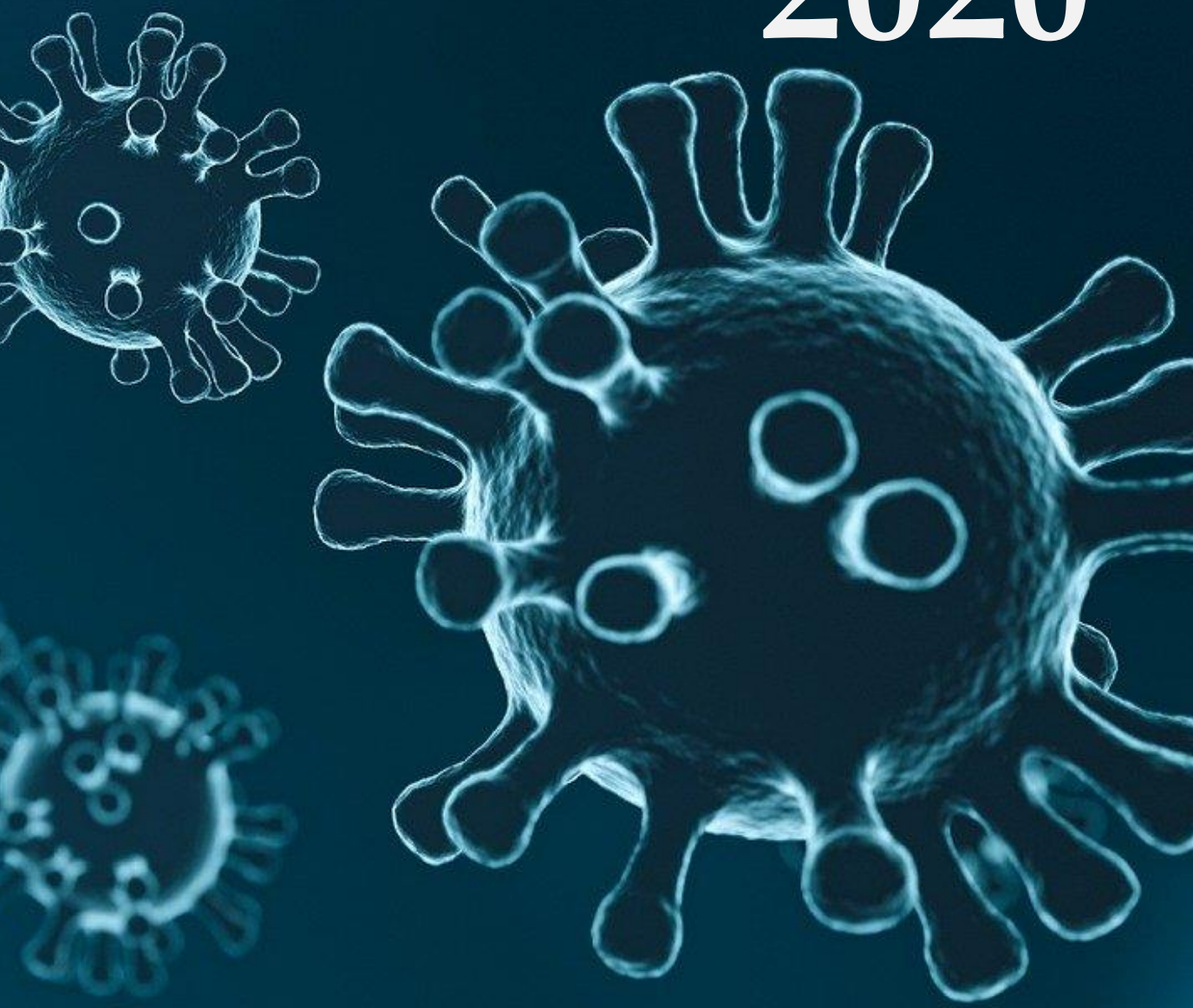
Annual Report
2020



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Labef
Laboratoire de Biomathématiques & d'Estimations Forestières

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Acknowledgment

This annual report was written under the direction of Professor Romain Glèlè Kakaï, Head of the "Laboratoire de Biomathématiques et d'Estimations Forestières (LABEF)". The report was written by the Forest Ecology and Management Research Unit with the full commitment of all the other research units of the Laboratory. Special thanks are also extended to all members who completed the individual annual report form. We are also grateful to all LABEF members for their contributions in framing, editing, and proofreading early drafts of this report. Finally, LABEF acknowledges the continued technical and financial support of its partners, which made the highlighted achievements possible.

Abbreviations & acronyms

AGNES	:	African German Network of Excellence in Science
FSA	:	Faculty of Agronomic Sciences (in English)
IF	:	Impact factor
IFS	:	International Foundation for Science
INRAB	:	Institut National de la Recherche Agricole du Bénin (National Institute of Agricultural Research of Benin)
LABEF	:	Laboratoire de Biomathématiques et d'Estimations Forestières
MSc	:	Master of Sciences
Ph.D.	:	Doctor of Philosophy
RUFORUM	:	Regional Universities Forum for Capacity Building in Agriculture
UAC	:	University of Abomey-Calavi
UNA	:	Université Nationale d'Agriculture
UP	:	University of Parakou
WIF	:	Without Impact Factor

Statement of the head of the Lab

Dear colleagues and friends,

I am delighted, as usual, to present the 2020 annual report of the "Laboratoire de Biomathématiques et d'Estimations Forestières" (LABEF).

With the global pandemic of COVID-19, as you are all aware, the year 2020 has been a challenging one. The pandemic has affected most of our activities. However, significant efforts have been made to achieve the insightful milestones presented in this report. The commitment of members, for example, strengthens LABEF's engagement in the progress of Biomathematics with a particular emphasis on application in forestry research. This is further demonstrated by the individual and collaborative projects underway and won in 2020.

Despite the global health crisis, we have sustained our standards regarding the amount and the quality of our scientific publications. These achievements have been possible mainly owing to the commitment of LABEF members who have been proactive in developing strategies to cope with the situation. I would like to take this opportunity to congratulate all the members for their efforts and their contributions to improving the visibility of the laboratory by maintaining a high scientific standard.

I hope you will enjoy reading this report. I look forward to sharing with you the future progress of LABEF.

Prof. Romain Glèlè Kakaï

Head of LABEF

CHAPTER 1.

LABEF: Overview and Team

1.1. Mission, vision, and objectives of LABEF

Created on 27th May 2014 by Romain Glèlè Kakaï, Professor in biometry and forest estimations, the "Laboratoire de Biomathématiques et d'Estimations Forestières", is part of the school of Environment Planning, Faculty of Agronomic Sciences, University of Abomey-Calavi. The Laboratory works towards the development and dissemination of innovative biomathematical methods in life sciences, and particularly in forestry, for the optimal delivery of their multiple contributions to life quality.

The mission of LABEF is to enhance understanding of biological systems through the effective use of biomathematical tools.

Its vision is to be a leading institution in developing mathematical tools for biologists and supporting decision-makers in forestry for a better life.

1.2. Organization of LABEF

LABEF is organized in four departments including the (i) fundraising department, (ii) social life department, (iii) administrative department, and (iv) research department. The research department includes four interrelated units namely: Unit of Biomathematics and Applied statistics; Unit of Forest Methods; Unit of Forest Ecology and Management and the Unit of Forest and People.

- **The Biomathematics and Applied Statistics** research unit deals with biology and mathematics and is interested in applications of mathematics in the field of biology. This unit is interested not only in the use of mathematical theories in biology but especially in publishing scientific notes describing the application of different mathematical tools in life sciences.
- **The Forest Methods** research unit falls into the overall perspective of assessing the wood resources, biomass, and carbon stock available in forest ecosystems. Hence, it provides the development of accurate and essential information for policy planning and forest resources management of the development of accurate and robust methods for estimating forest resources.
- **The Forest Ecology and Management** research unit is intended to understand ecological processes and patterns (forest ecosystems and forest ecosystem services, patterns and processes that govern the ecology

of species and the system of which these species are parts, seed ecology) and to develop accordingly clear and applicable management policies for forest managers and decision-makers.

- **The Forest & People** research unit undertakes investigations on forest governance approaches, their effectiveness, and replicability, their socio-economic and ecological outcomes, decision-making process, benefit-sharing, etc.

1.3. The core management team of LABEF in 2020

Prof Romain Glèlè Kakaï is the head of LABEF. He is a Full Professor in Biometry and Forestry, researcher, and lecturer at the Faculty of Agronomic Sciences. Prof Glèlè Kakaï is a chairman of the scientific council of agronomic sciences, chairman of the Scientific Council of the National Institute of Agricultural Research of Benin (INRAB), and chairman of the African German Network of Excellence in Science (AGNES). He is also coordinating the Doctoral program in Biometry at the University of Abomey-Calavi. His research areas include: Linear and nonlinear mixed models - Generalized linear models - Multiblock data analysis - Forest estimations - Forest management.

Dr Kolawolé Valère Salako is the scientific coordinator of LABEF. His research deals with population and community ecology, agroforestry systems analysis, and multivariate methods in community ecology. He is a young affiliate of The World Academy of Science (TWAS). He is also a member of multiple scholar societies and welcomes collaborative researches and grants that involve complementary disciplines.

Dr Charlemagne Gbemavo is the head of the Biomathematics and applied statistics research unit of LABEF. His research deals with Population Ecology, Forest Estimations, and Spatial Modeling. He teaches Biostatistics and Forest Estimations at the National Universities of Benin and takes the role of Biostatistician in several national or regional research projects.

Dr Rodrigue Castro Gbedomon is leading the research unit of Forest and People livelihood of LABEF. Castro's research concerns the social dimensions of biodiversity conservation, or, focuses on how people perceive, use, and interact with forest resources in a context of global changes. He is interested in advancing knowledge and practices on nature conservation, with a focus on topics such as ecosystem services, urban forestry, forest economics, and governance, etc.

Dr Rodrigue Idohou is coordinating the Forest Methods research unit of LABEF. Rodrigue's research focuses on aspects of the distribution and geography of wild species, the impact of human-induced factors on wild species conservation, spatial prioritization, planning, and wild species propagation. He teaches Biostatistics and Biodiversity Informatics at National Universities of Benin. His work usually involves geographers, computer scientists, and biologists.

Dr Achille Hounkpevi is leading the Forest Ecology and Management research unit of LABEF. Achille's research interests focus on Environmental Governance & Ecology including forest ecology & management, seeds ecology and biodiversity conservation, pollination network and ecosystem services.

Dr Marcel Donou is in charge of the social life department of LABEF. His Ph.D. research focused on conservation biology with a special focus on wild palms. His research interests include forest inventory, ethnobotany, and beekeeping.

Carl AKOTO is leading the administrative department. He is in charge of the administration and all related tasks. He assists the coordinator of the master program in statistics major Biostatistics for students' day-to-day management. He makes sure that students have their timetable, receive their lectures, submit their homework, and sit their exams on time. He also does everything students need to ensure their have a pleasant stay throughout the master program.

CHAPTER 2

RESEARCH: Milestones & Highlights

2.1. Scientific publications in 2020

2.1.1. Publications Milestones

In 2020, LABEF produced a total of 71 scientific documents. Among these documents (figure 1), 66.20% was scientific publications in peer-review journals (47 published papers), 14.08% was books and book chapters (10 documents), 9.86% was scientific papers in press (07 documents), 8.45% was scientific paper under review (06 documents) and 1.41% was abstracts in proceedings (01 document).

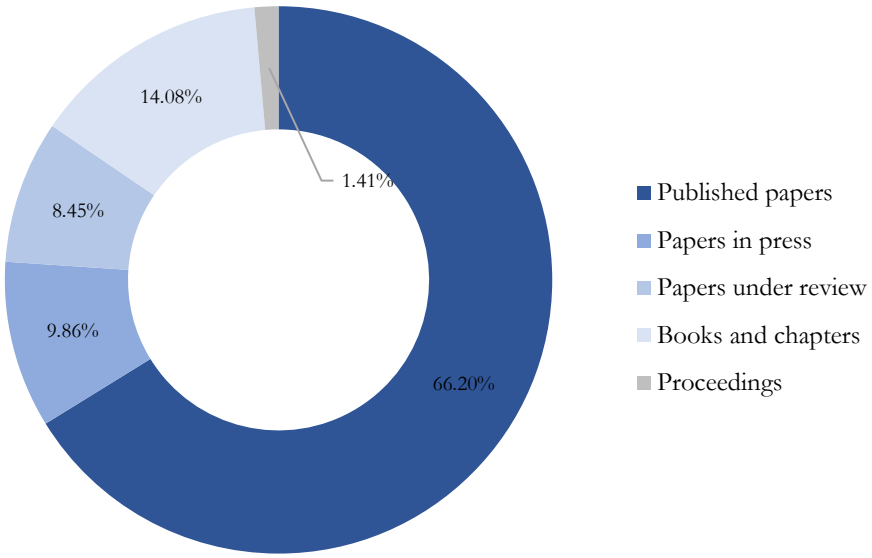

Figure 1. *Scientific documents produced by LABEF in 2020*

2.1.2. Diversity of Journals and scientific disciplines covered by publications of LABEF in 2020

In 2020, the papers were published in 44 journals as summarized in table 1. Several research domains were covered. Among the eleven research domains covered, quantitative ethnobotany (9 published papers), forestry (7 published papers), plant conservation biology (7 published papers), biostatistics (6 published papers), and ecology (5 published papers) were the most investigated (figure 2).

Table 1. *Diversity of journals for published, in press, and under review papers*

Journals	Published	In press	Under review
Advances in Traditional Medicine	1	-	-
African Journal of Applied Statistics	1	-	1
Agricultural Sciences	1	-	-
Agroforestry Systems	1	-	-
BMC Genetics	1	-	-
Ecological Indicators	1	-	-
Environment, Development, and Sustainability	1	-	-
Flora et Vegetatio Sudano-Sambesica	1	-	-
Functional Ecology	1	-	-
Global Ecology and Biogeography	1	-	-
Global Ecology and Conservation	1	-	-
International Journal of Progressive Science and Technologies	1	-	-
International Network For Natural Sciences	1	-	-
Journal de la recherche scientifique de l'Université de Lomé	1	-	-
Journal of Agricultural Extension	1	-	-
Journal of Environmental Management	1	-	-
Journal of Ethnobiology and Ethnomedicine	1	-	-
Journal of Ethnopharmacology	1	-	-
Journal of Probability and Statistics	1	-	-
Mathematical Biosciences	1	-	-
Modeling Earth Systems and Environment	1	-	-
Molecular Ecology	1	-	-
NeoBiota	1	-	-
Plant Ecology and Evolution	1	-	-
PloS ONE	1	-	1
Progress in Nutrition	1	-	-
Southern Forests	1	-	-
Sustainable Agriculture Research	1	-	-
Theoretical and Applied Climatology	1	-	-
Wetlands Ecology and Management	1	1	-
African Crop Science Society Journal	2	-	-
African Journal of Rural Development	2	-	-
Afrika Statistika	2	-	-
Bois et Forêts des Tropiques	2	1	2
Economic Botany	2	-	-
Genetic Resources and Crop Evolution	2	1	-
Knowledge Management for Development Journal	2	-	-
International Journal of Biological and Chemical Sciences	3	-	-
Ecosphere	-	1	-
European Journal of Forest Research	-	1	-
Journal of Arid Environments	-	1	-
Journal of Land Use Science	-	-	1
Mitigation and Adaptation Strategies for Global Change	-	1	-
Trees, Forests, and People	-	-	1

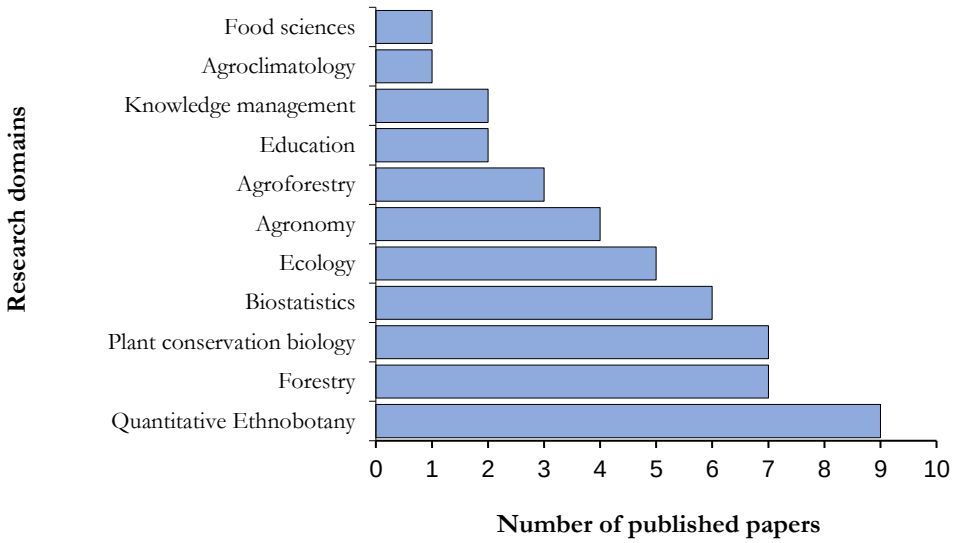

Figure 2. *Diversity of research domains for published papers by LABEF in 2020*

2.1.4. Performance and highlights in publication

LABEF produced overall slightly more documents in 2020 than in 2019 (figure 3a). Among the 69 documents of 2019, for instance, 40 were scientific publications in peer-review journals, while, 47 out of the 71 documents produced in 2020, were published in peer-review journals (figure 3b).

Regarding the published papers, 51.06% appeared in journals with impact factor (4a). As far as nearly published papers were concerned, 100% of papers were in journals with impact factor (figure 4b). Finally, for papers under review, 66.67% of papers were with impact factor journals (figure 4c). The standard of quality in publishing remain similar to 2019 with approximatively the same number (about 30 papers) of papers published in journal with impact factor.

