., KOUADIO N. J., KONAN F. K., BAMBA M., DANHO N., BAKAYOKO A., YAO K., DOSSO M., 2016 – Évaluation in vitro de l'activité des écorces de tige de *Anogeissus leiocarpus* (DC) Guill. et Perr. (Combretaceae) sur des bactéries responsables de maladies courantes en Afrique et criblage phytochimique. *Int. J. Biol. Chem. Sci*., 10 (3): 1139-1152.

SCHÜßLER A., SCHWARZOTT D., WALKER C., 2001 – A new fungal phylum, the Glomeromycota: phylogeny and evolution. *Mycological Research*, 105: 1413-1421.

SCOPEL E., FINDELING A., CHAVEZGUERRA E., CORBEELS M., 2005 – Impact of direct sowing mulch-based cropping systems on soil carbon, soil erosion and maize yield. *Agron. Sustain. Dev*., 25: 425-432.

SELOSSE M. A., 2016 – Au-delà de l'organisme: l'holobionte. *Pour la Science*, 269: 80-84.

SERPANTIÉ G., 2003 – *Persistance de la culture temporaire dans les savanes cotonnières d'Afrique de l'Ouest : étude de cas au Burkina Faso*. Thesis, Paris Agronomic Institute, 408 p.

SHACKLETON C. M., PANDEY A. K., 2014 – Positioning non-timber forest products on the development agenda. *Forest Policy and Economics*,38: 1-7.

SHACKLETON S., CAMPBELL B., LOTZ-SISITKA H., SHACKLETON C. M., 2008 – Links between the Local Trade in Natural Products, Livelihoods and Poverty Alleviation in a Semi-arid Region of South Africa.*World Development*, 36 (3): 505-526.

SHELTON A. M., BADENES-PEREZ F. R., 2006 – Concepts and applications of trap cropping in pest management. *Annu. Rev. Entomol*.,51: 285-308.

SIDIO S. R., N'GUESSAN K., 2021 – Ethnotaxonomie des plantes médicinales chez les Bété de Gagnoa, en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*.

SMITH S.,READ D., 2008, *Mycorrhizal Symbiosis*. Londres, Academic Press, 800 p.

SORO D., KONÉ W. M., BONFOH B., DRO B., TOILY K. B., KAMANZI K., 2013 – In vivo anthelmintic activity of *Anogeissus leiocarpus* Guill et Perr (Combretaceae) against nematodes in naturally infected sheep. *Parasitol Res*,112: 2681-2688.

SORO L. C., MUNIER S., OCHO-ANINATCHIBRI A. L., GROSMAIRE L., MENUT C., MALAN K. A., PELISSIER Y., 2015 – Chemical composition of leaf essential oils of *Lippia multiflora* Mold.grown in savannah and forest area in the Ivory Coast. *Journal of Essential Oil Bearing Plants*, 18 (1): 154-160.

SUNDARAMOORTHY S., BALABASKAR P., 2012 – Consortial effect of endophytic and plant growth promoting rhizobacteria for the management of early blight of tomato incited by Alternaria solani. *J. Plant Pathol. Microb*., 3 (7): 145.

SWIFT M. J., IZAC A.-M.N., VAN NOORDWIJK M., 2004 – Biodiversity and ecosystem services in agricultural landscapes—are we asking the right questions? *Agr.Ecosyst.Environ*., 104: 113-134.

SYLLA Y., SILUÉ K. D, OUATTARA K., KONÉ M. W., 2018 – étude ethnobotanique des plantes utilisées contre le paludisme par les tradithérapeutes et herboristes dans le district d'Abidjan (Côte d'Ivoire). *Int. J. Biol. Chem. Sci.*, 12 (3): 1380-1400.

TAÏ NATIONAL PARK MANAGEMENT UNIT, 2000 – *Flore du parc national de Taï, Côte d'Ivoire*, Max Kasparek ed..

TCHÉRO J., 2013 – Pensée et pratique médicales chez les Krou de Côte d'Ivoire. D'hier à la fin de la période coloniale. Malade et système de santé d'autrefois. *Revue ivoirienne d'histoire*, 21: 43-60.

