



UNIVERSITÉ D'ABOMEY CALAVI

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FACULTÉ DES SCIENCES AGRONOMIQUES  
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LABORATOIRE D'ÉCOLOGIE APPLIQUÉE



## 2015 SCIENTIFIC ACTIVITIES REPORT OF THE LABORATORY OF APPLIED ECOLOGY (LEA)

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## **Foreword**

The Laboratory of Applied Ecology (LEA) of the Faculty of Agronomic Sciences (FSA, University of Abomey-Calavi, UAC-Benin) was created in 1994 by Professor Brice Sinsin.

LEA is one of the advanced research institutions on natural resources management in Benin. The major research fields in which LEA is currently involved include (i) desertification and land degradation, biodiversity and climate change, (ii) carbon stock measurement and monitoring of carbon sequestration, (iii) agriculture productivity and capacity building in organic agriculture, (iv) ethnobotany and new crops development, (v) management of agroforestry systems; (vi) ecological restoration of degraded land, (vii) conservation and sustainable management of wild palms, (viii) management of Non Timber Forests Products, (ix) management of protected areas (National Parks, hunting zones, community conservation areas), (x) bio Monitoring of wildlife, (xi) red list of threatened plants and wildlife, (xii) grassland ecology, (xiii) Ecological and organic agriculture.

Scientific research at LEA up to now has yielded more than 400 scientific publications in peer-reviewed international journals, books and proceedings of scientific conferences. Moreover, LEA has executed and has been involved in several projects (e.g DADOBAT-UE ; SUN-UE ; BIOTA-West ; LOEWE; UNDESERT-EU ; Edulink-European Union (WANOART-EU) ; Global Climate Change Alliance ; CORAF/WECARD) on sustainable management of natural resources and/or tree domestication in Africa.

Up to date, the major achievements of LEA are the following: (i) climate change, vulnerability assessment and natural/climatic risk management in the coastal area of Benin, (ii) conservation and management of more than 10 forest genetic resources in Benin (e.g: *Adansonia digitata*, *Blighia sapida*, *Caesalpinia bonduc*, *Irvingia gabonensis*, *Pentadesma butyracea*, *Sclerocarya birrea*, *Tamarindus indica*, *Borassus aethiopum*, *Raphia soudanica*, *Dialium guineense*, etc.); (iii) management of more than 10 agroforestry systems involving medicinal plants in Northern Benin (e.g Community gardens of Papatia, Monts Kouffé, Dangbo, Porga, etc.) ; (iv) ecological restoration of more than 5 degraded areas (e.g. Lama forest reserve and Swampy forest of Lokoli in Southern Benin; dry dense forest of Bassila and Wari Maro in Northern Benin; etc.); (v) management of at least 5 protected areas in Benin (Biosphere Reserves of Pendjari and W in Northern Benin, three forests reserves, Goungoun and Sota forests in Northern Benin, Lama forest reserve in Southern Benin, etc.) ; (vi) Red list of threatened plants and wildlife in Benin (IUCN Red Book of Benin) ; (vii) remote sensing and mapping of vegetation (Swampy Forest of Lokoli, Dense Forest of Lama; Biosphere Reserves of Pendjari and W; etc.); (viii) atlas of biodiversity of Benin.

LEA works closely with many international and national partners (research institutions, NGOs, local communities and decision makers). LEA networks and working groups include:

- About 5 full Professors and 20 Associate Professors from many Departments (Regional Planning, Geography, Chemistry, Soil Science, Botany, Socio-economics, etc.) at the University of Abomey-Calavi ;
- International Scientific Groups such as AETFAT, IUCN (WCPA ; SSC ; CWRSG), etc.;

- International Institutions involved in nature conservation and biodiversity management i.e. World Union for Nature Conservation (IUCN), Bioversity International, World Agroforestry Centre, Wildlife Management, Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) etc.;
- Networks such as the South Saharan African Forest Genetic Program (SSAFOGP), Society for Ecological Restoration International (SERI-USA), African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE / ICRAF), African Forest Forum (AFF), etc.
- NGOs and Universities (Belgium, Burkina-Faso, Cameroon, Canada, Côte d'Ivoire, Denmark, France, Ghana, Germany, Japan, Mali, Niger, Nigeria, The Netherlands, Senegal, Sierra Leone, Switzerland, Togo, UK, USA, Uganda, South Africa, Kenya, Mozambique etc.).

This report is the eighth edition following seven consecutive previous reports since 2007. It is intended for several audiences of researchers in Benin and abroad, partners, developers, donators and other professionals interested in the fields of applied ecology. It summarizes the research activities which were performed at the laboratory in 2015 and is organized into nine major sections. Section 1 presents on the methodology used to gather information included in the report and shows how various indices have been calculated. Section 2 focuses on the types of research (individual, national teams, regional teams and international teams), types of publications (thesis, peer review articles, proceedings, technical reports, and newsletter), trends of publications for the last seventeen years (1998 – 2015) and the analysis of language of publications according to the types of publications at the laboratory. Section 3 provides a summary of conferences and seminars organized by the LEA in 2015 and those attended by researchers from LEA. Section 4 describes the research projects and research grants obtained at the laboratory in 2015 whereas section 5 shows details about active human resources at LEA as well as visitors who were in the laboratory in the framework of bilateral collaboration. Section 6 discusses the research activities performed at the laboratory in 2015 while section 7 shows the used references. The appendixes are presented in the section 8, showing full details on references of the different types of publications, research projects and grants as well as on conferences and visiting research in the laboratory. Finally, abstracts of publications in 2015 in peer review journals have been presented in the section 9 to allow easy searching and understanding of the full length papers.