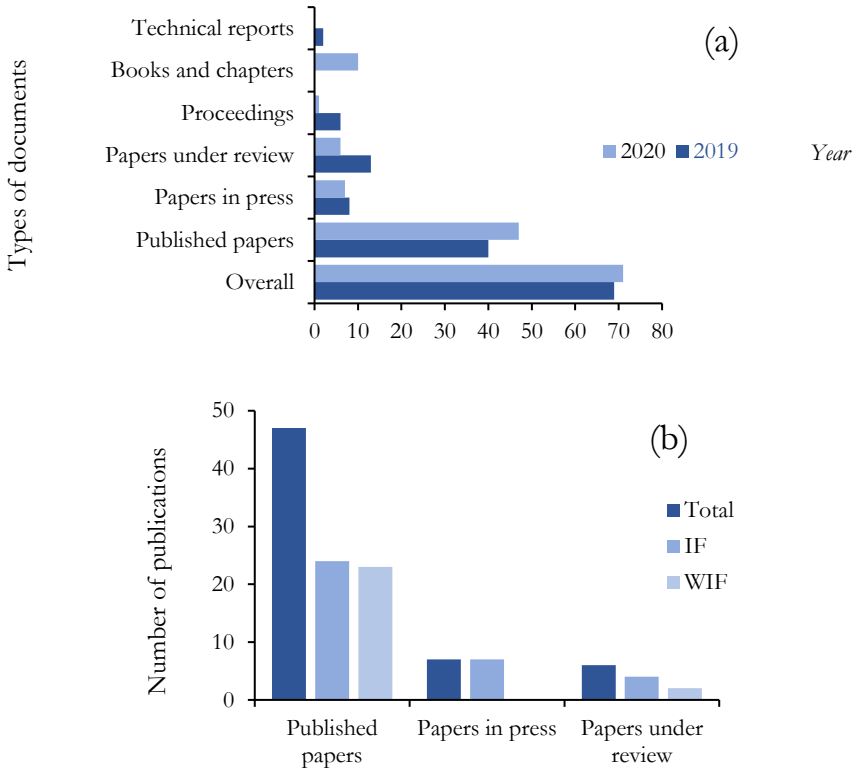

Figure 3. *Trends in types of published documents compared to year 2019 (a) and quality of publications (b). IF = Impact factored journals, WIF = Without impact factor journals*

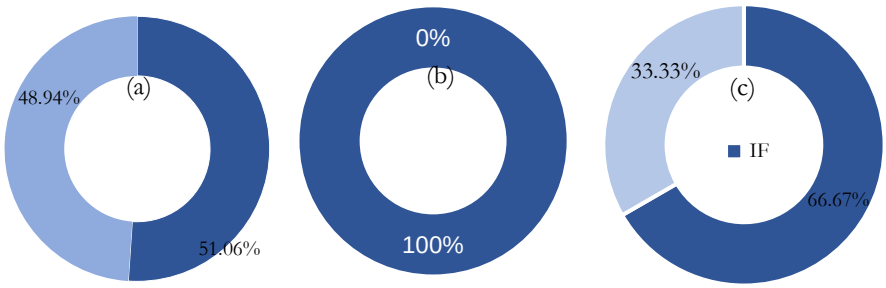

Figure 4. *Categories of papers in 2020: published (a), in press (b), and under review (c). IF = Impact factored journals, WIF = Without impact factor journals*

The cumulative impact factor was 59.051 in 2020 and is higher than in 2019 (38.127), illustrating that, members of LABEF have selected journals with higher impact factor for publications compared to 2019. Regarding papers in press, there was an increase in the quality of journals for publication compared to 2019, with a cumulative impact factor of 12.582 in 2020 and 4.074 in 2019 (figure 5).

However, as far as papers under review were concerned, the cumulative impact factor has decreased (4.716 in 2020 and 12.636 in 2019).

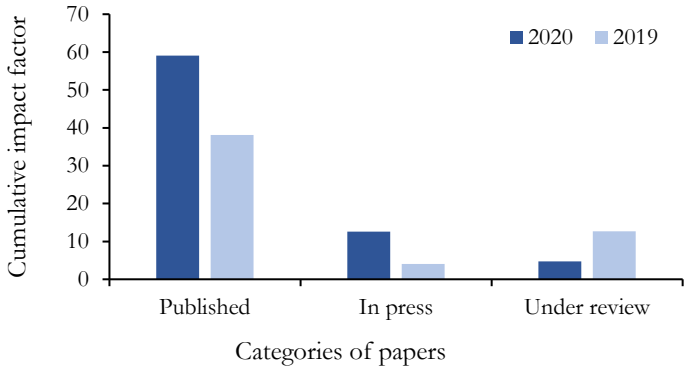

Figure 5. *Cumulative impact factor in 2019 and 2020*

Among the papers published in peer-review journals with an impact factor in 2020, 50% were in journals with an impact factor above 2, and 33.33 % in journals with an impact factor between 1 and 2 (figure 6a). For the papers accepted for publication (papers in press), 42.86% were in journals with an impact factor greater than 2 (figure 6b). However, for papers under review in journals with impact factors, only 25% are with journals having an impact factor above 2 (figure 6c).

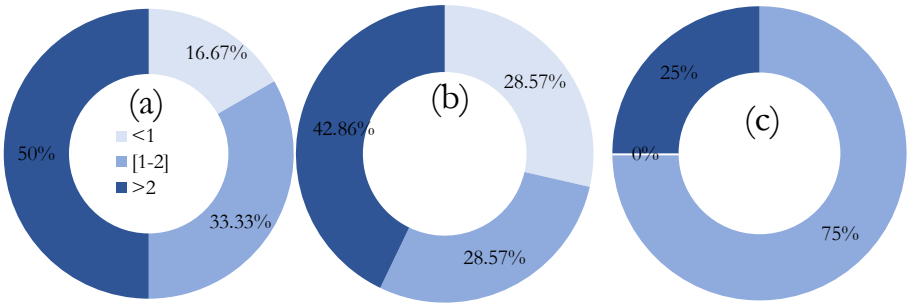

Figure 6. *Range of impact factor of published (a), in press (b), and under review (c) papers*

2.1.5. Authorship and leadership position in publications in 2020

In 2020, members of LABEF authored (co-authored) 47 scientific papers with various positions. For instance, members of the lab were exclusively the first author in 9 published papers (19.15%). In 31.92% of the published papers, members of the lab were among the first three authors (figure7). The leadership (last) position was occupied by members of the lab in 19.15% of the published

papers, while in 23.40% of the papers, the last as well as the first positions were ruled by LABEF's members.

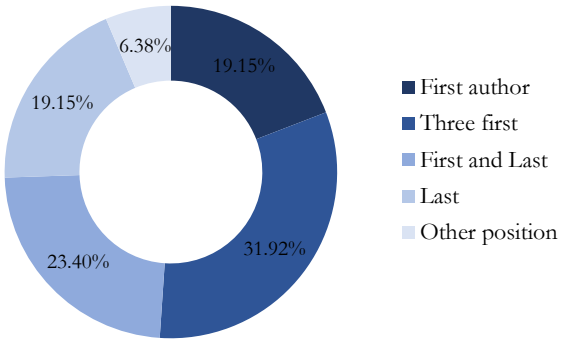

Figure 7. *(Co-) Authorship position of LABEF members in publications in 2020*

2.2. Research initiatives related to COVID-19

To contribute to the scientific debate around the health crisis, LABEF undertook, since April 2020, research on the dynamics of the first wave of COVID-19 in West Africa. Through these works, the impacts of non-pharmaceutical interventions and efficient management scenarios of the pandemic were investigated. The team devoted to this work within the laboratory consists largely of masters and Ph.D. students and postdoctoral fellows who had the opportunity to put into practice and in real-time, the knowledge and skills gained during their training in Biostatistics. From these research activities, six scientific publications have been prepared among which four have been published in 2020 and two others in revision. A scientific seminar has also been organized by the lab to share the findings with the scientific community of Benin at the University of Abomey-Calavi on September 8th, 2020 (photo 1 & 2).

- Taboe H. B., Salako K.V., Tison J., Ngonghala C.N, Glèlè Kakaï R. (2020). Predicting COVID-19 spread in the face of control measures in West Africa. *Mathematical biosciences*, 328, 108431. https://bit.ly/2V3seAJ
- Tovissodé F., Lokonon B., Glèlè Kakaï R. (2020). On the use of growth models to understand epidemic outbreaks with application to COVID-19 data. PLoS One, 15(10): e0240578. https://doi.org/10.1371/journal.pone.0240578
- Gnanvi J., Salako K. V., Kotanmi B., & Glèlè Kakaï, R. (2021). On the reliability of predictions on Covid-19 dynamics: A systematic and critical review of modelling techniques. Infectious Disease Modelling 6 (2021) 258-272. https://doi.org/10.1016/j.idm.2020.12.008

- Tovissodé C.F., Doumatè J.T., Glèlè Kakaï R. (2021). A Hybrid Modeling Technique of Epidemic Outbreaks with Application to COVID-19 Dynamics in West Africa. Biology, 10, 365. https://doi.org/10.3390/biology1005036

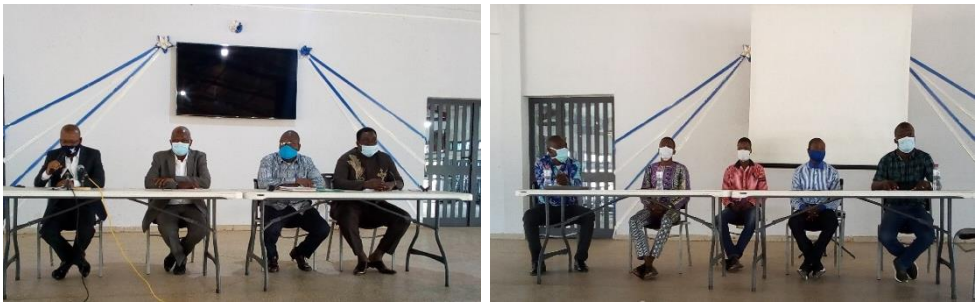

Photo 1. *The panel of officials (Left) and presenters (Right) at the scientific seminar on findings on COVID-19 (credit: Dr Achille Hounkpevi)*

Photo 2. *Presenter (Left) and participants (Right) at the scientific seminar on findings on COVID-19 (credit: Dr Achille Hounkpevi)*

2.3. Research projects in 2020

The research projects implemented by LABEF in 2020 included as usual small grants (less than USD 25000), medium (USD 25 000-200 000), and large (more than USD 200 000) projects. Six individual small grants were implemented by members of LABEF in 2020 (see table 2).

Table 2. *Individual small research grants in LABEF in 2020*

N°	Grants	Recipient	Topic/subject
1	IFS	Parfait Agonha	Habitat use, food preferences and conservation status of preferred food resources of elephants in the Pendjari National Park, Benin: implications for conservation and management

2	IMU	Hemaho Beaugard Taboe	Graduate Research Assistantships in Developing Countries (GRAID) Program from the International Mathematical Union (IMU), USA
4	IFS	Guillaume Hounsou-Dindin	Distribution, diversity, population structure, and ethnobotany of priority wild oil plants in Benin
5	University of Tennessee Knoxville	Nadejda B. Sero	Access and Diversity Scholarship
6	TWAS	Mahoutin Gildas Serge Zanvo	Fellowships for Research and Advanced Training

Four medium and one large research project were hosted by LABEF in 2020 (table 3). In the frame of these projects, LABEF partnered with several institutions from diverse countries in Africa (Mali; Burkina Faso; Niger), Europe (Belgium, Denmark), and America (Costa Rica). For more details on medium and large projects, please visit our website: http://labef-uac.org/en/ongoing-projects/.

Table 3. *Medium and large research projects in LABEF in 2020*

N°	Project title	Project type	Partner countries	Funding institution	Period
1	Scaling up African baobab food products valuation through enhancement of their safety and value chains for food and nutritional security in Benin (West Africa)	Medium	Benin	Mastercard Foundation & The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)	2018-2022
2	Mentoring young men and women agricultural graduates in the search for decent jobs in the labor market	Medium	Benin	International Development Research Centre (IDRC)	2019-2021
3	Contribution à l'élaboration d'un plan de gestion durable des mangroves dans le contexte des changements climatiques au Bénin	Medium	Benin	Fonds national de la recherche scientifique et de l'innovation technologique (FNRSIT)	2017-2020
4	Restauration, conservation et gestion durable des zones humides côtières du Costa Rica face au changement climatique	Medium	Costa Rica ; Benin	French Facility for Global Environment (FFEM)	2018-2022

N°	Project title	Project type	Partner countries	Funding institution	Period
5	Enhancing nutritious food availability through promotion of native edible tree/shrub species in Sub-Saharan Africa	Large	Benin; Mali; Burkina Faso; Niger; Denmark; Belgium	Fondation Agropolis, Fondazione Cariplo & Fondation Daniel et Nina Carasso	2017-2020
6	Modeling nonlinear trend in multilevel data using flexible distributions: a guideline for selecting the best of parametric and semi-nonparametric approaches	Medium	Benin	TWAS	2010-2021
7	"In-Country/In-Region Scholarship Programme" for Master in Statistics (Major Biostatistics) & Doctorate in Biometrics	Large	Africa	Deutscher Akademischer Austauschdienst German Academic Exchange Service (DAAD)	2019-2022

2.4. Bachelor, Master, and Ph.D. degree dissertations in 2020

Two students (one male and one female) completed their BSc training and defended their dissertation in natural resources management in 2020. Fifteen MSc students (2 females and 13 males) completed their MSc degree at LABEF (figure 8a). Among these theses, 10 were completed in biostatistics and 5 in natural resources management (figure 8b).

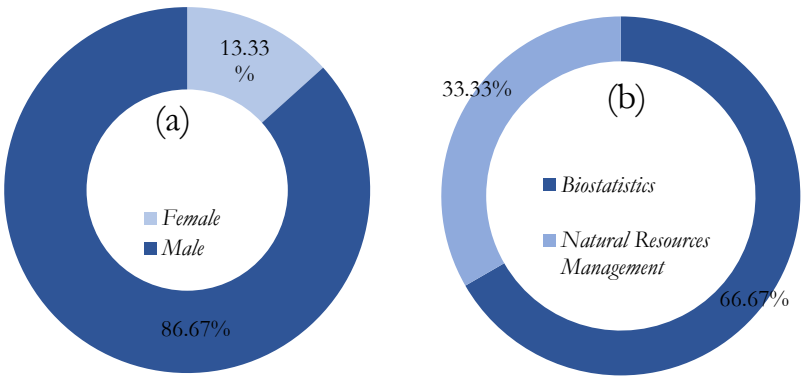

Figure 8. *Gender balance (a) and fields of research (b) for Master theses*

As far as Ph.D. works in 2020 were concerned, five students (4 male and 1 female) defended their theses (two in Biometry and three in natural resources management). Twenty-three Ph.D. initiatives are ongoing (5 females and 17 males). These Ph.D. initiatives covered several research domains, with, biostatistics being the most investigated discipline (13 initiatives, see figure 9a). Moreover, 34.78% of the Ph.D. students are in their first year, while 30.43% are in their third year in 2020 (figure 9b).

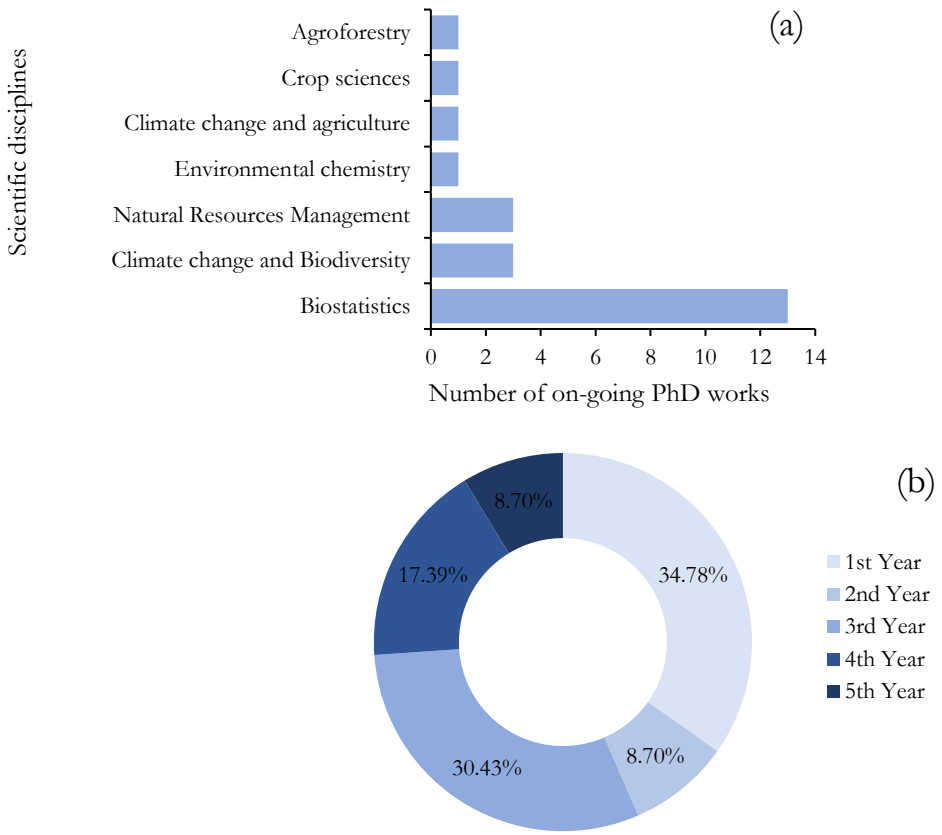

Figure 9. *Fields of research (a) and stages of ongoing Ph.D. theses in 2020*

CHAPTER 3

RESEARCH: Connection, share, and networking

3.1. Collaboration for publication in 2020

Collaboration for publications was done with researchers from several countries. In 2020, LABEF members collaborated with researchers from 21 countries, national collaborations being the most dominant (55%, figure 10a). The most represented continent for these collaborations was Africa with more than 80%, followed by Europe with more than 10% (figure 10b).