TÉRÉ H. G., 1996 – Signification des noms vernaculaires des plantes chez les Guérés (Côte d'Ivoire). Abidjan, CSRS Publishers, 96 p.

TIÉBRÉ M. S., OUATTARA D., VROH B. T. A., GNAGBO A., N'GUESSAN K. É., 2016a – Diversité floristique et disponibilité des plantes utilitaires en zone soudanienne de la Côte d'Ivoire. *Journal of Applied Biosciences*, 102: 9699-9707.

TIÈBRE M. S., OUATTARA D., KPANGUI K. B., KOUASSI D. F.,N'GUESSAN K. E., 2016b – Diversité floristique de la région de Foungbesso en zone de transition forêt-savane à l'Ouest de la Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*, 10 (3): 1007-1016.

TONZIBO Z. F., CHALCHAT J. C., N'GUESSAN Y. T., 2008 – Chemical Composition of Essential Oils of *Ocimum canum* Sims from Côte d'Ivoire. *Journal of Essential Oil Bearing Plants*, 11 (5): 530-535.

TRA BI F. H., 1997 – *Utilisation des plantes, par l'homme, dans les forêts classées du Haut-Sassandra et de Scio, en Côte d'Ivoire*. Doctoral thesis, University of Cocody, 215 p.

TRAORÉ Y. A., BÉKRO Y. A., MAMYRBÉKOVA-BÉKRO J. A., GUESSENND N. K., BOUA B. B., MÉITÉ S., 2014 – In vitro comparative screening of anti-inflammatory effect of crude extracts from *Cassia sieberiana* DC. (Ceasalpiniaceae) and *Khaya grandifoliola* C. DC.(Meliaceae).*Der Pharmacia Sinica*, 5 (6) :86-90.

TRAORÉ L., BOUA B. B., GUESSENND N. K., KADJA B. A., MAMYRBÉKOVA-BÉKRO J. A., BÉKRO Y.-A., 2015 – In vitro antibacterial potential of glycosidic and aglyconic crude extracts of *Cassia sieberiana* dc. (cesalpiniaceae) and *Khaya grandifoliola* c.dc. (meliaceae): a comparative survey. *International Journal Pharmaceutical Sciences and Research*, 6 (7): 2728-2733.

TRENBATH B. R., 1993 – Intercropping for the management of pests and diseases. *Field Crop. Res.*, 34: 381-405.

UEBT, 2017 – *Biodiversity-based innovation in the European Union.Key elements of EU Regulation 511/2014*.

UICN, 2015 – *IUCN red list of threatened species* [online]: https://www.iucnredlist.org [consulted on 17 March 2016].

UNCTAD (UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT), 2017 – *BioTrade et l'accès et le partage des avantages: de la théorie à la pratique. Manuel à l'intention des responsables de l'élaboration des politiques et des autorités de réglementation*, UNCTAD/DITC/TED/2017/6, 101 p.

UNCTAD, 2018a – European Union. Non-Tariff Measures (NTMs) applicable to biodiversity and BioTrade Product: Personal care, food and phytopharma sectors, *Technical Fact Sheet*: https://unctad.org/en/PublicationsLibrary/ditcted2018d8_en.pdf

UNCTAD, 2018b – United States of America. Non-Tariff Measures (NTMs) applicable to biodiversity and BioTrade Product: Personal care, food and phytopharma sectors, *Technical Fact Sheet*: https://unctad.org/en/PublicationsLibrary/ditcted2018d10_en.pdf

UNCTAD, 2018c – Switzerland. Non-Tariff Measures (NTMs) applicable to biodiversity and BioTrade Product: Personal care, food and phytopharma sectors, *Technical Fact Sheet*: https://unctad.org/en/PublicationsLibrary/ditcted2018d9_en.pdf

UNCTAD, 2018d – Japan. Non-Tariff Measures (NTMs) applicable to biodiversity and BioTrade Product: Personal care, food and phytopharma sectors, *Technical Fact Sheet*: https://unctad.org/en/PublicationsLibrary/ditcted2018d7_en.pdf

VAN NOORDWIJK M., LAWSON G., SOUMARÉ A., GROOT J. J. R., HAIRIAH K., 1996: Root distribution of trees and crops: competition and/or complementarity. *In* Ong C. K., Huxley P. W. (eds.), *Tree-Crop Interactions: A Physiological Approach*. Wallingford, CAB International: 319-364.