## **1. Data collection**

The methodology used for this report was mainly based on the research activities performed by researchers and students of the laboratory of applied ecology in 2015.

First, information related to dissertations (Postgraduate and undergraduate students), scientific articles (published, in press and under review) in peer-review journals and those published through proceedings, books of abstracts and technical reports were used. For each category of publication, the indices of specialization related to the scientific fields in which the works have been performed were assessed. Also, as far as the published papers in peer-review journals are concerned, two groups of papers were established: articles with Impact Factor

and those without Impact Factor (Web of Science of Thomson). Only publications addressing authors and/or co-authors in LEA were considered. Furthermore, collaborations and co-publications with scientists from developed countries and African countries have been detailed throughout the report.

The types of research were expressed respectively as the ratio between the number of publications produced individually or by co-publication with national, regional or international teams and the total number of publications in the laboratory.

Trends of publications from 1998 to 2015 were assessed both for proceedings and published articles in peer review journals (with Impact Factor or not). The ratio French/English was computed for various types of publications including those in press.

For data processing, the following indices were calculated:

- *Specialization Index of publications* which is the ratio between the number of publications in a given field or discipline and the total number of publications when considering all disciplines;
- *Impact Factor (IF) Index of Publication* for a given field of publication which is the ratio between the number of publications having an Impact Factor and the total number of publications in peer review journals related to the considered field of publication;
- *Weighted Impact Factor Index of a given field of publication* which is the product of the Impact Factor Index of Publications and the arithmetic sum of impact factor indices as described in the web of science of Thomson;
- *Index of co-publication at country vs. continental level* which is the ratio between the number of co-publications at country vs. international level and the total number of co-publications in the laboratory.
- *Estimated cost per publication* which is the ratio between the estimated budget of LEA at a given year and the total publication at this year
- *Estimated cost per impact factor unit* is the ratio between the estimated budget of LEA at a given year and the arithmetic sum of impact factor indices
- *Contribution of LEA to scientific publication at Faculty of Agronomic Sciences (FSA) and University of Abomey-Calavi (UAC)* which is the ratio between the total publication at LEA and the total publication at FSA or UAC.

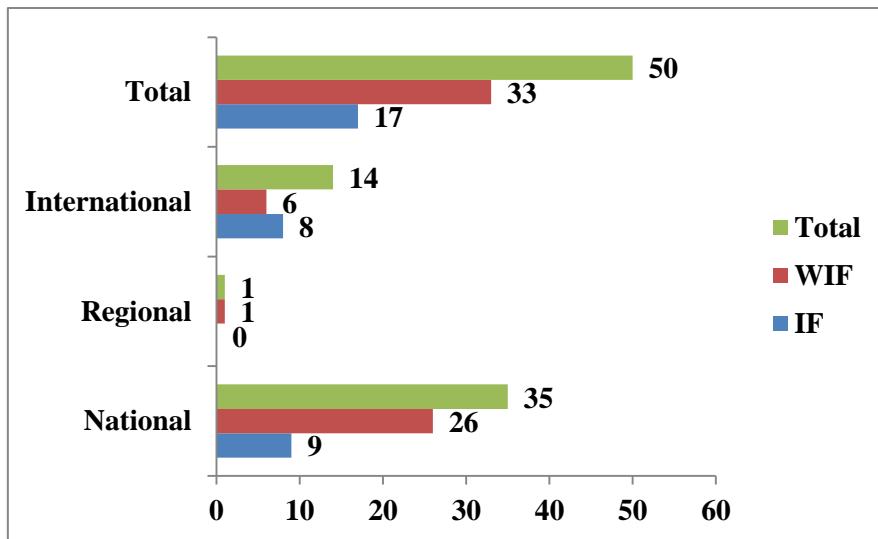
Information related to the conferences and seminars (organized by the laboratory and the ones to which the researchers from the laboratory have participated), research projects, grants, prices and awards are presented in the report.

To allow the assessment of the full references used to compute this report, a so called session “appendices” has been inserted at the end of the report as well as the abstracts of the published papers in the peer review journals.

## **2. Types of research and publications at LEA in the year 2015**

### **2.1 Type of research at LEA**

The published articles of the research team at LEA in 2015 were mostly produced through national teams (35 papers out of 50). About 34 % of the original research papers from LEA were published in international journals with Impact Factor. In most cases, these papers involved national and international partners (Figure 1).