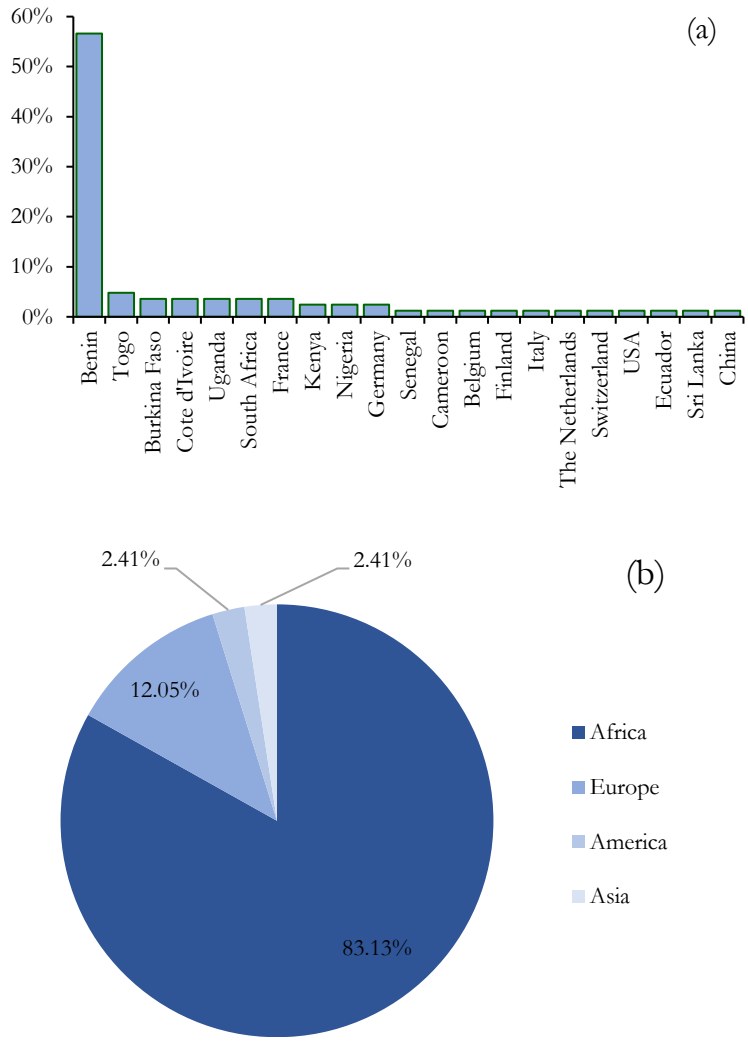

Figure 10. *Countries (a) and world regions (b) of co-authors of publications of LABEF in 2020*

3.2. Visitors to LABEF in 2020

In 2020, The COVID-19 global pandemic significantly affected the flow of visitors to LABEF. Several visits were announced but with the international travel restriction, only one Post-Doc researcher was able to visit LABEF in 2020.

3.3. Participation in scientific meetings in 2020

In 2020, members of LABEF contributed to knowledge sharing via participation in ten (10) scientific meetings. The number of conferences attended in the year is low compared to the 40 conferences attended in 2019, due to the COVID-19 pandemic. Moreover, 40% of these meetings were held online. The meetings attended by LABEF members were held in six countries (figure 11). The participation in these meetings was for oral communication (60 %) or simple attendance (40 %).

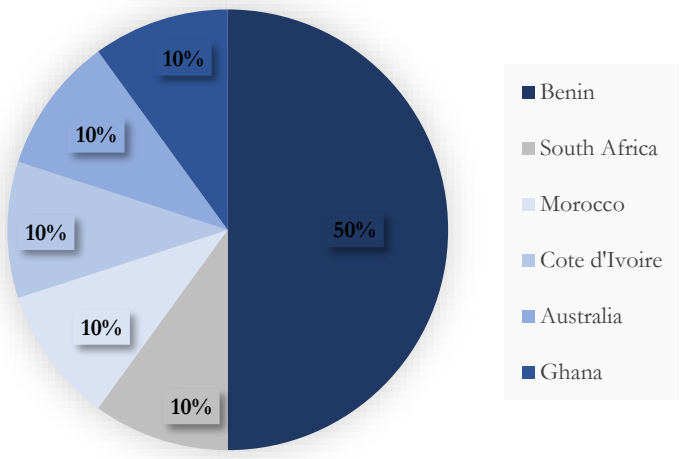

Figure 11. *Host countries of scientific meetings attended by LABEF members in 2020*

CHAPTER 4

CONTRIBUTION: Capacity building

4.1. Graduate program in Biostatistics and Post graduate program in Biometry

4.1.1. Graduate program in Biostatistics (MBIOST)

4.1.1.1. Presentation of the MBIOST

Since its creation in May 2014, LABEF runs an international graduate program in Biostatistics. This master's program offers extensive and unique training in recent statistical methods and tools toward their applications in Life sciences. At the end of the training, graduated students can easily go into professional life as Biostatisticians or engage in research in Biostatistics by integrating a doctoral school. This training is open to Bachelor Degree holders in Life Sciences domains (agronomy, health, biology, environment, etc.), or in Mathematics/Statistics or Master, Degree holders wishing to acquire knowledge and know-how in the field of data collection and analysis. The Master in Biostatistics has fully trained and released five batches of professional biostatisticians and data analysts. The 8th batch of students started in September 2020 and enrolled 29 students from 06 countries (Benin, Burundi, Democratic Republic of Congo, Nigeria, South Sudan, and Uganda). To date, 151 students were trained or are completing their degree in the program. The program is supported by an Intra-ACP Academic Mobility Program (AGREEMENT NUMBER 2013-4177/001-001), RUFORUM, German Federal Ministry of Education and Research through DAAD In Country/In Region Program, and the African Excellence Center for Mathematics Sciences and Application (ACE-MSA, through World Bank Group fund).

4.1.1.2. Aims of the MBIOST

The MBIOST program aims to provide Food Enterprises, Projects, Health Sector (Units of Clinical research), Department of Medical Information, etc.), Public and Private Research Institutions, Non-Governmental Organizations (NGO), International Organization (FAO, UNDP, World Bank, etc.), Education and International Research Institutions, with talented Biostatisticians and data analysts. The abilities this training gives in data collection, data management, statistical analysis, and valorization allow graduates to practice the job of Biostatisticians in charge of Statistical Studies in various sectors. Our alumni are working as data scientists and Statisticians in various institutions (e.g., AfricaRice, MTN, Global Fund TB, Benin National Institute of Agricultural Research, University of Malawi, University of Abomey-Calavi) and PhD-students or post-docs in Africa, Europe, Asia, and America.

4.1.1.3. How to apply?

Visit the website www.labef-uac.org and fill in the online application form (http://labef-uac.org/application). Candidates from Benin could submit their applications to the secretary of the program, located at the Laboratoire de Biomathématiques et d'Estimations Forestières. Please visit the webpage of the Master for detailed information (http://labef-uac.org/en/master/).

4.1.2. Post graduate program in Biometry

In addition, since the academic year 2017-2018, the doctoral school of agronomic sciences and water resources is offering a Ph.D. program in Biometry under the coordination of Prof Romain Glèlè Kakaï (the head of LABEF and coordinator of the master program in Biostatistics). Seven new members of LABEF who graduated from the Master's program in Biostatistics are currently enrolled in the Ph.D. program. Thus, to date, 13 members of LABEF are enrolled in the Ph.D. program and some of them are close to their thesis defense. In 2020, two members of the lab graduated for their Ph.D. in the program, namely Dr Bruno Lokonon and Dr Honfo Hermann).

4.2. The internship programs in 2020

In 2020, LABEF received six BSc and six MSc graduates for the academic internship program. Three of these interns were females. Nine of the interns were graduated from the Faculty of Agricultural Sciences (University of Abomey-Calavi), two from the National University of Agriculture, and one from the University of Parakou (table 4). During this internship program (May to November 2020), they were trained to develop skills in scientific writing and data analysis mainly with R software. They have also contributed to the scientific activities of the lab.

Table 4. *List of graduates received in LABEF in 2020 for an academic internship*

Name	University of graduation	Degree	Sex
AGOSSOU Habib	UAC	BSc	Male
ALAMOU A. Ben-ally	UNA	Msc	Male
CHAFFA Thierry	UAC	Msc	Male
CHODATON Yélognissè Gilles	UNA	Msc	Male
DOKAN D Romiard	UAC	BSc	Male
DOUMATEY A.P. Judith	UP	BSc	Female
FOUNDIE A. Maurice	UAC	BSc	Male
GANDAHO Stanislas Mahussi	UAC	BSc	Male
OUSSOUKPEVI J.K. Stanislas	UAC	BSc	Male
QUENUM T A. Ansano	UAC	Msc	Male
TOFFA Yessia	UAC	Msc	Female
TOSSOU FAGLA Sètchémin Nicole	UAC	Msc	Female

Unfortunately, in 2020, because of the global health crisis, the regional internship program did not welcome any foreign interns.

The program is still opened, and we wish to welcome interns in the future. For details, requirements, and conditions for participating in the internship programs of LABEF, please contact the Lab (contact.labef@gmail.com).

Appendix 1.

Scientific activities in 2020

- A1.1. Defended theses in 2020

Name	Sex	Research topic	Research field
Lokonon E. Bruno	M	Empirical comparison of parameter estimation methods used in generalized linear mixed model (GLMM) with applications on ecological data	Biostatistics
Honfo Hermann	M	Linear mixed effects models for fitting multivariate longitudinal data: application to natural regeneration of *Adansonia digitata* L.	Biostatistics
Houndonougbo Juliano	M	Ecology, conservation and domestication of *Parkia biglobosa* (Jack.) R. Br. (Mimosoideae) in Benin, West Africa	Plant conservation biology
Gnonlonfoun Isidore	M	Dynamics of savanna plants: effects of trophic interactions between elephants and woody plants in Pendjari Biosphere Reserve in Benin, West Africa	Ecology
Assogba Orgely Doris Imeilda	F	Ecology and dynamics of baobab regeneration (*Adansonia digitata* L.) in Benin (west Africa)	Natural Resources Management

- A1.2. On-going theses in 2020

N°	Name	Sex	Level	Topic	Field of research
1	Hemaho Beaugard Taboe	M	1st year	Mathematical meta-population models of emerging and re-emerging communicable diseases' dynamic patterns in developing countries: Application to COVID-19 pandemic and Lassa Fever virus outbreak in West Africa.	Biostatistics
2	Kakpo Dolou Angeline Reine	F	2nd year	Uses, fertilizing power, populations dynamic and conservation of some agroforestry species with high soil fertilizing potential in Benin.	Agroforestry
3	Tovissodé Chénangnon Frédéric	M	3rd year	Performance of Generalized Linear and Nonlinear Mixed Models under Flexible Parametric and Semi-Nonparametric Distributions with applications to plant-plant interactions in *Afzelia africana* Sm.	Biostatistics
4	Hounsou-Dindin Guillaume	M	2nd year	Biodiversity and ecological status of wild oil plants with implication for conservation and domestication in Benin	Natural Resources Management

N°	Name	Sex	Level	Topic	Field of research
5	Tahi Souand Peace Gloria	F	1st year	Artificial Intelligence-based problem-solving in agricultural yield prediction: Optimization of Ensemble Learning techniques performances and ability of base regressors in the prediction of yield of maize cultures under several controlled weather and fertilization patterns	Biostatistics
6	Zanvo Mahoutin Gildas Serge	M	3rd year	Population structure, dynamics, and ecosystem services of mangroves in southern Benin, West-Africa: implications for sustainable management	Natural Resources Management
7	Wabi Moudjahid Akorédé	M	5th year	Variabilités climatiques et riziculture au Bénin : cas des communes de Malanville, Glazoué et Tanguiéta	Crop sciences
8	Eclou Innocent Sènandé Benjamin	M	5th year	Assessing the potential of organic cotton production to improve the livelihoods of millions of poor households in Sub-Saharan Africa (SSA)	Environmental chemistry
9	Hounmenou Castro	M	4th year	Nonlinear regression analysis with multilayer perceptron neural networks for single and multidimensional outputs	Biostatistics
10	Sinsin Corine Bitossessi Laurenda	F	3rd year	Resilience and Vulnerability of mangroves in Benin, West Africa: implications for sustainable management	Climate change and Biodiversity
11	Assogbadjo Bidossèssi Eliane Juliette	F	3rd year	Biodiversity and Indigenous Knowledge in the areas surrounding the Lama Forest in Benin	Climate change and Biodiversity
12	Amoussou Biowa Eldys Narcisse	M	4th year	Évaluation et prédiction de l'impact des changements climatiques sur les produits forestiers non ligneux (PFNLs) d'Afrique tropicale : conséquences sur la distribution des espèces et implications économiques.	Climate change and Biodiversity
13	Mushagalusa Ciza Arsène	M	1st year	Practical use of Random Forest regression for count response data and diseases' vectors abundance prediction: application to ticks (*Rhipicephalus appendiculatus*)	Biostatistics

N°	Name	Sex	Level	Topic	Field of research
				abundance in grazed permanent pastures	
14	Houetohossou Ariane	F	1st year	Architectural and parametric optimization of pre-trained Convolutional Neural Network (CNN) with application on stress detection on tomato plants under climate and infection based simulated environments	Biostatistics
15	Ehnon Gongnet Emmanuel	M	1st year	Empirical assessment of Bayesian Maximum Entropy (BME) robustness in spatial estimation with application on soil data	Biostatistics
16	Ahlonsou Biowa Ceptime Galilée	M	3rd year	Empirical performance of Distance functions for farm efficiency analysis with application on organic cotton farming systems in Benin	Biostatistics
17	Bourobou Judie Armel	M	1st year	Inhomogeneous Poisson Process and its extensions for species distribution analysis: Accounting for sampling bias, imperfect detection, non-linear effect and spatial dependence.	Biostatistics
18	Tchandao Mangamana Essomanda	M	3rd year	Unsupervised and supervised strategies of multiblock data analysis	Biostatistics
19	Mugumaarhahama Yannick	M	1st year	Spatial point process model for analysis of presence-only data: accounting for species characteristics and uncertainties in data	Biostatistics
20	Dah-Dovonon Virgile-Marx	M	1st year	Evaluation des stratégies innovantes d'adaptation et apport de l'information climatique dans la Gestion des risques climatiques dans les exploitations agricoles au Bénin	Climate change and agriculture
21	Donhouede Janine	F	3rd year	Morphological variation, genetic diversity and proximate composition in *Annona senegalensis* in Western and Southern Africa	Natural Resources Management
22	Savi Merveille	M	4th year	Advanced system dynamic analysis approach to enhance the control of malaria in West Africa	Biostatistics

N°	Name	Sex	Level	Topic	Field of research
23	Amagnide Aubin	M	4th year	Empirical studies of plotless sampling techniques in vegetation studies	Biostatistics

- A1.3. Completed Master in 2020

N°	Name	Sex	Topic	Supervisor(s)	Field of research
1	Akouete Lally Espinel Pathmos	M	Structure, dominance et stabilité des peuplements dans une mosaïque forestière en zone semi-aride : Cas de la Réserve Forestière de Bellefoungou au Nord-Bénin	Prof. Romain Glèlè Kakaï	Natural Resources Management
2	Akouete Lally Espinel Pathmos	M	Effets de la salinité de l'eau d'arrosage sur l'émergence, la croissance et l'allocation de la biomasse de quatre provenances du Sud-Bénin de *Rhizophora racemosa* et *Avicennia germinans* en milieu contrôlé : implications pour la restauration des mangroves	Prof. Romain Glèlè Kakaï	Natural Resources Management
3	Tovissodé Chénangnon Frédéric	M	Empirical performance of stochastic EM algorithms in non-linear mixed models under scale mixture of skew normal distributions	Prof. Romain Glèlè Kakaï; Prof. Carlos Ogouyandjou	Biostatistics
4	Tchandao Mangamana Essomanda	M	Application of common components and specific weights method to analyze local perception patterns of land degradation in northern Benin (West Africa)	Prof. Romain Glèlè Kakaï	Biostatistics
5	Amagnide Aubin	M	Longitudinal data analysis: fitting an optimal variance-covariance structure under linear mixed effect models frameworks	Prof. Romain Glèlè Kakaï	Biostatistics
6	Ahlonsou Ceptime	M	Critical review of plotless sampling techniques in vegetation studies	Prof. Romain Glèlè Kakaï	Biostatistics

7	Houetohossou Ariane	F	Using multivariate longitudinal data analysis to assess growth patterns of maize (Zea mays L.) in Benin	Prof. Romain Glèlè Kakaï	Biostatistics
8	Tahi Souand Peace	F	Competing risks models: simulation and application with HIV data in Benin	Prof Gnéyou Kossi E./ Prof Glèlè Kakaï Romain	Biostatistics
9	Bourobou Judie Armel	M	Empirical Performance of Robust Principal Component Analysis	Prof. Romain Glèlè Kakaï	Biostatistics
10	Ehnon Gongnet Emmanuel	M	Empirical assessment of different Kriging methods in soil data analysis	Prof. Romain Glèlè Kakaï	Biostatistics
11	Mushagalusa Ciza Arsène	M	Random forest method for estimating livestock density in data-limited area (case of pig in Benin)	Prof. Romain Glèlè Kakaï	Biostatistics
12	Mugumaarhahama Yannick	M	Inhomogeneous Poisson Point Process for Species Distribution Models: Relative performance of methods accounting for sampling bias and imperfect detection	Prof Romain Glèlè Kakaï/Dr Ir Belarmain Adandé Fandohan	Biostatistics
13	Constant Setondé Gnansounou	M	Diversity of Mangrove Ecosystem Services and Drivers of Change in the Mono Transboundary Biosphere Reserve, West-Africa	Prof Denis Aheto (Main Supervisor) Prof. Romain Glèlè Kakaï (Co Supervisor)	Coastal Zone Management
14	Constant Setondé Gnansounou	M	Impacts de l'Anthropisation sur la Diversité et la Structure des Communautés de phytoplancton des Mangroves du Sud Benin	Prof Laleye Philippe (Main Supervisor) Prof. Romain Glèlè Kakaï (Co Supervisor)	Coastal Zone Management
15	Constant Setondé Gnansounou	M	Diversité structurale, Ethnobiologie et Services Ecosystémiques des mangroves de la Commune de Grand Popo, Sud Bénin	Prof Achile Assogbadjo	Coastal Zone Management