VANDERMEER J., VAN NOORDWIJK M., ANDERSON J., ONG C., PERFECTO I., 1998 – Global change and multi-species ecosystems: concepts and issues. *Agr.Ecosyst.Environ.*, 67: 1-22.

VANGAH MANDA O. M., 1986 – Contribution à la connaissance des plantes médicinales utilisées par les ethnies Akan de la région littorale de la Côte d'Ivoire. Doctoral thesis, National Unversity of Côte d'Ivoire, FAST Abidjan, I, 192 p.

VAN SETERS J., KONNON D., 2018 – *Capitalisation des expériences et acquis de la Côte d'Ivoire en matière de politiques publiques, de structuration et de gestion de la filière anacarde*. ECDPM, discussion document, 234, 48 p.

VERSCHAFFELT E., 1912 – Le traitement chimique des graines à imbibition tardive. *Rec. Trav. Bot. Neerl.*, 9: 401-435.

VISSER L. E., 1975 – *Plantes médicinales de la Côte d'Ivoire. Une étude ethnobotanique des usages médicaux et comestibles des plantes sauvages par les Ando de la Côte d'Ivoire (Afrique occidentale)*. Wageningen, Mededelingen Landbouwhogeschool, 79 p.

VON MAYDELL H.-J., 1983 – *Arbres et arbustes du Sahel. Leurs caractéristiques et leurs utilisations*. Eschborn ed, 531 p.

WEISS C. R., 1997 – *Ethnobotanische und Pharmakologische Studien zu Arzneipflanzen der Traditionellen Medezin der Elfenbeinküste*. Bâle, University of Bâle, 187 p.

WORLD BANK, 2018 – *Pour que demain ne meure jamais: la Côte d'Ivoire face aux changements climatiques*.

XU X. H., SU Z. Z., WANG C., KUBICEK C. P., FENG X. X., MAO L. J., WANG J. Y., CHEN C., LIN F. C., ZHANG C. L., 2014 – The rice endophyte Harpophora oryzae genome reveals evolution from a pathogen to a mutualistic endophyte. *Sci. Rep.*4: 5783.

YAO L., 2012 – Le sacré dans la thérapie africaine: l'exemple de la sociothérapie de la communauté baoulé de Côte d'Ivoire. *Revue africaine d'anthropologie, Nyansa-Pô*, 13: 64-78.

YAO K., KONÉ M. W., BONFOH B., KAMANZI K., 2014 – Antioxidant activity and total phenolic content of nine plants from Côte d'Ivoire (West Africa). *Journal of Applied Pharmaceutical Science*, 4 (8): 36-41.

YORO B. M., 2010 – Rôle de l'anthropologue dans la revalorisation de la médecine traditionnelle africaine. *Recherches qualitatives*, 29 (2): 57-67 [online]: http://www.recherche-qualitative.qc.ca/Revue.html

ZERBO P., MILLOGO-RASOLODIMBY J., NACOULMA-OUEDRAOGO O. G., VANDAMME P., 2011 – Plantes médicinales et pratiques médicales au Burkina Faso: cas des Sanan. *Bois et forêts des tropiques*, 307 (1): 41-53.

# Designations, acronyms and abbreviations

AGK: Global shea alliance

AgriFED: Women in agriculture and sustainable development

AIRP: Ivorian pharmaceutical regulation authority

ANDE: National environmental agency

ANSM: National medicine- and healthcare products safety agency

AOIP: African organisation of intellectual property

Apprexco-CI: Professional association of producers and exporters of cola in Côte d'Ivoire

APV-FLEGT: Voluntary partnership agreement on the application of forest-related regulations, management and trade in wood and wood-derived products

BNCI: Côte d'Ivoire national bank

BNCIK: National office for the creation of an inter-professional union of shea producers