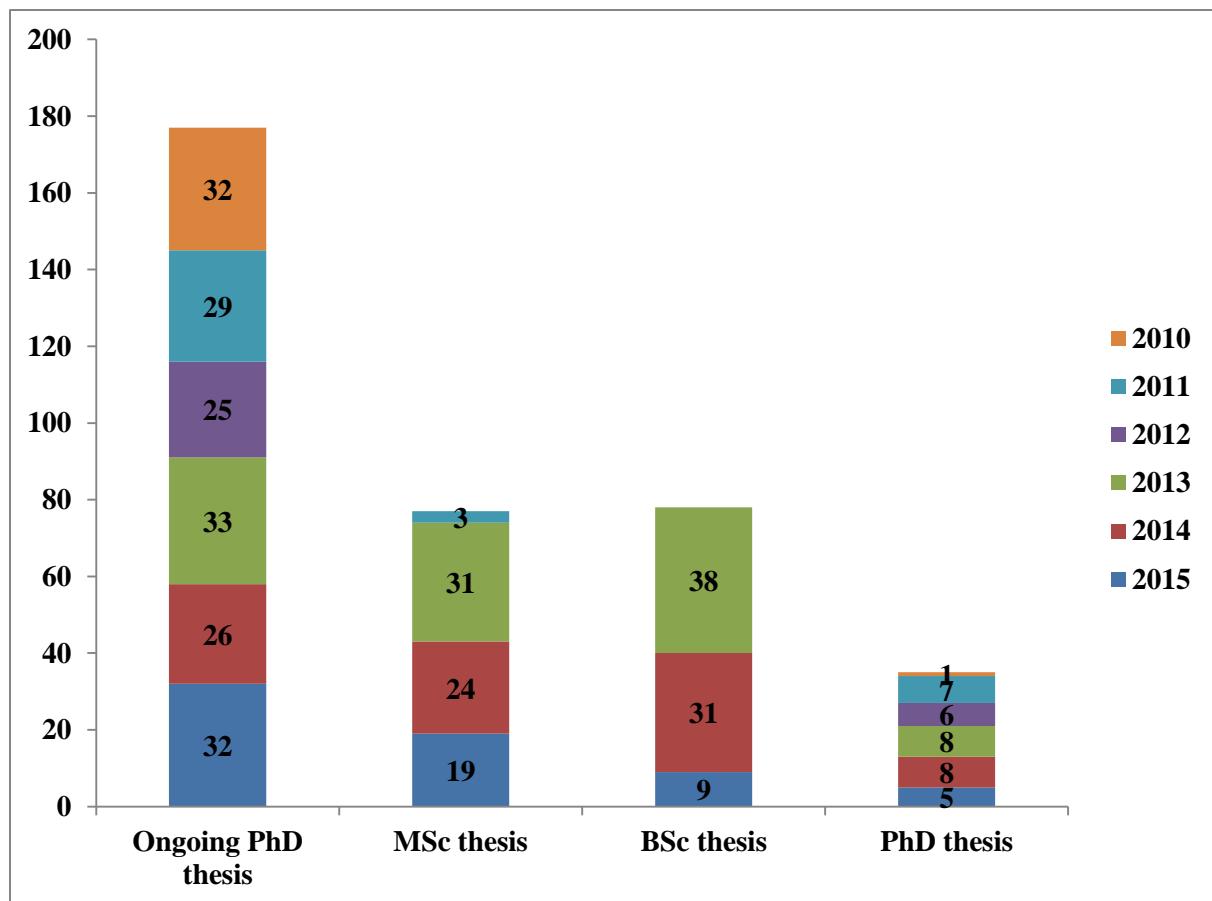
**Figure 1:** Scale context of research activities in LEA in the year 2015

Legend: IF = Impact Factor; WIF = Without Impact Factor

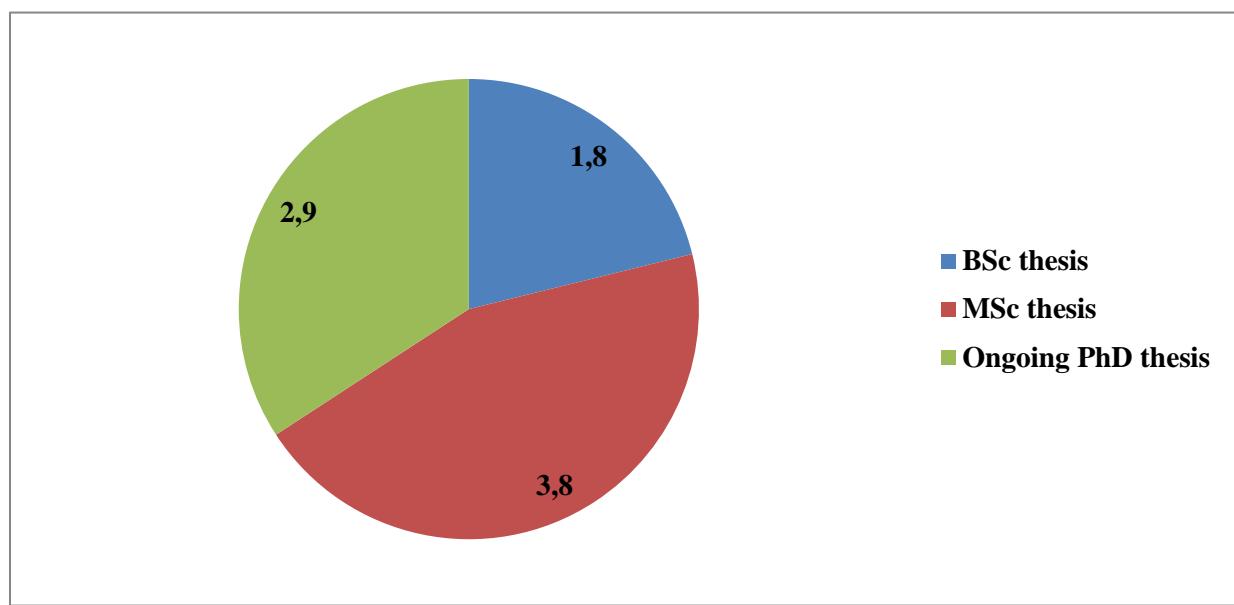
## 2.2 Type of publications at LEA in 2015

### 2.2.1 Theses at LEA

The number of enrolled students in Master degrees in 2015 (19 students) increased since 2007 due to the system LMD started at the University of Abomey-Calavi since 2007. The LMD allow more students to attend the course. The number of enrolled students in PhD degrees at LEA has increased globally from 2010 to 2015 (Figure 2). Five PhD students have defended their PhD in 2015 at LEA. The professors of LEA (full and associate) were actively involved in promotion and supervision of PhD and MSc theses (figure 3). One professor supervised at least 3 ongoing PhD and 5 MSc theses in 2015. The same trend is also observed between associate and assistant professors for the supervision of BSc thesis in 2015 (6 students per associate or assistant professor).