- A1.4. Scientific papers published in peer-review journals with IF in 2020

Discipline	N°	Authors' Names	Title of the article	Journals	IF
Ethnobotany	1	Tiétiambou Fanta Reine Sheirita, Salako Kolawolé Valère, Tohoun Jésukpégo Roméo and Ouédraogo Amadé	Local preferences for three indigenous oilseed plants and attitudes towards their conservation in the Kénédougou province of Burkina Faso, West-Africa	Journal of Ethnobiology and Ethnomedicine	2.264
Forestry	2	Assogba Orgely Doris Imeilda, Salako Kolawolé Valère, Fantodji Benjamin, Assédé Éméline P. S., Assogbadjo Achille Ephrem and Chirwa Paxie Wanangwa	Does land-use type impact the demographic and spatial structures of *Adansonia digitata* L. in the Biosphere Reserve of Pendjari in Northern Benin?	Bois et Forêts des Tropiques	0.688
Plant conservation biology	3	Helmstetter Andrew J., Amoussou Biowa E. N., Bethune Kevin, Kandem Narcisse G., Glèlè Kakaï Romain, Sonké Bonaventure and Couvreur Thomas L. P.	Phylogenomic approaches reveal how climate shapes patterns of genetic diversity in an African rain forest tree species	Molecular Ecology	5.163
Biostatistics	4	Taboe Hémaho B., Salako Kolawolé V., Tison James M., Ngonghala Calistus N. and Glèlè Kakaï Romain	Predicting COVID-19 spread in the face of control measures in West Africa	Mathematical Biosciences	1.81
Ecology	5	Hounkpèvi Achille, Salako Valère Kolawolé, Donhouédé Janine Conforte Fifonssi, Daï Emilienne Houévo, Tovissodé Frédéric, Glèlè Kakaï Romain and Achille Ephrem Assogbadjo	Natural intraspecific trait variation patterns of the wild soursop *Annona senegalensis* (Annonaceae) along a climatic gradient in Benin, West Africa	Plant Ecology and Evolution	1.119
Ethnobotany	6	Ahoyo Carlos C., Houehanou Thierry D., Yaoitcha Alain S., Prinz Kathleen, Glèlè Kakaï Romain L., Sinsin Brice A. and Houinato Marcel R.B.	Classification of diseases treated with woody species at the national scale and among climatic zones in Benin (West Africa)	Journal of Ethnopharmacology	3.69

Discipline	N°	Authors' Names	Title of the article	Journals	IF
Ecology	7	Alowanou Géorcelin G., Houéhanou Thierry D., Mensah Sylvanus, Alissou Bénoit K., Ahoyo Carlos C., Akpako Rauldin S., Wabi Faroukou, Houinato Marcel R.B. and Hounzangbé-Adoté Sylvie M.	Status and population structures of three anthelmintic tree species along climatic gradient in Benin and the implications for conservation	Southern Forests	1.2
Ethnobotany	8	Avakoudjo Hospice Gérard Gracias, Hounkpèvi Achille, Idohou Rodrigue, Koné Mamidou Witabouna and Assogbadjo Achille Ephrem	Local knowledge, uses and factors determining the use of *Strychnos spinosa* organs in Benin (West Africa)	Economic Botany	1.867
Ethnobotany	9	Biara Emmanuel, Egeru Anthony, Mensah Sylvanus, Salamula Jenipher Biira and Kadigo Mark Marvin	Socio-economic factors infuencing *Afzelia africana* Sm. use value and traditional knowledge in Uganda: implications for sustainable management	Environment, Development and Sustainability	2.19
Education	10	Bodjrenou Fifali Sam Ulrich, Hounkpatin Waliou Amoussa, Mitchodigni Irène, Salako Valère, Glèlè Kakaï Romain, Dadele Ysé, Bouzitou Gervais Ntandou, Schneider Lauriina, Mutanen Marja, Savy Mathilde, Kennedy Gina, Hounhouigan Joseph D. and Termote Céline	Comparing video and poster-based education for improving 6-17 months children feeding practices: a cluster randomized trial in rural Benin	Progress in Nutrition	0.323
Ethnobotany	11	Dadjo Colombe, Aggrey Bernard Nyende, Salako Kolawolé Valère, Hounkpèvi Achille and Assogbadjo Achille Ephrem	Socio–Economic factors determining conservation and cultivation of *Garcinia kola* Heckel—A medicinal plant extinct in the wild in Benin	Economic Botany	1.867

Discipline	N°	Authors' Names	Title of the article	Journals	IF
Plant conservation biology	12	Gbedomon Rodrigue C., Valère K. Salako and Martin A. Schlaepfer	Diverse views among scientists on non-native species	NeoBiota	2.75
Agroforestry	13	Houndonougbo J. S. H., Kassa B., Mensah S., Salako V. K., Glèlè Kakaï R. and A. E. Assogbadjo	A global systematic review on conservation nd domestication of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, an indigenous fruit tree species in Sub-Sahara African traditional parklands: current knowledge and future directions	Genetic Resources and Crop Evolution	1.071
Plant conservation biology	14	Houndonougbo J. S. H., Kassa B., Salako V. K., Idohou R., Assogbadjo A. E. and Glèlè Kakaï R.	Perceived variation of fruit traits, and preferences in African locust bean [*Parkia biglobosa* (Jacq.) Benth.] in Benin : implications for domestication	Genetic Resources and Crop Evolution	1.071
Plant conservation biology	15	Kpatènon Mariano Joly, Salako Kolawolé Valère, Santoni Sylvain, Zekraoui Leila, Latreille Muriel, Tollon-Cordet Christine, Mariac Cédric, Jaligot Estelle, Beulé Thierry and Adéoti Kifouli	Transferability, development of simple sequence repeat (SSR) markers and application to the analysis of genetic diversity and population structure of the African fan palm (*Borassus aethiopum* Mart.) in Benin	BMC Genetics	2.917
Ecology	16	Mensah Sylvanus, Salako Valère Kolawolé, Assogbadjo Achille, Glèlè Kakaï Romain, Sinsin Brice and Seifert Thomas	Functional trait diversity is a stronger predictor of multifunctionality than dominance: Evidence from an Afromontane Forest in South Africa	Ecological Indicators	4.2
Ecology	17	Mensah Sylvanus, Salako Valère K. and Seifert Thomas	Structural complexity and large-sized trees explain shifting species richness and carbon relationship across vegetation types	Functional Ecology	4.4
Ecology	18	Mensah Sylvanus, Noulèkoun Florent, Dimobe Kangbéni, Atanasso Justin, Salako Valère K., Assogbadjo Achille	Revisiting biotic and abiotic drivers of seedling establishment, natural enemies and survival in a tropical tree species in a West Africa semi-arid biosphere reserve	Journal of Environmental Management	5.6

Discipline	N°	Authors' Names	Title of the article	Journals	IF
		and Glèlè Kakaï Romain			
Forestry	19	Mensah Sylvanus, Noulekoun Florent and Ago Expédit E.	Aboveground tree carbon stocks in West African semi-arid ecosystems: dominance patterns, size class allocation and structural drivers	Global Ecology and Conservation	2.5
Forestry	20	Panzou, Fayolle, Jucker et al	Pantropical variability in tree crown allometry	Global Ecology and Biogeography	6.4
Biostatistics	21	Tovissodé Chénangnon Frédéric, Lokonon Bruno Enagnon and Glèlè Kakaï Romain	On the use of growth models to understand epidemic outbreaks with application to COVID-19 data	PloS ONE	2.78
Agroforestry	22	Raveendra T, Nissanka SP, Somasundaram D, Atapattu AJ and Mensah S	Coconut-Gliricidia mixed cropping systems improve soil nutrients in dry and wet regions of Sri Lanka	Agroforestry Systems	1.9
Forestry	23	Zanvo M. G. Serge, Barima Y. S. Sabas, Salako K. Valère, Koua K. A. Noël2, Kolawolé Moustapha A., Assogbadjo A. Ephrem and Glèlè Kakaï Romain	Mapping spatio-temporal changes in mangroves cover and prediction of their future dynamics in Benin	Bois et Forêts des Tropiques	0.688
Forestry	24	Zanvo M.G. Serge, Salako K. Valère, Gnanglè Césaire, Mensah Sylvanus, Assogbadjo Achille and Glèlè Kakaï Romain	Human disturbances have less effect on tree taxonomic diversity than structural diversity, population structure, and stability in a west-African mangrove forest	Wetlands Ecology and Management	0.593

- A1.5. Scientific papers published in peer-review indexed journals without IF in 2020

Disciplines	N°	Authors' Names	Title of the article	Journals
Agronomy	1	Dayou Ephrème Dossavi, Ajav Emmanuel A., Zokpodo K. L.	Factors determining continuous tractor use in Benin Republic	Journal of Agricultural Extension

		Barnabé, Bamgboye A. Isaac and Glèlè Kakaï L. Romain		
Food sciences	2	Gbaguidi A.M., Chadare F.J., Salako V.K., Idohou Y.O.V. and Assogbadjo A.E.	Optimisation of oven-drying of baobab leaves using a central composite design	African Crop Science Society Journal
Plant conservation biology	3	Agbohessou M., Salako K.V., Idohou R., Gbedomon R.C., Hounkpèvi A., Chadare F.J., Glèlè Kakaï R. and Assogbadjo A.E.	Status of vegetative propagation of baobab: a review	African Crop Science Society Journal
Biostatistics	4	Hounmenou Castro Gbêmêmali, Gneyou Kossi Essona and Glèlè Kakaï Romain	An extension of the quadratic error function for learning imprecise data in multivariate nonlinear regression	Journal of Probability and Statistics
Forestry	5	Adjonou Kossi, Bindaoudou Issa Adbou-Kérim, Segla Kossi Novinyo, Idohou Rodrigue, Salako Kolawole Valère, Glele Kakaï Romain and Kokou Kouami	Land use/land cover patterns and challenges to sustainable management of the Mono transboundary biosphere reserve between Togo and Benin, West Africa	International Journal of Biological and Chemical Sciences
Ethnobotany	6	Ahononga Fiacre Codjo, Gouwakinnou Gérard Nounagnon, Honoré Biaou Samadori Sorotori, Biaou Séverin and Sonounameto Roland Christel	Socioeconomic factors determining ecosystem services local perceptions in two ecological zones in Benin (West Africa)	International Journal of Biological and Chemical Sciences
Ethnobotany	7	Compaore Souleymane, Lazare Belemnaba, Achille Hounkpevi, Rodrigue Idohou, Issouf Zerbo, Sylvin Ouedraogo and Adjima Thiombiano	Diversity of plants used in the management of hypertension by three associations of traditional healers along a climate gradient in Burkina Faso	Advances in Traditional Medicine
Plant conservation biology	8	Gbemavo D.J.S. C, Z. Assani, R. Idohou, J. Laly, A. Gbaguidi and A. Dansi	Modelling current agro-ecological zones for the cultivation of *Dioscorea dumetorum* (Kunth) Pax, a neglected and underutilized yam species in Benin (West Africa)	Modeling Earth Systems and Environment

Agronomy	9	Dayou Ephrème D., Barnabé K. L. Zokpodo, Marthe Montcho, Emmanuel A. Ajav, Isaac A. Bamgboye and Romain L. Glèlè Kakaï	Current Agricultural and Environmental Policies in Benin Republic	Sustainable Agriculture Research
Plant conservation biology	10	Deguenonvo Aymar Guy, Dossou Justin and Idohou Rodrigue	Aptitude à la multiplication de *Pseudocedrela kotschyi* (Schweinf.) Harms par graines et par boutures de tige et de racine au Bénin	International Journal of Biological and Chemical Sciences
Biostatistics	11	Hounmenou Castro Gbêmêmali, Tohoun Romeo, Gneyou Kossi Essona and Glèlè Kakaï Romain	Empirical determination of optimal configuration for characteristics of a multilayer perceptron neural network in nonlinear regression	Afrika Statistika
Biostatistics	12	Lokonon Bruno Enagnon, Djibril-Moussa Freedath, Diouf Saliou and Glèlè Kakaï Romain	Empirical performance of estimation methods in Beta mixed models with application to ecological data	Afrika Statistika
Agroclimatology	13	Lokossou Romaric S., Akponikpè P. B. Irénikatché, Akouèhou Gaston S., Matilo Augustin Orou, Prudencio Moriel, Glèlè Kakaï Romain and Ganglo Jean	Trend analysis of growing season characteristics and agro-climatic risks in the “Trois Rivières” forest reserve agro-ecosystems in North Benin	Theoretical and Applied Climatology
Ethnobotany	14	Dassou Hospice Gbèwonmèdéa, Idohou Rodrigue, Adomou Aristide Cossi, Ouachinou Jéronime Marie-Ange Sènami and Yédomonhan Hounnankpon	Indigenous knowledge and local practices concerning the endemic plant *Ipomoea beninensis* Akoègn., Lisowski & Sinsin (Convolvulaceae): an initial assessment for its conservation in Benin	Flora et Vegetatio Sudano-Sambesica
Knowledge management	15	Thoto F.S., Houessou M.D., Lamain C. and Gbedomon R.C	The private sector in knowledge processes and partnerships for food and nutrition security in the Global South: a case study from the Dutch Food and Business Applied Research Fund programme	Knowledge Management for Development Journal
Knowledge management	16	Thoto F.S., Gbedomon R.C., Houessou D.M.,	Does participation of agricultural entrepreneurs	Knowledge Management for

		Aoudji A. and Honfoga B.G.	in knowledge networks improve firm performance in Benin?	Development Journal
Agronomy	17	Mensah S. and Adipala E.	Agricultural production, food nutrition and capacity building in higher education in Africa.	African Journal of Rural Development
Education	18	Mensah S. and Adipala E.	Promoting dissemination and application of African Universities' research outputs	African Journal of Rural Development
Biostatistics	19	Gbemavo Charlemagne Judes Dossou Seblodo	Mathematical prediction of the Jatropha curcas L. plant yield: comparing Multiple Linear Regression and Artificial Neural Network Multilayer Perceptron models.	African Journal of Applied Statistics
Agroforestry	20	Tahi Souand, Gbenou Pascal and Gbesso François	Characterization of cashew production actors (Anacardium occidentale L.) in the municipality of Djidja in central Benin	International Network For Natural Sciences
Ethnobotany	21	Boukari Saliou, Tahi Souand, Arouna Ousséri, Toko Imorou, Tente Brice and Sinsin Brice	Perception des populations sur les facteurs de dégradation et les mesures de protection de la réserve de biosphère transfrontalière du W au Bénin	International Journal of Progressive Science and Technologies
Forestry	22	Baguiri Oumêmath, Tingbé Azalou and Tahi Souand	Organisation socio institutionnelle autour de l'aménagement des forêts classées des Monts Kouffé et de Wari Maro	Journal de la recherche scientifique de l'Université de Lomé
Agronomy	23	Katé S., Sossa E. L., Agbangba C. E., Idohou R., Aïdé E. S., Tovihoudji G. P. and Sinsin B.	Mineral Fertilization Influences the Acceptability of Fresh Pulp and Juice Made from Sugarloaf Pineapple	Agricultural Sciences

- A1.6. Scientific papers in press in peer-review journals with IF in 2020

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Biostatistics	1	Assogba D., Idohou R., Chirwa	On opportunities and challenges to conserve the African baobab in Benin	Journal of Arid	1.83

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
		P. and Assogbadjo A.E.	(West Africa): a spatial model integrating dispersal events	Environments	
Ecology	2	Mensah S., Van der Plas F. and Noulekoun F.	Do functional identity and diversity promote aboveground carbon differently in forest and savanna?	Ecosphere	2.8
Ecology	3	Mensah S., Assogbadjo A. and Glèlè Kakaï R.	Functional evenness of wood traits and structural diversity mediate aboveground biomass positive response to species richness in mixed-species stands.	European Journal of Forest Research	2.4
Ecology	4	Salako K.V., Mensah S., Avakoudjo G., Donou-Hounsode M., Assogbadjo A. and Glèlè Kakaï R.	Potential for soil carbon stock in human modified ecosystems: a comparative analysis of different agroforestry parklands in West Africa.	Mitigation and Adaptation Strategies for Global Change	3.2
Forestry	5	Zanvo M. G. Serge, Barima Y. S. Sabas, Salako K. Valère, Koua K. A. Noël2, Kolawolé Moustapha A., Assogbadjo A. Ephrem and Glèlè Kakaï Romain	Mapping spatio-temporal changes in mangroves cover and prediction of their future dynamics in Benin	Bois et Forêts des Tropiques	0.688
Forestry	6	Zanvo M.G. Serge, Salako K. Valère, Gnanglè Césaire, Mensah Sylvanus, Assogbadjo Achille & Glèlè Kakaï Romain	Human disturbances have less effect on tree taxonomic diversity than structural diversity, population structure, and stability in a west-African mangrove forest	Wetlands Ecology and Management	1.379
Plant conservation biology	7	Hospice Gérard Gracias Avakoudjo, Rodrigue Idohou, Kolawolé Valère Salako, Achille Hounkpèvi, Mamidou Witabouna Koné and Achille Ephrem Assogbadjo	Diversity in Tree and Fruit Traits of *Strychnos spinosa* along a Climatic Gradient in Benin: A Step towards Domestication	Genetic Resources and Crop Evolution	1.071

- A1.7. Scientific papers under review in peer-review journals with IF in 2020

Discipline	N°	Authors' Names	Title of the article	Journals	Impact factor
Land use	1	Raheem Abdul-Kareem, Constant Setondé Gnansounou, Reynolds Adongo	Impact of oil-find in land use dynamics in Sekondi-Takoradi, Western Ghana	Journal of Land Use Science	0.56
Biostatistics	2	Tovissodé C. F., Diop A. & Glèlè Kakaï R	Inference in skew generalized t-link models for clustered binary outcome via a parameter-expanded EM algorithm	Plos One	2.78
Biodiversity conservation	3	Assogba A., Fandohan, B., Gandji, K., Salako, V.K., Adomou, A., Assogbadjo, A.E.	Impacts des affectations de terres sur la structure des peuplements de Bombax costatum en zone soudanienne du Bénin	Bois et Forêt des Tropiques	0.688

- A1.8. Scientific papers under review in peer-review journals without IF in 2020

Disciplines	N°	Authors' Names	Title of the article	Journals
Biostatistics	1	Sewanou H. Honfo, Taboe Hémaho Beaugard and Glèlè Kakaï Romain	Modeling COVID-19 dynamics in the sixteen West African countries.	Scientific African
Mangrove conservation	2	Gnansounou S. Constant, Toyi Mireille, Salako K. Valère, Ahossou Oscar, Akpona T. Jean Didier, Gbedomon Castro, Assogbadjo Achille and Glèlè Kakaï Romain	Local use of mangrove and perceived impacts of their degradation in Grand-Popo Municipality, a hotspot of mangrove in Benin, West Africa	Tree, Forests and People