BPF: Best practices for fabrication

Cames: African and Malagasy council for higher education

Cémac: Central African economic and monetary community

Cepici: Centre for the promotion of investment in Côte d'Ivoire

CHRCP: Unit for medicines regulation harmonisation and cooperation

CHU: University hospital centre

Ciapol: Ivorian antipollution centre

Cirad: Agricultural research centre for international development

Cita: Centre for cashew innovation and technologies

Cires: Ivorian economic and social research centre

CITES: Convention on the international trade in endangered species

CNLC: National committee for the fight against counterfitting

CNUCED: United Nations conference on trade and development

Sommaire

Coci: Côte d'Ivoire consortium of citrus and perfume plants

Codinorm: Côte d'Ivoire normalisation

CPNP: Cosmetic product notification portal

CSRS: Swiss centre for scientific research

DGI: Directorate- general for taxation

DMT: Department of traditional medicine

DPML: Directorate for medicines, medications and laboratories

DSDI: Directorate of statistics, documentation and information

ECOWAS: Economic community of Western African states

ECTS: European credits transfer scale

EPA: Public administrative entity

ESA: Specialist higher education establishment for agronomy

Fika-CI: Shea industry of Côte d'Ivoire

Firca: Inter-professional fund for agricultural research and counsel

FLEGT: Forest law enforcement governance and trade

Fonsti: Fund for science, technology and innovation

GC-MS: Gas chromatography combined with mass spectrometry

GIE: Economic interest group

GIZ: Gesellschaft für internationale zusammenarbeit

Guce: Single service counter for foreign commerce

HAS: Supreme healthcare authority

HPLC: High performance liquid chromatography

IFFN: National forestry- and fauna census

INPHB: Félix Houphouët-Boigny national polytechnic institute

INRPMT: National institute for research on the traditional pharmacological stock and medicine

IPCC: Intergovernmental panel on climate change

IPCI: Côte d'Ivoire Pasteur institute

IRD: French national research institute for sustainable development

IST: Scientific and technical information service

IUCN: International union for the conservation of nature

LCBOSN: Laboratory for bio-organic chemistry and chemistry of natural substances

LNSP: National laboratory for public health

LOTERRE: Linked open terminology resources

LSTM: Laboratory for tropical- and Mediterranean symbiosis

MAM: Mycorrhizalar buscular mushrooms

MEF: Ministry of water and forestry

MESRS: Ministry of higher education and scientific research

MIC: Minimal inhibitory concentrations

Minader: Ministry of agriculture and sustainable development

Minefor: Ministry of water and forests

Minesuud: Ministry of the environment, urban hygiene and sustainable development

MNHN: National museum of natural history

NCBI: National centre for biotechnology information

NGO: Nongovernmental organisation

OECD: Organisation of economic cooperation and development

Oiacola: Inter-professional agricultural organisation for cola

OIPI: Ivorian office of intellectual property

OOAS (WAHO): West African health organisation

PGI: Protected geographic indication

PFNL: Non-wood forest-based products

PMTA: The pharmacological stock and traditional African medicine

PNDS: National plan for healthcare development

PNPMT: National programme for the promotion of traditional medicine

POGCI: Official portal of the government of Côte d'Ivoire

REDD: Reduction in emissions due to deforestation and forest degradation

Rika: Ivorian shea network

Sepri: Ivorian research promotion week

Sodéfor: Society for forestry development

SOV: Plant-based substances

Sepri: Promotion of Ivorian research week

TLC: Thin layer chromatography

TMI: Traditional medicines improved

UEBT: Union for ethical biotrade

UEMOA: West African economic and monetary union

UFHB: Félix Houphouët Boigny University

UFR: Training- and research unit

UJLOG: Jean Lorougnon Guédé University

UNA: Nagui Abrogoua University

UNCTAD: United Nation conference on trade and development

UNIDO: United Nations industrial development organisation

UPGC: Péléforo Gon Coulibaly University

VPA-FLEGT: Voluntary partnership agreement on the application of forest-related regulations, management and trade in wood and wood-derived products

WHO: World health organisation

WOIP: World organisation for intellectual property