**Figure 2:** Trends of types of defended and ongoing PhD Theses from 2010 to 2015

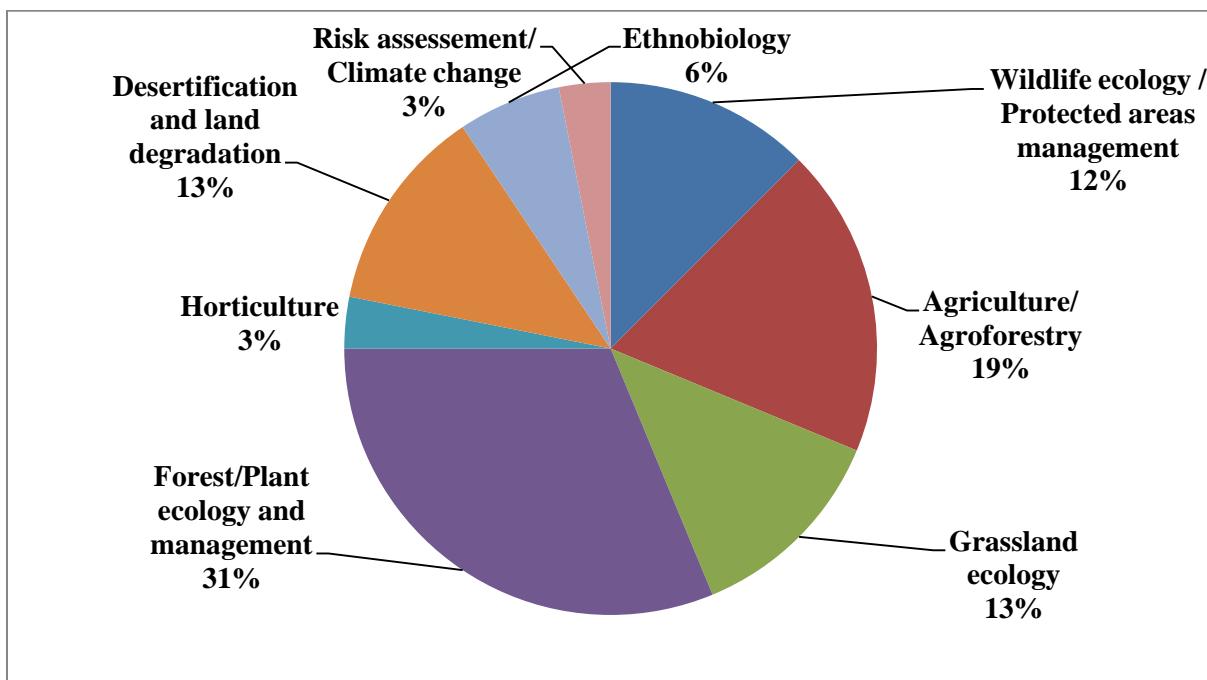


**Figure 3:** Number of students supervised per professor at LEA in 2015

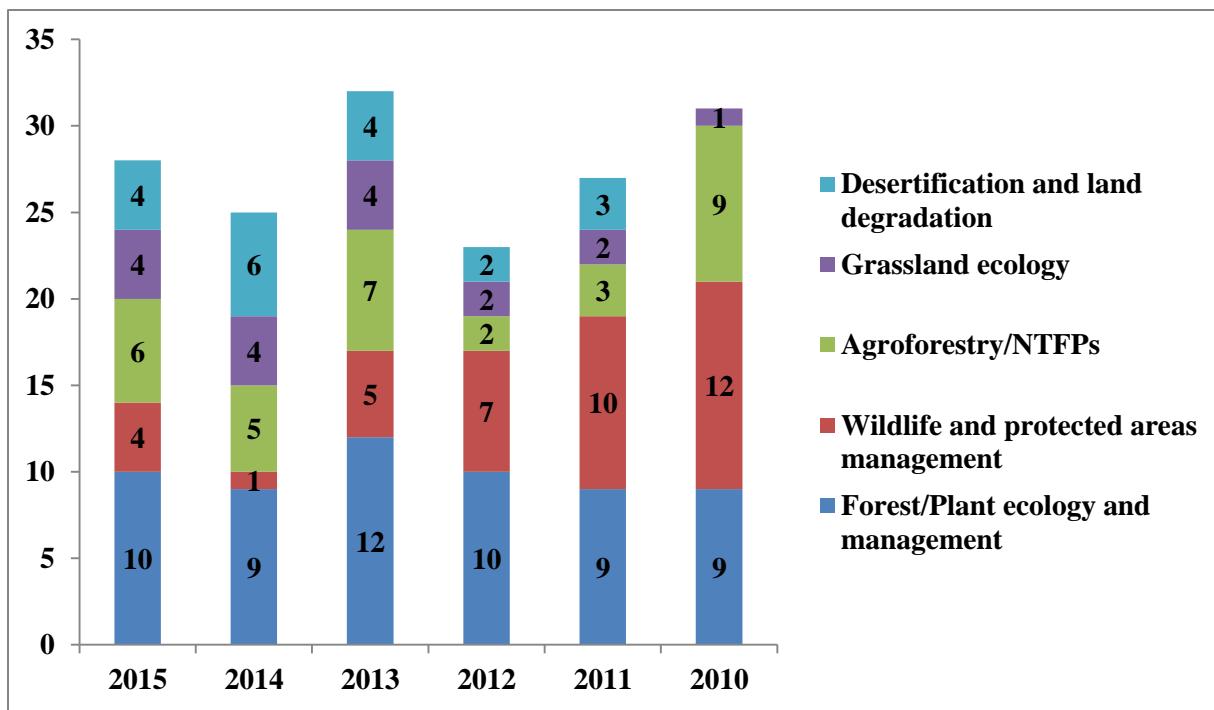
### 2.2.1.1 Ongoing PhD theses at LEA in 2015

Six main fields of research were covered by the PhD students at LEA in 2015 (Figure 4). Forest and Plant Ecology management (31 %), Agriculture/Agroforestry (19 %), Risk assessment/climate change (3 %) and Horticulture (3 %) are respectively the most and less represented (Figure 4). Figure 5 highlights that PhD research in LEA was mainly focused in the fields of: Forest and Plant ecology, Wildlife management, Agroforestry and NTFPs (Figure 5). This is congruent with the laboratory's main research projects.