- A1.9. Books and book chapters in 2020

Field of research	N°	Authors' Name	Title	References
Research method	1	Gbedomon, R.C., Aoudji, A. & Vodouhe, F. (2020).	A hand note for value chains analysis of Non-Timber Forest Products	Assogbadjo A. E., Okou F. A. Y., Sinsin A. B. (Eds.). 2020. Hand Note for NTFP's Scientists: Approaches and Methods for Monitoring, Assessment and

Field of research	N°	Authors' Name	Title	References
				Conservation, pp 29-41. Abomey-Calavi, Benin
Research method	2	Hounkpèvi A., Gandji K., Salako K. Valère & Assogbadjo A.E.	Synthesized methodological approaches for estimation of fruit production of wild edible species	Assogbadjo A. E., Okou F. A. Y., Sinsin A. B. (Eds.). 2020. Hand Note for NTFPs scientists: Approaches and Methods for Monitoring, Assessment and Conservation, pp. 96-119. Abomey-Calavi, Benin
Research method	3	Mensah Sylvanus	A non-destructive field sampling method for quantifying foliage and woody biomass production	Assogbadjo A. E., Okou F. A. Y., Sinsin A. B. (Eds.). 2020. Hand Note for NTFP's Scientists: Approaches and Methods for Monitoring, Assessment and Conservation, pp: 120-130. Abomey-Calavi, Benin
Education	4	Mensah S & Adipala E	On the role of Higher Agricultural Education Institutions in Promoting Inclusiveness and Transforming African Agriculture	RUFORUM Working Document Series
Education	5	Mensah S & Adipala E	Catalysing African Universities role and relevance across and beyond the RUFORUM network	RUFORUM Working Document Series
Education	6	Mensah S, Ferris ND, Rukarwa JR, Egeru A, Osiru M & Adipala	Insights and lessons from a multi-criteria approach for identifying potential students for implementation of university transformation agenda	RUFORUM Working Document Series
Education	7	Waswa M, Mensah S & Adipala E	Promoting Inclusivity in RUFORUM Operations	RUFORUM Working Document Series
Education	8	Rukarwa RJ, Mensah S, Elamin H & Egeru A	Building entrepreneurial acumen among graduates in business incubators: the RUFORUM Entrepreneurship Challenge Program (RECAP)	RUFORUM Working Document Series
Education	9	Rukarwa RJ, Mensah S & Egeru A	Universities responding to advancing community transformation through action research in Africa	RUFORUM Working Document Series

Field of research	N°	Authors' Name	Title	References
Education	10	Rukarwa RJ, Mensah S & Egeru A	The role of universities in agribusiness innovation and incubation development.	RUFORUM Working Document Series

- A1.10. Participation to conferences/seminars/workshops in 2020

N°	Title, Place and periode of the conference/seminar	Type of Presentation (oral, poster, ..)	Attendee from LABEF
1	Participation to the conference on: Modelling and Simulation in South African Medicine: Public Trust in Numbers and COVID-19. This conference was held by the Agency for Science and Technology Advancement (SAASTA) of South African, November 27, 2020.	Participant	Hemaho Beaugard Taboe
2	Predicting COVID-19 spread in the face of control measures in West Africa, (LABEF/FSA/UAC), September 08, 2020.	Oral speaker	Hemaho Beaugard Taboe
3	Calcul des Moyennes en statistique descriptive : des erreurs sont commises, FSA/UAC, November 16, 2020	Participant	Hemaho Beaugard Taboe
4	GIS introductory and intermediate technical trainings	Participant	Gnansounou S. Constant
5	Journées Scientifiques sur les résultats obtenus avec le financement de PAPAPE (22 au 24/12/2020)	Oral speaker	Kakpo Dolou Angeline Reine
6	vISEC2020 virtual International Statistical Ecology Conference June 22-26, 2020, Sidney	Oral speaker	Tovissodé Chénangnon Frédéric
7	Diversity and Prioritization of useful wild oil plants for valorization in Benin: A multicriteria analysis approach - June, 4th 2020, Morocco (online)	Oral speaker	Hounsou-Dindin Guillaume
8	Enhancing local community knowledge on key non-timber forest products for biodiversity protection: priority wild oil plants for valorization in Benin - October, 19th 2020, Parakou (online)	Oral speaker	Hounsou-Dindin Guillaume
9	Colloque national de l'Université de Parakou	Oral speaker	Zanvo Mahoutin Gildas Serge
10	Colloque National sur les Gestion durable de la forêt classée du Haut Sanssandra de la Côte d'Ivoire	Participant	Zanvo Mahoutin Gildas Serge

Appendix 2.

Abstracts of published scientific papers in peer-review journals in 2020

Factors Determining Continuous Tractor Use in Benin Republic

Dayou Ephrème Dossavi, Ajav Emmanuel A.; Zokpodo K. L. Barnabé, Bamgboye A. Isaac & Glèlè Kakaï L. Romain

Journal of Agricultural Extension

DOI: https://dx.doi.org/10.4314/jae.v24i3.10

This study investigated the factors determining continuous tractor use in Benin. A multi stage sampling procedure was used to select tractor users in the country. A total of 203 households using agricultural machinery were surveyed through interviews and using a structured questionnaire. The information concerned socioeconomic characteristics, the equipment used and agricultural production. The logit model was used for data analysis. About 75% of tractor owners use it for service delivery, while 71.4% of them possess their own land. Continuous use of tractor is significantly influenced by the number of hours for one hectare tilled, the total area tilled per year as well as the tractor age. Moreover, the tractor brands available in the country also influenced tractor use. The hierarchized failures were hydraulic lifting pump (16.4%), fuel filter (14.6%), clutch disc failure (9.9%), breakage of plough (8.8%) and injection pump (7.6%). The future of agricultural equipment use can now be anticipated and take action to deal with any tractor use difficulties for sustainable agricultural extension in Benin.

Keywords: Farm machinery, adoption, failure, Benin Republic.

Optimisation of oven-drying of baobab leaves using a central composite design

Gbaguidi A.M., Chadare F.J., Salako V.K., Idohou Y.O.V. & Assogbadjo A.E.

African Crop Science Society Journal

DOI: https://dx.doi.org/10.4314/acsj.v28i1.2S

Baobab (*Adansonia digitata*) leaves represent a key nutritional resource; although their consumption is apparently restricted to local communities, mainly as a sticky sauce, cosmetics, and a variety of purposes. Ready-to-use powder of oven-dried baobab leaves can improve the availability of the product on markets, and hence its utilization and shelf life. This study was carried out to optimise the oven-drying temperature and duration for the best conservation of baobab leaf powder and its sustainable availability for multipurpose uses. Different combinations of values of temperature and drying duration were generated, using a central composite design, in response surface methodology framework. Findings showed that dry matter, hue, chroma and lightness were significantly influenced by oven-drying temperature and duration, while the least gelation concentration was significantly influenced by the temperature. Based on leaf dry matter, hue and chroma models, the optimal oven drying conditions for baobab leaves for good preservation leading to human consumption and other purposes are set at 45 °C for 23.5 hours.

Keywords: *Adansonia digitata,* colour, dry matter

Status of vegetative propagation of baobab: a review

Agbohessou M., Salako K.V., Idohou R., Gbedomon R.C., Hounkpèvi A., Chadare F.J., Glèlè Kakaï R. & Assogbadjo A.E.

African Crop Science Journal

DOI: https://dx.doi.org/10.4314/acsj.v28i1.16S

The African baobab (*Adansonia digitata* L.) is a large tree of great socio-economic and cultural importance in Africa, with almost all the parts of the species used for various purposes. A major concern about baobab fruit pulp production is the long time it takes for first fruiting (about 15 years). Vegetative propagation offers several advantages about consumers' preferences and precociousness of fructification. The objective of this study was to synthesize existent knowledge related to vegetative propagation methods of baobab and examine prospects for improving the species propagation. This will ultimately contribute to better integrate baobab-based agroforestry systems into the diversification and poverty alleviation programmes. Cutting, grafting and *in vitro* multiplication are the vegetative propagation methods already tested on baobab. The success of grafting methods ranges from 10 to 89%, depending on the technique used. The Murashige and Skoog environment, supplemented with or without growth regulator hormones is by far the best condition for the *in vitro* reactivity of baobab explants, regardless of their types. With regards to cuttings, the average success rates stand around 30% when Indole-3-butyric acid (IBA) hormone is used. Other approaches such as marcotting techniques are yet to be tested and data on fruit production using these techniques are still needed to determine the best promising method for rapid and efficient vegetative propagation of baobab.

Keywords: African baobab, cuttings, grafting, marcotting

An extension of the quadratic error function for learning imprecise data in multivariate nonlinear regression

Hounmenou Castro Gbêmêmali, Gneyou Kossi Essona & Glèlè Kakaï Romain

Journal of Probability and Statistics

DOI: https://doi.org/10.1155/2020/9187503

Multivariate noises in the learning process are most of the time supposed to follow a standard multivariate normal distribution. (is hypothesis does not often hold in many real-world situations. In this paper, we consider an approach based on multivariate skew-normal distribution. It allows for a multiple continuous variation from normality to nonnormality. We give an extension of the generalized least squares error function in a context of multivariate nonlinear regression to learn imprecise data. The simulation study and application case on real datasets conducted and based on multilayer perceptron neural networks (MLP) with bivariate continuous response and asymmetric revealed a significant gain in precision using the new quadratic error function for these types of data rather than using a classical generalized least squares error function having any covariance matrix.

Local preferences for three indigenous oilseed plants and attitudes towards their conservation in the Kénédougou province of Burkina Faso, West-Africa

Tiétiambou Fanta Reine Sheirita, Salako Kolawolé Valère, Tohoun Jésukpégo Roméo & Ouédraogo Amadé

Journal of Ethnobiology and Ethnomedicine
DOI: https://doi.org/10.1186/s13002-020-00393-1

Carapa procera, Lophira lanceolata, and *Pentadesma butyracea* are three underutilized but increasingly threatened indigenous oil-seed tree species (IOS) in tropical Africa. Because local knowledge is vital for sustainable management, this study investigated the socio-economic factors that explain local people's (i) preferences for these IOS, (ii) attitudes toward their conservation, and (iii) ability to identify "plus trees" based on seed traits. We predicted a positive relationship between response variables and informants' age, residence status, gender (femaleness), and existence of market opportunities for each IOS. We also predicted that a higher preference for a given IOS has a positive effect on people's attitudes for its conservation and the aptitude to identify its "plus trees." We additionally expected significant differences among ethnic groups for each response variable. Methods: Data were collected through individual semi-structured interviews with 336 informants from 14 randomly selected villages in the species distribution area of Kénédougou province. For each species, the collected data were the number of actual uses reported (converted to use value—UV, as a measure of the species preference), practiced conservation actions (converted to conservation attitude using a four-scale scoring method), and possible criteria for selecting preferred trees for seed oil extraction. Generalized linear mixed models were used to test for the fixed effects of socio-economic factors, and account for the random variation across villages. The results showed species-specific patterns. *Carapa procera* had the highest UV and hence was the most preferred IOS, particularly by women. Informants from the Siamou ethnic group had the highest UV irrespective of IOS. The most cited conservation actions were assisted natural regeneration and banning of tree cutting, which were practiced for *C. procera* and *L. lanceolata*. No conservation measure was cited for *P. butyracea*. The practice of tree planting was not recorded for any of the IOS. Young and male informants participated less in conservation actions. Tree selection for oil-seed collection was mainly guided not by "oil extraction yield" but rather by the "quality of extracted oil" (namely oil color and taste for food uses, and oil bitterness for medicinal efficacy). The selection mainly concerned *L. lanceolata* and was mostly practiced by elderly people. This study provided useful local knowledge-based information to guide conservation actions and valorization strategies of three IOS. The study sheds further light on the socio-economic factors that are associated to local people's preferences, conservation attitudes, and individual tree selection.

Keywords: Conservation actions, Local knowledge, Kénédougou, Plus-tree, Underutilized-plants, Use value

Does land use type impact the demographic and spatial structures of *Adansonia digitata* L. in the Biosphere Reserve of Pendjari in Northern Benin?

Assogba Orgely Doris Imeilda, Salako Kolawolé Valère, Fantodji Benjamin, Assédé Éméline P. S., Assogbadjo Achille Ephrem & Chirwa1Paxie Wanangwa

Bois et Forêts des Tropiques
DOI : https://doi.org/10.19182/bft2019.344.a31888

Changes in land use type (LUT) are a major driver of biodiversity loss and species decline. Responses to changes in LUT are species-specific, which may in turn be context dependent. Understanding such responses is essential for the management of socio-economically important wild tree species. The baobab, *Adansonia digitata* L., is an important traditional agroforestry tree species in Sub-Saharan Africa. This study assesses how LUT affects the demographic and spatial structures of baobab stands. Using data from a census and mapping of baobab trees in 12 plots of 250 m × 250 m each, the study compared baobab tree density, total height and diameter, diameter size-class distribution (SCD), stand stability, and spatial relationships in a strictly protected area (national park), a buffer zone and farmlands (Matéri and Boukombé) in the Pendjari Biosphere Reserve in Benin. The results show that the highest young and adult tree densities are in farmlands (particularly in Matéri), followed by the buffer zone and the national park. No significant differences in tree diameter and total height of baobab trees were found among the different LUT. The SCD had a reverse J-shape with a better negative slope and population stability metrics in farmlands (particularly in Matéri) but a flattened slope in the buffer zone. The spatial distributions of juvenile and adult baobab trees were random, and independent of each other. The spatial distribution of juvenile and adult baobabs was also independent of the other tree species, irrespective of LUT. It was concluded that baobab conservation is better in farmlands than in the national park but that the difference between park and farmlands may be context-dependent, probably linked to local environmental conditions, the socio-ecological context, and interactions with baobab trees.

Keywords: farmland, population structure, protected area, recruitment, spatial distribution, Benin.

Phylogenomic approaches reveal how climate shapes patterns of genetic diversity in an African rain forest tree species

Helmstetter Andrew J., Amoussou Biowa E. N., Bethune Kevin, Kandem Narcisse G., Glèlè Kakaï Romain, Sonké Bonaventure & Couvreur Thomas L. P.

Molecular Ecology
DOI :10.1111/MEC.15572

The world's second largest expanse of tropical rain forest is in Central Africa and it harbours enormous species diversity. Population genetic studies have consistently revealed significant structure across central African rain forest plants, a North-South genetic discontinuity around the equatorial line, in a continuous expanse of rain forest but where a climatic inversion is documented. Here, we took a phylogeographic approach

by sequencing 351 nuclear markers in 112 individuals across the distribution of the African rain forest tree species *Annickia affinis* (Annonaceae). We showed for the first time that the North-South divide is the result of a single, major colonisation event across the climatic inversion from an ancestral population located in Gabon. We suggested that differences in ecological niche of populations located on either side of this inversion may have contributed to this phylogenetic discontinuity. We found evidence for inland dispersal, predominantly in northern areas, and variable demographic histories among genetic clusters, indicating that populations responded differently to past climate change. We show how newly developed genomic tools can provide invaluable insights into our understanding of tropical rain forest evolutionary dynamics.

Keywords: Annonaceae, climatic inversion, immigrant inviability, nuclear baiting kit, phylogeography, refugia

Predicting COVID-19 spread in the face of control measures in West Africa

Taboe Hémaho B., Salako Kolawolé V., Tison James M., Ngonghala Calistus N. & Glèlè Kakaï Romain

Mathematical Biosciences
DOI: https://doi.org/10.1016/j.mbs.2020.108431

The novel coronavirus (COVID-19) pandemic is causing devastating demographic, social, and economic damage globally. Understanding current patterns of the pandemic spread and forecasting its long-term trajectory is essential in guiding policies aimed at curtailing the pandemic. This is particularly important in regions with weak economies and fragile health care systems such as West Africa. We formulate and use a deterministic compartmental model to (i) assess the current patterns of COVID-19 spread in West Africa, (ii) evaluate the impact of currently implemented control measures, and (iii) predict the future course of the pandemic with and without currently implemented and additional control measures in West Africa. An analytical expression for the threshold level of control measures (involving a reduction in the effective contact rate) required to curtail the pandemic is computed. Considering currently applied health control measures, numerical simulations of the model using baseline parameter values estimated from West African COVID-19 data project a 67% reduction in the daily number of cases when the epidemic attains its peak. More reduction in the number of cases will be achieved if additional public health control measures that result in a reduction in the effective contact rate are implemented. We found out that disease elimination is difficult when more asymptomatic individuals contribute in transmission or are not identified and isolated in a timely manner. However, maintaining a baseline level of asymptomatic isolation and a low transmission rate will lead to a significant reduction in the number of daily cases when the pandemic peaks. For example, at the baseline level of asymptomatic isolation, at least a 46% reduction in the transmission rate is required for disease elimination. Additionally, disease elimination is possible if asymptomatic individuals are identified and isolated within 5 days (after the incubation period). Combining two or more measures is better for disease control, e.g., if asymptomatic cases are contact traced or identified and isolated in less than 8 days, only about 29% reduction in the disease transmission rate is

required for disease elimination. Furthermore, we showed that the currently implemented measures triggered a 33% reduction in the time-dependent effective reproduction number between February 28 and June 26, 2020. We conclude that curtailing the COVID-19 pandemic burden significantly in West Africa requires more control measures than those that have already been implemented, as well as more mass testing and contact tracing to identify and isolate asymptomatic individuals early.

Keywords: Public health control measures, SARS-CoV-2 pandemic, Mathematical model, Reproduction number, Contact tracing, Asymptomatic transmission

Land use/land cover patterns and challenges to sustainable management of the Mono transboundary biosphere reserve between Togo and Benin, West Africa

Adjonou Kossi, Bindaoudou Issa Adbou-Kérim, Segla Kossi Novinyo, Idohou Rodrigue, Salako Kolawole Valère, Glèlè-Kakaï Romain & Kokou Kouami

International Journal of Biological and Chemical Sciences
DOI: https://doi.org/10.4314/ijbcs.v14i5.19

The Mono Transboundary Biosphere Reserve (RBTM) has significant resources but faces many threats that lead to habitat fragmentation and reduction of ecosystem services. This study, based on satellite image analysis and processing, was carried out to establish the baseline of land cover and land use status and to analyze their dynamics over the period 1986 to 2015. The baseline of land cover established six categories of land use including wetlands (45.11%), mosaic crops/fallow (25.99%), savannas (17.04%), plantation (5.50%), agglomeration/bare soil (4.38%) and dense forest (1.98%). The analysis of land use dynamics showed a regression for wetlands (-23%), savannas (-16.06%) and dense forest (-7.60%). On the contrary, occupations such as mosaic crops/fallow land, urban agglomerations/bare soil and plantation increase in area estimated at respectively 128.64%, 93.94% and 45.23%. These results are of interest to stakeholders who assess decisions affecting the use of natural resources and provide environmental information essential for applications ranging from land-use planning, forest cover monitoring and the production of environmental statistics.

Keywords: Land use, baseline, spatial dynamics, environmental statistics, ecological monitoring.

Socioeconomic factors determining ecosystem services local perceptions in two ecological zones in Benin (West Africa)

Ahononga Fiacre Codjo, Gouwakinnou Gérard Nounagnon, Honoré Biaou Samadori Sorotori, Biaou Séverin & Sonounameto Roland Christel

International Journal of Biological and Chemical Sciences
DOI: https://doi.org/10.4314/ijbcs.v14i5.18

Forests have been undergoing diverse threats due to human activities and these may affect their role as Ecosystem Services (ES) providers. Therefore, it becomes crucial to undertake some analysis of the current socio-economic context of ES offerings to provide valuable information for the decision-making process and policy regarding sustainable forest management. This study aimed at highlighting the local perception of ES in two contrasting ecological regions. 689 respondents distributed in six districts were interviewed through a semi-structured survey on the various ES and their assessment. The analysis in principal components is used to understand socio-cultural group perception. Then, we used Beta regression to know how socio-economic factors influence the rate of people knowledge of ES. Our results show that provisioning services were more overall perceived, followed by cultural services and regulating services. Youth perceived less regulating and supporting services. Furthermore, cultural services were the most perceived by the seniors. The perception of provisioning and regulating services is influenced respectively by education level and the poverty index. Taking into account the local perception of the different actors and the factors in the decision-making, local development can be improved in compliance with the objectives of biodiversity conservation.

Keywords: Local perceptions, Ecosystem Services, environmental education, forest management, Benin Republic.

Diversity of plants used in the management of hypertension by three associations of traditional healers along a climate gradient in Burkina Faso

Compaore Souleymane , Belemnaba Lazare , Hounkpevi Achille, Idohou Rodrigue , Zerbo Issouf, Ouedraogo Sylvin, Thiombiano Adjima

Advances in Traditional Medicine

DOI: https://doi.org/10.1007/s13596-020-00495-x

Hypertension is a global public health problem. This study aimed to determine the diversity of plant species used by traditional healers. Thus, semi-structured interviews were carried out with 195 informants through traditional healers associations of Sanmatenga, Bazega and Zounweogo located in different phytogeographical sectors. Questionnaire referred mainly to plants vernacular names, organs used and recipes formulation. Citation frequencies and use values were calculated for each plant. Data were then submitted to comparison tests and multivariate statistics in R program. Traditional healers of Sanmatenga, Bazega and Zounweogo used respectively 70 species, 64 and 88 species for the hypertension management. However, the Jaccard index of similarity showed that there was no similarity between three associations demonstrating the importance of climatic gradient in the availability of species used. The age, sex and association belonging traditional healer did not influence species richness but, were determinants for use patterns of the plant. These results show that a sociodemographic parameter alone cannot be decisive for several local knowledge at once, but rather the interaction with other factors. Thus, the sustainable use of plant resources by the

traditional healers recommends that the effects of this interaction of the various factors be considered.

Keywords: Healers, Survey, Hypertension, Management

Natural intraspecific trait variation patterns of the wild soursop *Annona senegalensis* (Annonaceae) along a climatic gradient in Benin, West Africa

Hounkpèvi Achille, Salako Valère Kolawolé, Donhouédé Janine Conforte Fifonssi, Daï Emilienne Houévo, Tovissodé Frédéric, Glèlè Kakaï Romain & Assogbadjo Achille Ephrem

Plant Ecology and Evolution
DOI: https://doi.org/10.5091/plecevo.2020.1576

Geographic patterns of phenotypic variability can inform understanding of the resilience potential of plant species to environmental hazards such as climate change. Such understanding provides support for conservation and domestication efforts. Here, we investigated natural morphological variation of the individuals, fruits, seeds, and leaves of the tropical shrub Annona senegalensis Pers. along a climatic gradient. Morphological data were collected on shrubs, fruits, seeds, and leaves of 150 shrubs from five populations in the three climatic zones of Benin. Linear mixed effects models were used to test the variability of the morphological traits of the species and to estimate the variance components in order to tease apart the importance of each source of variation. The most important morphological descriptors discriminating climatic zones were identified using a stepwise discriminant analysis. Redundancy analysis was then used to determine the relationships between discriminant morphological traits and bioclimatic variables. Morphological traits of *A. senegalensis* varied greatly both within and among climatic zones. A substantial part (42%) of the among-climatic zones phenotypic variability in the species was attributable to climate, mainly rainfall and temperature. Morphological traits such as big shrubs, big fruits, and high number of seeds per fruit were associated with high mean annual rainfall and low mean temperature of the warmest quarter. The findings suggest an important zonal adaptation of the species to climate variability. The phenotypic diversity pattern that we highlighted can be useful when designing conservation policies for the species. However, quantitative genetics through common garden or reciprocal transplantation experiments related to the species' populations would enable to explore the heritable part of the observed variability to support effective conservation and domestication efforts.

Keywords: *Annona senegalensis*; bioclimatic variables; climate variability; plant morphology; zonal adaptation.

Modelling current agro-ecological zones for the cultivation of *Dioscorea dumetorum* (Kunth) Pax, a neglected and underutilized yam species in Benin (West Africa)

Gbemavo D. S. J. C. , Assani Z. , Idohou R. , Laly J. , Gbaguidi A. & Dansi A.

Modeling Earth Systems and Environment

DOI: https://doi.org/10.1007/s40808-020-00973-w

Yam species (*Dioscorea spp.*) constitute important staple foods for local communities in Sub-Saharan in Africa. Among yam species, *Dioscorea dumetorum* (Kunth) Pax, commonly consumed, has been reported to be among the most nutritious and well-appreciated local resource although it remains neglected and underutilized species in Benin. Here, we combined occurrence records and environmental data (bioclimatic and soil data) in ecological niche models to assess the suitable areas for the two locally acknowledged varieties of the species: the cultivated and the wild varieties. Results showed that the potential cultivable area of the cultivated variety is twofold, the one of the wild varieties. Seven and five of the eight agro-ecological zones of Benin are potentially suitable for the cultivation of the cultivated variety and the wild variety, respectively. Differences in the two varieties of ranges could result from the adaptation of each variety to local conditions reinforced by intrinsic characteristics of each variety. These results constitute an important step towards scaling up the species valorization while developing conservation programs for both varieties. Further genetic investigation and field experiments could shed light on the origin of the differences between these two forms.

Keywords : Benin, Conservation, Domestication, *Dioscorea dumetorum*, Distribution

Classification of diseases treated with woody species at the national scale and among climatic zones in Benin (West Africa)

Ahoyo Carlos C., Houehanou Thierry D., Yaoitcha Alain S., Prinz Kathleen, Glèlè Kakaï Romain L., Sinsin Brice A., Houinato Marcel R.B.

Journal of Ethnopharmacology

DOI: https://doi.org/10.1016/j.jep.2020.113417.

Plant parts are often used by local people to treat their affections. This study addressed the classification of diseases treated with woody species in Benin and the dependence of medicinal use of woody species on climatic zones. It reports (i) the main diseases categories treated with woody species in Benin and changes across climatic zones, and (ii) the woody species involved and their treatment according to climate conditions. Ethnobotanical interviews were undertaken using a semi-structured questionnaire. Five hundred and ninety medicinal plant professionals (healers, traders…) were interviewed in the whole country. Frequency of citation and informant consensus factor were calculated to highlight the main human international diseases categories and woody species used for their treatment. A principal component analysis was performed to determine the occurrence of diseases categories in different climatic zones. About 77.27% of international diseases categories were treated using woody species in Benin.

One hundred diseases in 17 international diseases categories were identified. Among them, six diseases categories were highlighted as important. In the Guineo-Congolean zone, the highest rate of diseases categories was observed, and the lowest was found in the Sudanian zone. The epidemiological status of some phytodistricts was worrisome. In our Journal Pre-proof 2 study, 128 woody species belonging to 96 genera and 36 families were reported, and among them, 7 were the most used as treatments. There is a lack of consensus among traditional healers about which woody species to use. Many different species were used to treat a given diseases category. Also, information concerning their organ composition was not available in the literature, for the majority of species. Biological and chemical investigations are thus needed for a better valorization of the most frequently used plants in the future.

Keywords: traditional medicinal use, woody species, phytodistricts, climatic zone

Status and population structures of three anthelmintic tree species along climatic gradient in Benin and the implications for conservation

Alowanou Géorcelin G., Houéhanou Thierry D., Mensah Sylvanus, Alissou Bénoit K., Ahoyo Carlos C., Akpako Rauldin S., Wabi Faroukou, Houinato Marcel R.B. & Hounzangbé-Adoté Sylvie M.

Southern Forests

DOI: https://doi.org/10.2989/20702620.2019.1654811

Smallholder farmers make intensive use of anthelmintic plant species in the traditional treatment of animal parasitic infections. As a result, populations of these plant species are exposed to increased disturbances such as plant harvesting, threatening their stability. Information on population structure of threatened plant species is important not only for understanding their ecological status but also for conservation and restoration purposes. Using floristic and structural data from 61 plots of 0.09 ha each, we assessed the population structures of the three anthelmin- tic species (*Bridelia ferruginea, Mitragyna inermis,* and *Combretum glutinosum*) along the climatic gradient (Guinean, Sudano–Guinean and Sudanian climatic zones) in Benin. Structural characteristics (tree density, basal area, mean diameter, tree height), and species-specific diameter and height distribution were assessed. Results showed that *B. ferruginea* was found in all three climatic zones, but more prominent in the Sudano–Guinean zone with a scarcity index of less than one per cent. *Mitragyna inermis* and *C. glutinosum* were only observed in the Guinean zone and Sudanian zone, respectively. *Bridelia ferruginea* population structures, especially density and basal area, varied significantly among climatic zones. Diameter- and height-class distributions for the three species exhibited a bell shape with a tendency to right skewness, indicating a predominance of younger trees. These results suggest that the three species are not currently threatened in Benin; however, it would be necessary to prevent overexploitation to guarantee future sustainability.

Keywords: *Bridelia ferruginea, Combretum glutinosum, Mitragyna inermis*, population structure, scarcity index, West Africa

Local knowledge, uses and factors determining the use of *Strychnos spinosa* organs in Benin (West Africa)

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Economic Botany

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Green monkey orange (*Strychnos spinosa*) is an important multipurpose tree in rural communities in sub-Saharan Africa, including Benin. The objectives of this study were to (i) examine the various indigenous uses of *Strychnos spinosa*, (ii) assess local perception of the major threats to *Strychnos spinosa*, and (iii) identify the conservation strategies adopted by local communities to ensure its sustainable use in Benin. A participatory rural appraisal study was undertaken across three climatic zones in Benin. Data were collected through structured questionnaires involving 733 informants from 22 ethnic and 7 sociolinguistic groups. Correspondence analysis (CA) showed that *S. spinosa* is most widely used in the Sudanian zone (20 uses). About 73% of the informants used *Strychnos spinosa* as food, and 68% used it for medicine. The most valued organs were fruits, leaves, bark, and seeds. The major threats to *Strychnos spinosa* were human activities rather than climatic factors. Religion and cultural values were the main strategies adopted by local communities to conserve the species. The value of *Strychnos spinosa* is well appreciated in Benin, and local knowledge depends on the particular climatic zone, ethnic group, study level, and gender.

Keywords: *Strychnos spinosa*, Ethnobotany, Local knowledge, Traditional uses, Wild edible fruits, Benin

Socio-economic factors infuencing *Afzelia africana* Sm. use value and traditional knowledge in Uganda: implications for sustainable management

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Environment, Development and Sustainability

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Afzelia africana Sm. is a highly valued multi-purpose and overexploited tree species in Africa. Ethnobotany of *A. africana* can guide its sustainable usage, yet there is limited information on such aspect for the species in Uganda. Here, we assessed use values of *A. africana* and users' traditional knowledge, and how they relate to plant parts and socioeconomic factors including ethnicity, gender, education, age, marital status, profession, household size, income, land size and livestock ownership. Two hundred face-to-face semi-structured interviews were conducted. Use values were assessed based on plant part value (PPV) and use value per use category (UVk), while users' traditional knowledge was compared using overall use value (OUV) and reported use value (RUV). All plant parts were used, with stem (PPV=41.4%), seeds (19.6%) and leaves (19.3%) being the most important. Nine plant use categories were enumerated, with most

dominant being material (UVk=0.63), followed by social (0.49) and fuel wood (0.41). Bark and root were mostly used for medicinal purpose, and branch and stem for fuelwood and material, respectively. Men and youngsters had higher OUV than females and older people, respectively. In particular, men frequently mentioned the use in agriculture, for fuelwood, environment and medicine, while women reported social use. Although socio-cultural group did not influence significantly OUV and RUV, multivariate analyses revealed differentiation in use category according to socio-cultural group. Land size also predisposed informants to report more uses for the species. Taking these significant socio-economic factors into account in participative forest management will facilitate *A. africana* sustainable use.

Keywords: Ethnobotany; Socio-cultural group; Multi-purpose tree species; Gender; Traditional knowledge; Uganda

Comparing video and poster based education for improving 6-17 months children feeding practices: a cluster randomized trial in rural Benin

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Progress in Nutrition

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This study aimed to assess whether short nutrition educational videos were more effective to improve child feeding practices compared to posters in a highly food insecure rural area in Southern Benin. Materials and Methods: A two-arm cluster-randomized trial was implemented in two districts of the Mono region, Benin. Over a 6 months period, eight villages received nutrition education sessions using either short videos (n=4 villages) or posters and flyers (n=4 villages). Dietary practices were collected among 6-17 months children (n=155) before and at the end of the nutrition education program using a qualitative 24 hours recall. UNICEF/WHO indicators for dietary diversification and meal frequency assessing were derived for each child. The videos versus posters effect was assessed by the difference-in-differences (DID) estimator using generalized estimated equations (GEE). Results: Overall, respectively 49% and 72% of children had achieved Minimum Dietary Diversity (MDD) and Minimum Meal Frequency (MMF) at baseline. Results from DID analysis showed that videos did not have significant advantage in terms of improving children feeding practices compared to posters neither for dietary diversity (DID = -0,036; p-value=0,651) nor for meal frequency (DID = -0,048; p-value=0,574). However, others factors namely children age, mother age and districts, had significant influence on these feeding practices. Conclusions: The nutrition education program using posters and videos performed the same in improving complementary feeding practices. The conditions of the utilisation of videos might be

improved and other factors determining children feeding practices taken into account to allow mothers and other participants to benefit from nutrition sessions.

Keywords: nutrition education, communication, complementary feeding practices, dietary diversity, meal frequency, 6-23 months children.

Socio–Economic factors determining conservation and cultivation of *Garcinia kola* Heckel—A medicinal plant extinct in the wild in Benin

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Economic Botany

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Garcinia kola is a multipurpose tree and an important medicinal plant in most Western and Central African communities. The species is highly valued for its edible nuts and its different parts are used for the treatment of diverse ailments. Because of its overexploitation, *G. kola* is now extinct in the wild in Benin. Conservation and cultivation are crucial for its maintenance. Eliciting determinants that influence farmers' decisions in maintaining or cultivating the species in their homestead or land would contribute to design effective management policies. A semi–structured survey was carried out with 155 respondents involved in *G. kola* exploitation to elucidate those determinants. Data collected were related to the socio–economic characteristics of respondents, *G. kola* ownership and number of individuals owned, current propagation methods and management of the species, willingness to cultivate or in situ conservation of the species. Binomial logistic and Poisson generalized linear models were used to test the effects of land area size, gender, age, and main occupation on respondents' decision to cultivate and/or to conserve the species in situ and its management. It was found that men were more likely to own *G. kola* trees than women. Similarly, the likelihood of owning a *G. kola* tree was higher for farmers than non–farmers and was positively correlated with respondents' age. Furthermore, men were more willing to conserve and cultivate *G. kola*. Our findings suggest that the studied factors are instrumental when designing conservation policies and programs for the species.

Keywords: Conservation, threatened species, Bitter kola, Sustainable management, Benin, Ethnobotany.

Current Agricultural and Environmental Policies in Benin Republic

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Sustainable Agriculture Research
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The need to feed the population growth conducts to the development of material intensive production systems in many countries. However, the absence of adequate policies has adverse consequences on the environment and the performance of the agricultural and rural sectors. Benin Republic, through its Strategic Plan for Agricultural Sector Development (PSDSA) focuses on improving food and nutrition security, improving farm level income, and building resilience to climate change within the Government Action Plan (PAG Bénin Révélé) 2016-2021. The aim of this study is to analyze the current agricultural policies and his link with the current environmental policies in Benin Republic. The data from Ministries and Structures in charge of Agriculture, Environment, Health and Human being were used. Reports from some international organizations such as FAO, PNUD and FIDA were also used. It is observed and planed an increase in cultivation area, all crops yields and crops production from 2016 to 2021. That will involve the more use of agricultural machinery, fertilizers, and pesticides. Added to the current environment challenges, it appears the risk of soil degradation, deforestation, water, and air pollution, then global impact on the environment when this plan will be implemented. It is right that some Environment Impact Assessment (EIA) are purposed for many of the actions. However, these EIA are sometime neglected and sacrificed for the profitability of agricultural production. To achieve this agricultural goal without affect the environment, the respect of the adequate law and EIA for each single activity becomes necessary.