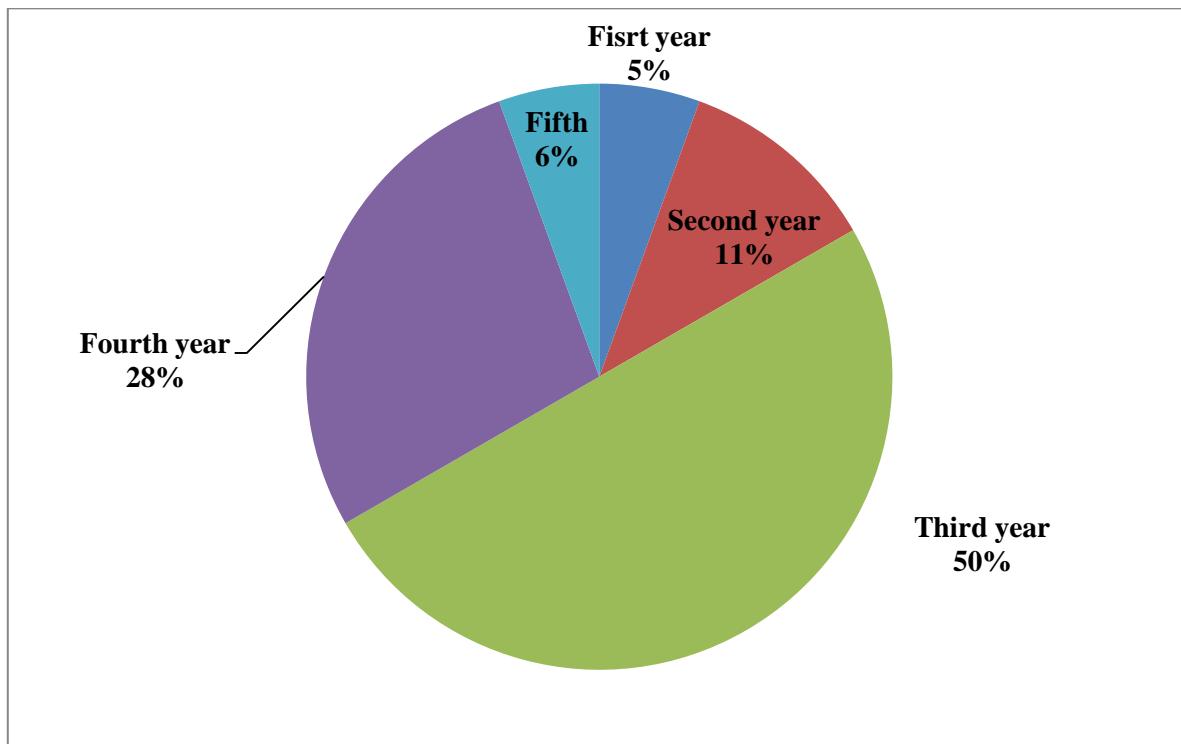
Eighty four percent (84 %) of the students enrolled in PhD have already spent at least 3 years for their research activities while 16 % are beginning (first and second year) their thesis at LEA in 2015 (Figure 6).



**Figure 4:** Spectrum of ongoing PhD thesis and related field of research in 2015



**Figure 5 :** Trends of ongoing PhD thesis according to the fields of research from 2010 to 2015



**Figure 6 :** Typology of PhD students in LEA based on the number of year related to their research activities

## 2.2.2 Scientific productions at LEA in 2015

A total of 77 scientific publications were produced by teams of LEA in peer-reviewed journals in 2015 with 50 papers already published; 11 in press and 16 under review. Moreover, 11 abstracts were published in the books of abstracts and 11 technical report elaborated.

### 2.2.2.1 Publications in peer review journals

#### (i) Number, categories and impact factor indexes of publications

The published articles in 2015 are mostly in the peer review journals without IF (66 %) compared to the number of published papers in peer reviews with Impact Factor (34 %), (Figure 7). The number of articles in press also follows the same trend (64 % vs. 36 %); while more articles are under review in journals with Impact Factor (56 %) than the ones without Impact Factor (44 %). Full references (authors, journals, etc.) of the publications are provided in appendices 6, 7, 8, 9, 10 and 11.