Keywords: food production policy, natural resource management policy, environmental degradation, sustainable development, Benin Republic

Aptitude à la multiplication de *Pseudocedrela kotschyi* (Schweinf.) Harms par graines et par boutures de tige et de racine au Bénin

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International Journal of Biological and Chemical Sciences
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Pseudocedrela kotschyi, is one of the most exploited species in timber, charcoal and other uses in Benin. Faced with this exploitation, it is faced with the problem of natural regeneration. For sustainable management of this species, it is imperative to carry out assisted regeneration. The objective of this study was to highlight the ways in which the species multiplies. For this purpose, a germination test was done on 200 seeds without pregerminative treatment. A vegetative reproduction by stem and by root was made on 92 cuttings according to two classes of diameter ([0 cm to 1.5 cm] and [1.5 cm to 3 cm]). The results obtained show that the germination rate of *P. kotschyi* seeds is 84% over a period of 12 days. The size and type of cuttings have a significant effect ($P < 0.05$) on

budding, budding and monitoring of buds. Large diameter root cuttings gave the highest averages, i.e. 10.62 buds with 6.12 buds budded by cuttings with a follow-up rate of 47.82%. It appears that *P. kotschyi* can be propagated by seeds and by root cuttings.
Keywords: Multiplication; reforestation; cuttings; germination; *Pseudocedrela kotschyi*

Diverse views among scientists on non-native species

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NeoBiota
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Conservation scientists have traditionally viewed non-native species (NNS) as potential threats to native biodiversity. Here, we question whether alternative views of NNS exist in the scientific community that stand in contrast to the dominant narrative that emerges from the literature. We asked researchers from the biological, social, and environmental sciences to participate in an anonymous poll regarding the perceived values and threats of NNS. Some 314 individuals responded, approximately half of whom were biologists and half were social or environmental scientists. We grouped responses into three statistical clusters defined by shared responses. We then analyzed the correlation of responses to individual questions and membership of clusters with predictor variables age, gender, and field of work. Overall, most respondents in our sample supported statements that the species-component of biodiversity should include all species (55%) or some types of non-native species (an additional 32%), which contrasts with the way major biodiversity assessments and indicators are constructed. Most respondents in our sample (65%) also supported that measurement of the impact of invasive species should be based on the net biological, social, and economic effects, which also represents a marked departure from current methods that focus only on the adverse effects of a subset of NNS considered as invasive. Field of work and age were correlated with clusters and numerous individual responses. For example, biologists were three-times more likely than non-biologists to support a definition of species richness that included only native species. Two clusters (Cluster 1 and Cluster 3), mainly composed of non-biologists and biologists, respectively, differed in their support for statements that NNS would provide useful ecosystem services in the future (66% and 40%, respectively). Thus, a key result of this study is that a variety of normative stances regarding NNS is present within the scientific community. Current international indicators of progress (e.g., Aichi Targets) capture only a "nativist" set of values, which, if our sample is representative of the scientific community, appears to be a minority view. Therefore, we argue that indicators should be modified to integrate the diversity of views that exist within the scientific community.

Keywords: conservation ethics; exotic species; invasive species; nativism; values

A global systematic review on conservation and domestication of *Parkia biglobosa* (Jacq.) R. Br. ex G. Don, an indigenous fruit tree species in Sub-Sahara African traditional parklands: current knowledge and future directions

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Genetic Resources and Crop Evolution

DOI: https://doi.org/10.1007/s10722-020-00892-w

Parkia biglobosa (Jacq.) R. Br. ex G. Don is one of the most common traditional parkland tree species that generates vital non-timber forest products and benefits for local people in Sub-Saharan Africa. Despite its socio-economic importance and value for local and regional economies, the species has remained at infant stage of domestication, yet declining in the nature. While several studies addressed various ecological, social, and economic aspects, systematic reviews and literature syntheses on current knowledge and research gaps are lacking, despite their relevance for future research directions. Based on research publications from ScienceDirect, Google Scholar and African Journals Online, we provide a systematic literature review of the current knowledge on the ecological, socio-economic, conservation, and domestication aspects of *P. biglobosa*. We also identified important research gaps and prospects for the species conservation and domestication. From 2060 publications initially recorded, 221 received full-text assessment after screening, of which 184 scientific papers were finally reviewed. Approximately 75% of these studies were undertaken in three West-African countries: Nigeria, Burkina Faso, and Benin. Critical analyses were presented in line with perspectives on ecological, socio-economic, conservation and domestication aspects. The review highlighted the critical research gaps in distributional ecology, tree physiology, plant demography, molecular biology, genomics, and evolutionary biology, but also called for more research effort from Central and East Africa, where a limited number of publications was recorded on *P. biglobosa*, in spite of being within the native distribution range. Such investigations would help in decision-making and elaboration of breeding strategies, as steps towards sustainable use and domestication of the species in Africa.

Keywords: Agroforestry systems, Domestication, Indigenous fruit tree, Non-timber forest products, Africa

Perceived variation of fruit traits, and preferences in African locust bean [*Parkia biglobosa* (Jacq.) Benth.] in Benin: implications for domestication

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Genetic Resources and Crop Evolution

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Understanding folk classification system of perceived variation and preferences in fruit traits are necessary to effectively engage farmers in the domestication of wild edible fruit tree species. Social attributes can help to better understand perception of variation, and

preferences. We focused on *Parkia biglobosa* (Jacq.) Benth., a valuable fruit tree in Benin, examining the folk classification systems and preferences for fruit morphotypes, and the extent to which they are related to social attributes in the two major climatic zones of its occurrence in Benin. Using random sampling, we selected 648 informants for individual semi-structured interviews which focused on recognized morphotypes, local classification system, and both desirable and undesirable traits related to pod, pulp, and seeds. Data were analyzed using relative frequency of citation, and principal component analysis. Informants used similar criteria to differentiate fruits of species including pod shape (RFC = 100%), pulp yield (RFC = 100%) and number of seeds per pod (RFC = 99.84%), color (RFC = 100%) and taste (RFC = 99.84%) of pulp as well as brightness (RFC = 99.07%) and color (RFC = 100%) of seed. Informant's preferences were marked for fruits containing large number of seeds with larger size and of good seed quality. Sweetness of the pulp was also mentioned, though some differences were noted among gender and sociolinguistic groups. Our findings provide essential information for decision-making for effective domestication initiatives. To advance further domestication, while conserving essential genetic resources, quantitative morphological and molecular characterization of the observed variations in *P. biglobosa* are needed.

Keywords African locust bean, Domestication, Agroforestry systems, West Africa

Empirical determination of optimal configuration for characteristics of a multilayer perceptron neural network in nonlinear regression

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Afrika Statistika

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In this paper, we determine an optimal configuration for characteristics of a multilayer perceptron neural network (MPL) in nonlinear regression for predicting crop yield. Monte Carlo simulation approach has been used to train several databases generated by varying the internal structure of 3-MLP from simple to complex for 5 different algorithms most used. Results showed that the optimal configuration is obtained with the Levenberg Marquard algorithm, 75% of the number of input variables as number of hidden nodes, learning rate 40%, minimum sample size 150, tangent hyperbolic and exponential functions in the hidden and output layers respectively.

Keywords: artificial neural network; machine learning; sample-size effect; nonlinear models; prediction

Transferability, development of simple sequence repeat (SSR) markers and application to the analysis of genetic diversity and population structure of the African fan palm (*Borassus aethiopum* Mart.) in Benin

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BMC Genetics

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In Sub-Saharan Africa, *Borassus aethiopum* Mart. (African fan palm) is an important non-timber forest product-providing palm that faces multiple anthropogenic threats to its genetic diversity. However, this species is so far under-studied, which prevents its sustainable development as a resource. The present work is a first attempt at characterizing the genetic diversity and population structure of *B. aethiopum* across nine collection sites spanning the three climatic regions of Benin, West Africa, using microsatellite markers. During a first phase we relied on the reported transferability of primers developed in other palm species. We find that, in disagreement with previously published results, only 22.5% of the markers tested enable amplification of *B. aethiopum* DNA and polymorphism detection is very low. In a second phase, we generated a *B. aethiopum*-specific genomic dataset through high-throughput sequencing and used it for the de novo detection of microsatellite loci. Among the primer pairs targeting these, 11 detected polymorphisms and were further used for analyzing genetic diversity. Across the nine sites, expected heterozygosity (He) ranges from 0.263 to 0.451 with an overall average of 0.354, showing a low genetic diversity. Analysis of molecular variance (AMOVA) shows that within-site variation accounts for 53% of the genetic variation. Accordingly, the low number of migrants and positive values of the fixation index (F) in sites from both the Central (Sudano-Guinean) and the Southern (Guinean) climatic regions suggest limited gene flow between sites. The global correlation between genetic and geographic distances is weak; however, our clustering analyses indicate that *B. aethiopum* palms from Savè (Center) are genetically more like those from the North than to samples from other Central sites. In the light of our results, we discuss the use of inter-species transfer vs. de novo development of microsatellite markers in genetic diversity analyses targeting under-studied species, and suggest future applications for our molecular resources. We propose that, while prominent short-range pollen and seed dispersal in Benin explain most of our results, gene flux between the Central and Northern regions, because of animal and/or human migrations, might underlie the Savè discrepancy.

Empirical performance of estimation methods in Beta mixed models with application to ecological data

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Afrika Statistika

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This study uses a Monte Carlo simulation design to assess the performance of Beta and linear mixed models on bounded response variables through comparison of four estimation methods. Four factors affecting the performance of the estimation methods were considered: the number of groups, the number of observations per group, the variance and distribution of the random effects. Our results showed that, for small number of groups (less than 30), the Beta mixed model outperformed the linear mixed model whatever the size of the groups. In the case of a large number of groups (superior or equal to 30), both approaches showed relatively close performance. The results from the simulation study have been illustrated with real life data.

Keywords: Beta distribution; continuous proportion; transformations; hierarchical modelling; performance; application.

Trend analysis of growing season characteristics and agro-climatic risks in the "Trois Rivières" forest reserve agro-ecosystems in North Benin

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Theoretical and Applied Climatology

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Few studies regarding the assessment of the growing season's trends and the associated agro-climatic risks are focused on agroecosystems around forest reserve although adaptive extensive agriculture poses severe threats due to climate variability and change. This study aims at analyzing the evolution of agro-climatic characteristics to identify the associated risks. It firstly consisted in analyzing the temperatures within the period from 1960 to 2016 in the forest reserve of "Trois Rivières." Secondly, the characteristics of the growing season and their distribution were analyzed. Statistic-based tests were further performed to identify major trends and breaks as well as the associated agro-climatic risks. Thus, the period from 2000 to 2016 generally presents wet conditions (increasing trends of Standardized Precipitation Index and rainy days) similar to the period of 1960 to 1975, which are separated by a relatively dry period (increasing trends of dry spells) from 1975 to 2000. Those facts reveal an apparent return to wet conditions after the 2000s which is coupled with the acceleration of warming resulting in the increase of minimum temperatures by 1.5 °C and the maximum by 1 °C. We also noticed a great variability of the dry spells within the growing season which has accentuated especially the risk of sowing failure (false start) by 56 to 74% and the yields failure risks by 52%. Our findings showed the degree to which farmers are affected by the realities of climate

variability and change in "Trois Rivières" forest agro-ecosystems. That led farmers, mostly poor, to resort to extensive agriculture which unfortunately is the main cause of deforestation.

Keywords: Agro-climatic risks, Agro-ecosystems, Growing seasons, "Trois Rivières" forest reserve, Benin., West Africa

Functional trait diversity is a stronger predictor of multifunctionality than dominance: Evidence from an Afromontane forest in South Africa

Mensah Sylvanus, Salako Kolawolé Valère, Assogbadjo Achille, Glèlè Kakaï Romain, Sinsin Brice, Seifert Thomas

Ecological Indicators

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Studies on how biodiversity influences ecosystem multifunctionality (EMF) help elucidate ecological mechanisms (e.g. niche complementarity and selection) underlying provision of multiple ecosystem services. While it is acknowledged that biodiversity contributes to EMF, the relative importance of functional traits diversity (niche complementarity) and dominance (selection effects) for EMF needs further investigation. To address this gap, we analysed how tree species diversity influences EMF, using data on species functional traits (specific wood density, specific leaf area and maximum plant height) and four ecosystem functions (carbon storage, habitat quality, forage provision and rockfall protection) in an Afromontane Forest in South Africa. We tested the hypotheses that (i) trait diversity rather than dominance would link species richness to EMF; and (ii) diversity rather than species richness effects would increase with the level of EMF. For all possible scenarios of EMF indices, functional trait diversity metrics, especially functional divergence and functional richness correlated positively with EMF. On the other hand, functional dominance also influenced EMF, but played limited role in mediating EMF response to species richness, when compared with functional diversity. Results further revealed that total diversity effects, not species richness effect, generally increased with the level of EMF. In summary, we show that species richness does not fully capture the functional contribution of different species. Compared to dominance, trait diversity had significant advantage in explaining biodiversity-EMF relationship, stressing a greater role of niche complementarity as mechanism underpinning delivery of multiple functions. We argue that functional dominance reflects more the competitive dominance of traits and species within a given community and therefore is more likely to have greater effects on single functions than on multifunctionality.

Keywords: Ecosystem multifunctionality; Functional trait diversity; Mistbelt forest; Niche complementarity; Structural equation modelling; South Africa.

Structural complexity and large-sized trees explain shifting species richness and carbon relationship across vegetation types

Mensah Sylvanus, Salako Valère K., Seifert Thomas

Functional Ecology

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It is prominently claimed that enhancing forest diversity would play a dual role of nature conservation and climate regulation. While the idea is intuitively appealing, studies show that species richness effects on above-ground carbon (AGC) are not always positive, but instead unpredictable especially across scales and complex terrestrial systems having large-diameter and tall-stature trees. Previous studies have further considered structural complexity and larger trees as determinants of AGC. Yet it remains unclear what drives differential diversity–AGC relationships across vegetation types. Here we test whether structural complexity and large-sized trees play an influential role in explaining shifting diversity–AGC relationships across vegetation types, using a 22.3-ha sampled dataset of 124 inventory plots in woodlands, gallery forests, tree/shrub savannas and mixed plantations in West Africa. Natural vegetation had greater species richness and structural complexity than mixed plantations, as expected. In addition, AGC was highest in gallery forests and mixed plantations, which is consistent with favourable environmental conditions in the former and high stocking densities and presence of fast-growing species in the latter. Significant interaction effects of species richness and vegetation on AGC revealed a vegetation-dependent species richness–AGC relationship: consistently, we found positive species richness–AGC relationship in both mixed plantations and woodlands, and nonsignificant patterns in gallery forests and tree/shrub savanna. Furthermore, there was a vegetation-dependent mediation of structural complexity in linking species richness to AGC, with stronger positive structural complexity effects where species richness–AGC relationships were positive, and stronger positive large-sized trees' effect where species richness–AGC relationships were neutral. Our study provides strong evidence of vegetation-dependent species richness– AGC relationships, which operated through differential mediation by structural complexity of the species richness and large trees' effects. We conclude that even higher species richness in diversified ecosystems may not always relate positively with AGC, and that neutral pattern may arise possibly as a result of larger dominant individual trees imposing a slow stand dynamic flux and overruling species richness effects.

Keywords: larger trees, niche complementarity, species diversity, stand structures, structural equation model

Revisiting biotic and abiotic drivers of seedling establishment, natural enemies and survival in a tropical tree species in a West Africa semi-arid biosphere reserve

Mensah Sylvanus, Noulèkoun Florent, Dimobe Kangbéni, Atanasso Justin, Salako Valère K., Assogbadjo Achille, Glèlè Kakaï Romain

Journal of Environmental Management
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Biotic and abiotic drivers of seedling establishment and survival are fundamental not only for elucidating processes occurring at plant early life stages, but also for assisting species natural regeneration. Keystone, multipurpose and economically important tree species such as *Afzelia africana* Sm. are reportedly facing recruitment constraints, yet little is known about how abiotic and biotic factors shape the species seedling dynamics. Here, we monitored the species seedlings over one year across three seasons in West Africa savannahs to determine how conspecific and heterospecific biotic neighborhood and habitat heterogeneity correlate with initial seedling density, leaves' fungal infection and herbivory and how all these factors combined, influence the species seedling survival. Seedling densities increased with increasing conspecific adult densities and were highest in tree savannahs and on sandy-silt soils. Leaves' fungal infection and herbivory were also positively associated with conspecific adult density but were more abundantly observed in tree savannahs than in shrub savannahs. Seedling survival was constrained on higher slope, and negatively affected by conspecific adult density, especially in shrub savannahs. There was a strong evidence for negative density-dependence effects of conspecific adults on seedling survival, which operated through negative effects of herbivory and fungal infection. Habitat heterogeneity was also an important driver, which modulated biotic factors' effects on seedling survival: tree savannahs promote positive conspecific density-dependence of seedling fungal infection and herbivory more than shrub savannahs. Nonetheless, seedlings were more sensitive to natural enemies in shrub savannahs, suggesting increased negative conspecific density-dependence effects on seedling survival in less dense vegetation, possibly because of enhanced specialization of predators and pathogens on a limited set of species. The study brings important insights into the mechanisms that drive the establishment and survival of the species seedling, which should be considered in the design of management activities aiming at the conservation of this endangered species.

Keywords : *Afzelia Africana*; Biotic neighborhood; Conspecific adult density; Phylogeny Seedling survival; Semi-arid environment.

Aboveground tree carbon stocks in West African semi-arid ecosystems: dominance patterns, size class allocation and structural drivers

Mensah Sylvanus, Noulekoun Florent, Ago Expédit E.