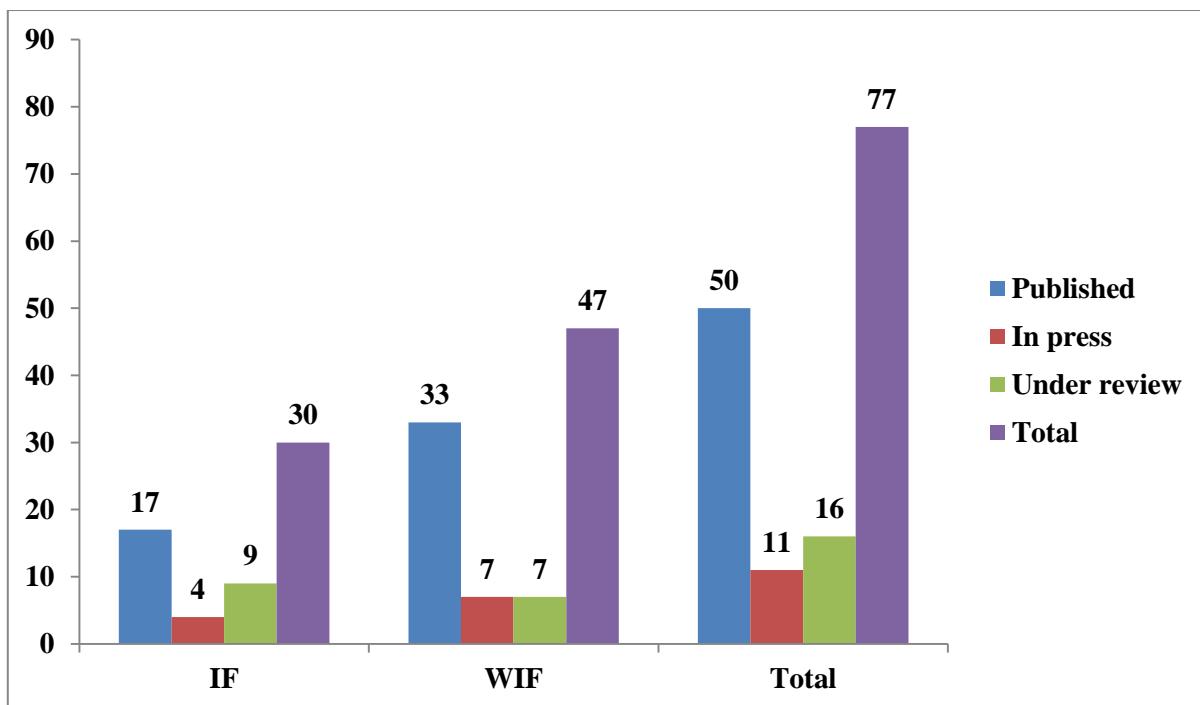
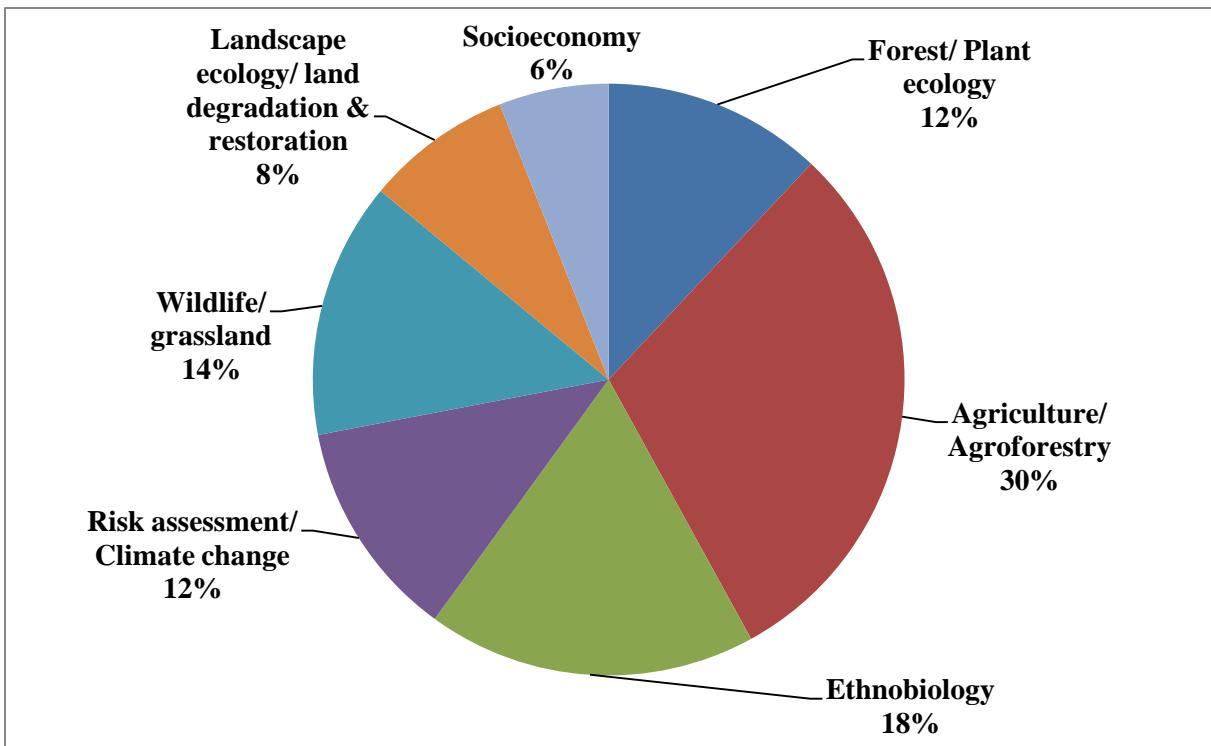


Figure 7: Spectrum of scientific productions of LEA in 2015

#### (ii) Specialization Indexes of publications

##### a) Published articles

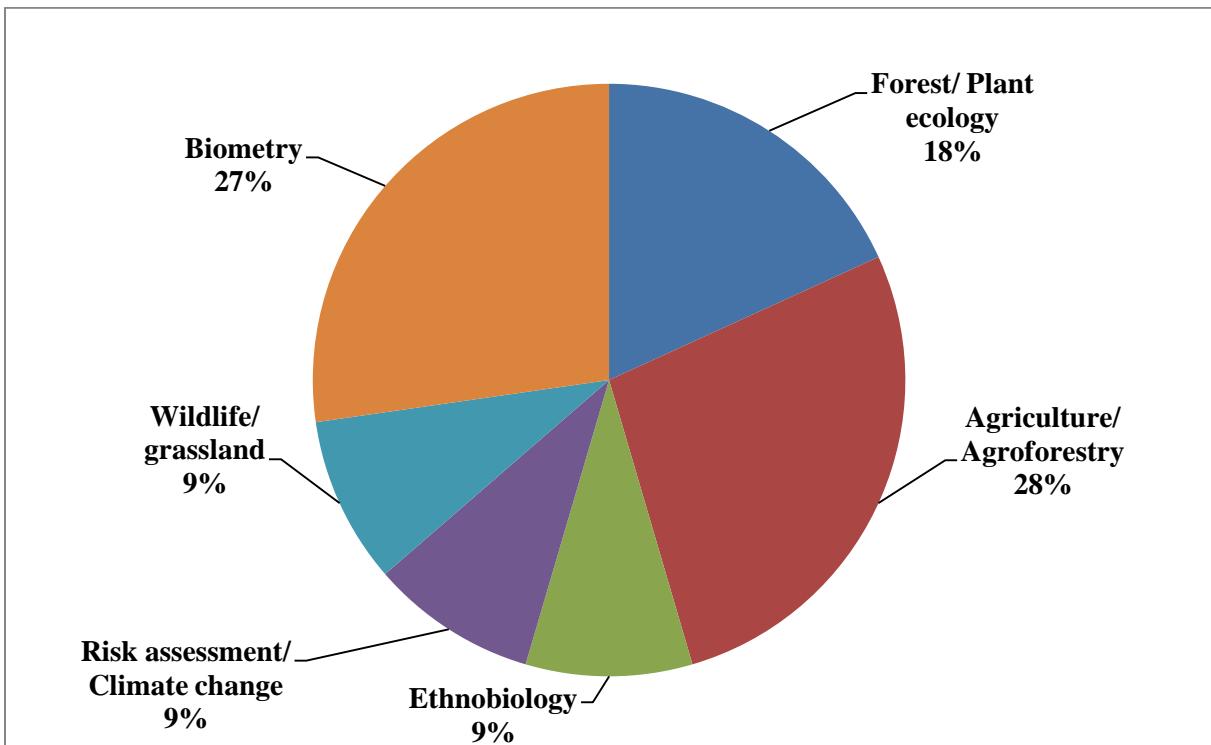
The published articles in 2015 cover various fields of research as the previous year including Agriculture and Agroforestry (15 papers), Ethnobiology (9 papers), Wildlife and Grassland (7 papers), Forest and Plant ecology (6 papers), Risk assessment and Climate change (6 papers), Landscape ecology/land degradation (4 papers) and socio-economy (3 papers). Most articles were published in Agriculture and Agroforestry, Ethnobiology, Wildlife and Grassland and Forest and Plant ecology, which are the main research's field of LEA.



**Figure 8:** Published articles according to the fields of research in 2015

**b) Articles in press**

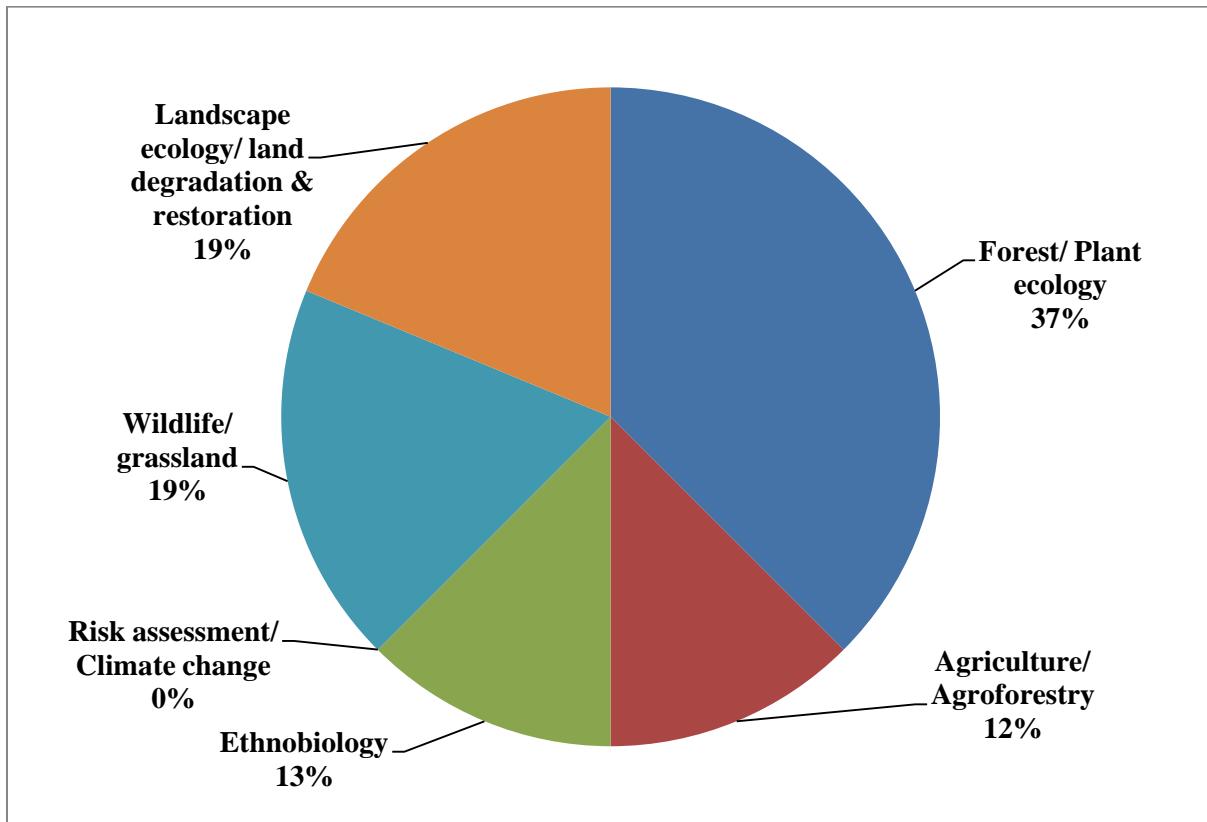
Agriculture and Agroforestry (3 manuscripts), Biometry (3 manuscripts), and Forest and Plant ecology (2 manuscripts) will provide more original research papers in the next year.