Global Ecology and Conservation
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The importance of terrestrial ecosystems for carbon sequestration and climate regulation is acknowledged globally. However, the underlying structural drivers are still not well

understood, particularly across distinct tropical forest ecosystems where trees species have different growth habits and potential to reach different maximal size. In particular, how important are different tree size classes in contributing to stand aboveground carbon (AGC) remains unclear across forest ecosystems. Here, we hypothesized that (i) tree size classes would contribute differently to stand AGC across forest ecosystems; and (ii) few species, possibly dominant, would determine most of stand AGC. We tested these hypotheses using a 17-ha sampled inventory data from gallery forests, woodlands and savannahs in the Republic of Benin. We examined (i) how AGC stocks vary among small- (<20 cm), medium- (20–40 cm) and large-size (>40 cm diameter at breast height - dbh) trees; (ii) how the large size class and its individual species contribute to AGC; and (iii) how size class-based taxonomic and structural variables influence AGC? Stand AGC was 23 ± 5, 30 ± 8 and 42 ± 12 MgC ha^{-1} in savannah, woodland and gallery forest, respectively. There were significant main and interaction effects of vegetation types and size classes. As expected, medium and large-size classes contained more of the AGC, irrespective of the vegetation type. However, gallery forests had the lowest AGC in the <20 cm dbh class, but higher values in medium- and large-size classes as compared to woodlands and savannahs. The top 10 species contributed 82%, 89% and 91% of AGC in gallery forests, woodlands and savannahs, respectively. In addition, five of the top 10 dominant species were shared by the three vegetation types and alone contributed 70–76% of AGC. Tree basal area was the most constant structural attribute influencing AGC; however, its influence shifted with vegetation type and size class, with greater effects of large-size tree basal area in gallery forests, and of medium trees and small trees' basal area in woodlands and savannahs, respectively. The study shows that (i) AGC allocation to size class varied across vegetation types, and (ii) small and medium trees are also important in predicting AGC, especially in semi-arid environments dominated by high densities of small-size trees (e.g. woodlands and savannahs). It also highlights the importance of few dominant species in contributing a large proportion of AGC stocks. The conservation of these dominant species is essential to avoid substantial decline of AGC stock.

Keywords : Benin; Tree biomass; Dominant species; Large-size trees; Savannah; Stand structure

Pantropical variability in tree crown allometry

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Global Ecology and Biogeography

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Tree crowns determine light interception, carbon and water exchange. Thus, understanding the factors causing tree crown allometry to vary at the tree and stand level matters greatly for the development of future vegetation modelling and for the calibration of remote sensing products. Nevertheless, we know little about large-scale variation and determinants in tropical tree crown allometry. In this study, we explored the continental variation in scaling exponents of site-specific crown allometry and assessed their relationships with environmental and stand-level variables in the tropics. Using a dataset of 87,737 trees distributed among 245 forest and savanna sites across the tropics, we fitted site-specific allometric relationships between crown dimensions (crown depth, diameter and volume) and stem diameter using power-law models. Stand-level and environmental drivers of crown allometric relationships were assessed at pantropical and continental scales. The scaling exponents of allometric relationships between stem diameter and crown dimensions were higher in savannas than in forests. We identified that continental crown models were better than pantropical crown models and that continental differences in crown allometric relationships were driven by both stand-level (wood density) and environmental (precipitation, cation exchange capacity and soil texture) variables for both tropical biomes. For a given diameter, forest trees from Asia and savanna trees from Australia had smaller crown dimensions than trees in Africa and America, with crown volumes for some Asian forest trees being smaller than those of trees in African forests. Our results provide new insight into geographical variability, with large continental differences in tropical tree crown allometry that were driven by stand-level and environmental variables. They have implications for the assessment of ecosystem function and for the monitoring of woody biomass by remote sensing techniques in the global tropics.

Keywords: crown allometry, environment, forest, precipitation, savanna, soil, stand-level variable, tropical biomes

On the use of growth models to understand epidemic outbreaks with application to COVID-19 data

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PloS ONE

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The initial phase dynamics of an epidemic without containment measures is commonly well modelled using exponential growth models. However, in the presence of containment measures, the exponential model becomes less appropriate. Under the implementation of an isolation measure for detected infectives, we propose to model epidemic dynamics by fitting a flexible growth model curve to reported positive cases, and to infer the overall epidemic dynamics by introducing information on the detection/testing effort and recovery and death rates. The resulting modelling approach is close to the Susceptible-Infectious-Quarantined-Recovered model framework. We focused on predicting the peaks (time and size) in positive cases, active cases and new infections. We applied the approach to data from the COVID-19 outbreak in Italy. Fits on limited data before the observed peaks illustrate the ability of the flexible growth model to approach the estimates from the whole data

Indigenous knowledge and local practices concerning the endemic plant *Ipomoea beninensis* Akoègn., Lisowski & Sinsin (Convolvulaceae): an initial assessment for its conservation in Benin

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Ipomoea beninensis Akoègn., Lisowski & Sinsin (Convolvulaceae) is the only endemic plant known for Benin. To date, no data exist on its usages, distribution, abundance, and threats. An improved understanding of indigenous know- ledge and of local practices can provide insight into how the species could be sustainably conserved. We interviewed 114 local residents for collecting ethnobotanical and ethnoecological data in six sites known to host the species. Data were pro- cessed by calculation of descriptive statistics and variance and multivariate analyses. A total of twelve uses were reported. Among them, treatment of varicella (19%), malaria (18%) and fodder (17%) were the most recurrent. These mainly involve use of the species rootstock. Almost all respondents mentioned decline of the species in natural habitats. None of them was aware about the endemic status of the species. Consequently, negative practices toward the protection of *I. beninensis* were prevalent among local residents. Several conservation measures are proposed to ensure the longterm survival of *I. beninensis*.

Keywords: *Ipomoea beninensis*, resident' knowledge and perceptions, negative practices, endemism, conservation, Benin.

The private sector in knowledge processes and partnerships for food and nutrition security in the Global South: a case study from the Dutch Food and Business Applied Research Fund programme.

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Knowledge Management for Development Journal

www.km4djournal.org/

Based on a recent outlook on the food and nutrition security, the zero-hunger goal is unlikely to be achieved by 2030. To improve the situation, there is a need for transformational changes not only by producing high-quality knowledge and innovations on food and nutrition security but also by ensuring their uptake and upscaling. On this challenge, the private sector is increasingly seen to play a critical role. However, the underlying factors and dynamics supporting such private sector mainstreaming in knowledge processes and partnerships are poorly known. This paper, therefore, contributes to the knowledge gap and learns from the Dutch Food and Business Applied Research Fund (ARF) programme to explore the role the private sector has played. We found that for-profit actors can bring value to research processes and knowledge development. However, the collaborations come with challenges related to goals and interests, implementation approach, and marketing strategies. The outcomes of such collaborations may be mixed and, in some cases, lead to results that are not inclusive for the most food insecure. Partnerships that include the private sector should be cognizant of the possible challenges and proactively define approaches that leverage the private sector to add value to food and nutrition security outcomes.

Keywords: For-profit actors; agribusiness; inclusive business; smallholders; agriculture; food systems; knowledge co-creation; knowledge management; Sustainable Development Goals

Does participation of agricultural entrepreneurs in knowledge networks improve firm performance in Benin?

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Knowledge Management for Development Journal

Knowledge network is a key element of the entrepreneurship environment. It is claimed to provide entrepreneurs with information, resources, and knowledge likely to positively impact the performance of their firms. In the African context, where agricultural entrepreneurship is rapidly evolving in adverse conditions, knowledge networks are presumed to be critical for entrepreneurs. However, it is still unclear if and how knowledge networks can improve the performance of firms. This study empirically investigated that question in Benin where 819 agricultural entrepreneurs were interviewed. Descriptive statistics were used to evidence the participation in knowledge networks, and an ordinal logistic regression to assess the effect of participation on the

firm's performance. Findings showed that agricultural entrepreneurs use both formal and informal knowledge networks with more intensity towards the informal ones. Participation in these knowledge networks is influenced by age, gender, education level, and sector of activities. Moreover, entrepreneurs who can access advice or information on resources from organizations in their networks or actively participate in professional events displayed higher performance. This study provides critical information for institutions that are active in encouraging or crowding out the involvement of the private sector in agricultural and rural development.

Keywords: private sector; knowledge networks; agricultural development; entrepreneurs; Benin

Agricultural production, food nutrition and capacity building in higher education in Africa

S. Mensah and E. Adipala

African Journal of Rural Development

Agriculture is a vital activity that sustain millions of people livelihoods and build local, national and regional economies. Progress in agricultural development is expected to translate in living standards in rural areas, commodities value chains and commercialization. However, in Sub-Saharan Africa, rural development faces a number of challenges such as poor soil restauration and agronomic practices leading to low agricultural productivity. Adding to this is the daunting task of securing food and enhancing food nutrition for the continent. This editorial of the African Journal of Rural Development introduces eight peer-reviewed journal papers that reflect on three key gaps areas deemed important for Africa in realizing the aspirations of the Agenda 2063. These include education, food nutrition and agriculture, including soil/agronomic practices, livestock and forestry. The information presented in these papers provides interesting insights on (i) soil fertility and soil water management through use of biochar produced from locally available sources as well as the need for monitoring of nitrate loading even at small scale; (ii) factors affecting citrus production and sawmill profitability and sustainability of wood resource utilization; (iii) production practices and quality defects of hides and skins, and gastrointestinal parasites in Angora goats; (iv) food nutrition and dietary intake patterns among agricultural households; and (v) capacity building the field of higher education, particularly the experiences on the implementation of the Intra Africa training initiative established by RUFORUM. It is our hope that the readers will find these information relevant for their own use and application in their respective fields.

Keywords: soil water management; citrus; livestock; food nutrition; higher education

Promoting dissemination and application of African Universities' research outputs

S. Mensah and E. Adipala

African Journal of Rural Development

In the current context of demographic explosion, particularly in Sub-Saharan Africa, empirical research on aspects that relate to livelihoods is deemed to have considerable long-term implications for societal well-being and sustainable development. Whereas these aspects are various and include a wide range of specific issues from agriculture and food security to health sciences and environment, it is increasingly becoming evident that impacts on society are greater when research outputs are practical and locally exploitable. This editorial introduces the third issue of the fourth volume of the African Journal of Rural Development (AFJRD: Vol. 4, Issue 3), which presents seven research and one review papers on topics that are relevant to the journal audience. In particular, the issue highlights research studies that have investigated complementary aspects of (i) livestock productivity; (ii) crop productivity and marketing; and (iii) interdisciplinary research capacity and scholarly publishing in African universities. The work presented in this issue provides recommendations that enable livestock farmers attain profitable returns and assure economic sustainability of dairy, piggery and small ruminant farming. Further, it highlights the importance of managing infected soil and debris to address the spread and control of plant pathogens. Finally, the results of the studies in this issue highlight some of the challenges faced by universities in Africa in producing original research output and building research collaboration, in particular, the need to evaluate existing capacities and map out strategic areas of development in higher education institutions. Our goal in collating and sharing these findings is to catalyze understanding of the issues being addressed, promote research application and facilitate advancement in scientific research on the continent.

Keywords: African universities; agricultural productivity; livelihoods; plant breeding; postharvest stability

Coconut-gliricidia mixed cropping systems improve soil nutrients in dry and wet regions of Sri Lanka

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Agroforestry Systems

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Agroforestry systems are alternative solutions for production and management of agricultural systems which may improve soil quality. In this study, we evaluated the potential of coconut Cocos nucifera-based Gliricidia (Gliricidia sepium) systems to improve soil quality of coconut lands in Sri Lanka in dry and wet regions. A three-year

field experiment was conducted in a randomized complete block design with three treatments T0, T5 and T20, being respectively the control, five and twenty years aged Gliricidia intercropped coconut-based mixed systems. Three replicates of soil samples were taken at 0–15, 15–30 and 30–45 cm and differences in soil physical and chemical properties were evaluated among treatments and sites. We found significant effects of mixed system treatments on the soil chemical properties. In particular, organic matter, soil exchangeable potassium, total nitrogen and available phosphorus contents showed higher values in most coconut-gliricidia mixed systems' soils, with highest values obtained for T20. Cumulatively for all soil depths, organic matter content (22%) and available phosphorus content (20%) were higher on the wet site, and total exchangeable potassium content (69%) higher on the dry site for T20. The pH, bulk density, microbial respiration and electric conductivity did not vary among treatments, but were influenced by the site characteristics, with the dry site showing higher values for pH and the wet site showing higher values for bulk density (5%), microbial respiration (33%) and electric conductivity (2%) in T20 treatment. The study demonstrates that the systems with Gliricidia differed in their soil chemical attributes and had higher levels of soil nutrients when compared to coconut monocrop even at early ages, underlying the potential of Gliricidia for the rehabilitation of coconut growing soils.

Keywords: Agroforestry, *Gliricidia sepium*, Intercropping systems, Monoculture, Soil rehabilitation

Characterization of cashew production actors (*Anacardium occidentale* L.) in the Municipality of Djidja in Central Benin

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International Network for Natural Sciences

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Cashew plantations are a boom for the socio-economic development of local populations in Benin. The aim of the study is to characterize the actors involved in the cashew production chain in Djidja commune, one of the production areas in Benin. The study was carried out on a sample of 150 producers distributed in the various districts of the commune. However, a multifactorial analysis on mixed data and a hierarchical classification are carried out to identify the categories of producer. A multiple linear regression is then performed to assess the productivity of the plantations according to various parameters. The results obtained show the presence of four categories of producers in Djidja commune. Category 1 producers are characterized by large area of nut production and the purchase of fields. As for category 2 producers, they are characterized by the purchase of fields with an average area of nut production. Category 3 Producers are characterized by the secondary level with a small field those of category 4 are characterized by land donation with a small field. The significant factors in cashew yield are the mode of individual organization and production expenses. This implies that

the increase of one unit of production expenses increases the yield of plantations by 9.25 e-06 while the increase of one unit of the mode of individual organization decreases the yield of plantations of 0.73.

Keywords: Cashew, Type of producer, Multifactorial analysis, Djidja, Benin

Perception des Populations sur les Facteurs de Dégradation et les Mesures de Protection de la Réserve de Biosphère Transfrontalière du W au Bénin

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International Journal of Progressive Science and Technologies

Beninese protected areas are under pressure which is felt more on the W Cross-border Biosphere Reserve in Benin (RBTWB) located in an area with high agricultural production. Knowledge of the factors of degradation and measures to reduce this pressure is necessary for optimal conservation of natural resources. The présent research aims to analyze the perceptions of local residents on the factors of degradation and the pressure reduction measures on the RBTWB. To achieve this objective, qualitative data on the factors and causes of degradation as well as the pressure reduction measures were collected. Documentary research, interviews, focus groups and observations in 53 villages bordering the reserve were carried out. The sample size is 273 of which 46.52% benefited from support in terms of income generating activities. The results obtained after statistical analysis of the data showed that the densification of the agricultural front is the main factor of degradation of the reserve followed by poaching and overgrazing. The main causes are the search for well-being of the population and population growth. The majority (80%) of those surveyed believe that the funding of IGA microprojects appears to be the main pressure reduction measure followed by the creation of agricultural and pastoral enclaves (60%) around the reserve. These measures are respectively considered as an alternative source of income and a means of reducing conflicts between actors.

Keywords: Perceptions, factors, measures, reduction, RBTWB.

Mathematical prediction of the *Jatropha curcas* L. plant yield: comparing Multiple Linear Regression and Artificial Neural Network Multilayer Perceptron models

Gbemavo Charlemagne Judes Dossou Seblodo

African Journal of Applied Statistics

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The aim of this study was to predict *Jatropha curcas* plant yield through an Artificial Neural Network (ANN) Multi-Layer Perceptron (MLP) model. The predictive ability of the developed model was tested against the Multiple Linear Regression (MLR) using

performance indexes. According to the performance indexes the use of ANN-MLP model improved *Jatropha curcas* plant yield prediction comparatively to MLR model.

Keywords: Yield; Jatropha curcas plant; Multiple Linear Regression; Artificial Neural Networks-Multi-Layer Perceptron; Modeling.

Impacts of harvesting intensity on tree taxonomic diversity, structural diversity, population structure, and stability in a West African mangrove forest

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Wetlands Ecology and Management

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Understanding the impacts of wood harvesting intensity on the diversity and structure of ecosystems such as mangroves is essential for defining actions for their sustainable management. We compared tree taxonomic diversity, structural diversity and dominance patterns, density, growth characteristics, size class distribution-SCD and stand stability in West African mangroves subject to low vs. high wood harvesting intensity. Data on tree species identity, total height, diameter (dbh), and conditions (logged, topped or pruned) were collected from ten mangrove sites per harvesting intensity. We found seven species of which two true mangroves species (*Rhizophora racemosa* and *Avicennia germinans*) that were dominant across all sites. As expected, there were significantly 3–4, 3–7, and 2–4 times more logged, topped and pruned trees respectively in high-harvesting sites than in lowharvesting sites. Taxonomic diversity was less affected than structural diversity (dbh and heightbased diversity metrics). Tree density was significantly 1.3–5 times higher in low-harvesting sites than in high-harvesting sites for the whole stand and each of the dominant species. Total regeneration density was also low in high-harvesting sites. However, regeneration density was relatively higher in high-harvesting sites for *R. racemosa* contrary to *A. germinans*. Trees were also significantly smaller and shorter in high-harvesting sites. The SCD indicated inverse J-shaped distributions, irrespective of the harvesting intensity and showed that tree harvesting targeted mostly dbh classes 10–30 cm. The density of this class was 2.6–6.2 times lower in high-harvesting sites. This study provides important information on impacts of wood harvesting in a marginally studied mangroves' area.

Keywords: Anthropogenic activities; Tree diversity and structure; Mangroves; *Rhizophora*; *Avicennia*; Benin

Mineral Fertilization Influences the Acceptability of Fresh Pulp and Juice Made from Sugarloaf Pineapple

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Agricultural Sciences

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Fertilization practices can influence the quality of pineapple fruit and consequently its acceptability by consumers who are increasingly oriented towards high quality agri-food products. This study aimed at evaluating the influence of N, P and K on some physico-chemical and organoleptic characteristics of pineapple (Ananas comosus L. Merr) for fresh consumption and juice processing. A complete NPK factorial design was installed in the south Benin. The treatments NPK in g plant-1 were randomized into four blocks: T1; T2; T3; T4; T5; T6; T7; T8; T9. Brix juice was determined using a refractometer and pH with a pH meter. An evaluation of sensory characteristics such as sweetness, acid taste and aroma of fresh pineapple pulp and processed juice was made by a panel of tasters selected and trained. A principal components analysis, followed by a numerical classification was performed on fruits' sensory and physicochemical characteristics. Results showed that juice pH was significantly influenced by the phosphorus and potassium. Potassium influenced significantly juice yield. Some physico-chemical characteristics and sensory attributes were correlated between them, and groups of treatments are formed for both the juice and the fresh fruit.

Keywords: *Ananas comosus*, Fertilizer, Fruit, Intensification, Juice, Sensory