**Figure 9:** Articles in press according to the fields of research in 2015

**c) Articles under review**

Fields having more articles under review were Forest and Plant ecology (6 manuscripts), Wildlife and Grassland (3 manuscripts), and Landscape Ecology/Land degradation & Restoration, Agriculture and Agroforestry (3 manuscripts). These fields have also contributed more in articles published and in press confirming these areas as the more scientifically productive within LEA.



**Figure 10:** Articles under review according to the fields of research in 2015

**(iii) Weighted Impact Factor Index of publications**

Publications which have highly contributed to gain the Impact Factor of the laboratory in 2015 were related to Forest/Plant ecology, Landscape ecology/Land degradation & restoration, Ethnobiology, Wildlife/grassland and Agriculture/Agroforestry followed by publications in Risk assessement/Climate change (Table 1). Therefore, these fields of publication are the ones in which the recorded scientific publications in LEA had the highest Impact Factor in 2015.

**Table 1:** Weighted Impact Factor Indices of publications according to the disciplines of specialization

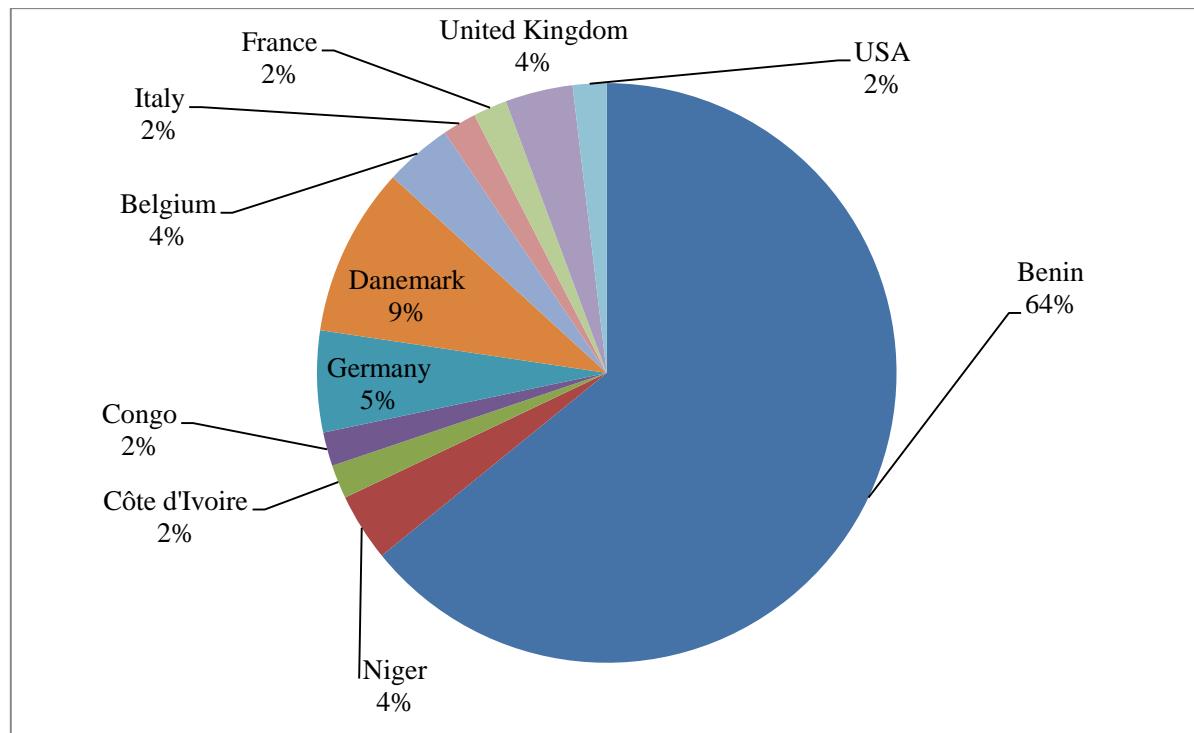
Field of publication	Total number of publications related to the field in peer review journal	Total number of publications related to the field in the reviews having an impact factor	Weighted Impact Factor indices
Agriculture/Agroforestry	15	4	<b>1.185</b> (1.215, 0.681, 0.546, 2)
Ethnobiology	9	3	<b>1.784</b> (2, 1.856, 1.495)
Forest/Plant ecology	6	4	<b>2.801</b> (0.986, 0.54, 0.82, 1.856)
Landscape ecology/Land degradation & restoration	4	2	<b>1.822</b> (2.82, 0.824)
Risk assessment /Climate change	6	1	<b>0.174</b> (1.041)
Wildlife/Grassland	7	3	<b>1.395</b> (0.541, 1.646, 1.069)

( ): The numbers in bracket are the Impact Factor (IF) recorded respectively for each article having an IF in a given field of publication

#### **(iv) Indices of co-publications in peer review journals**

##### *a) Country level*

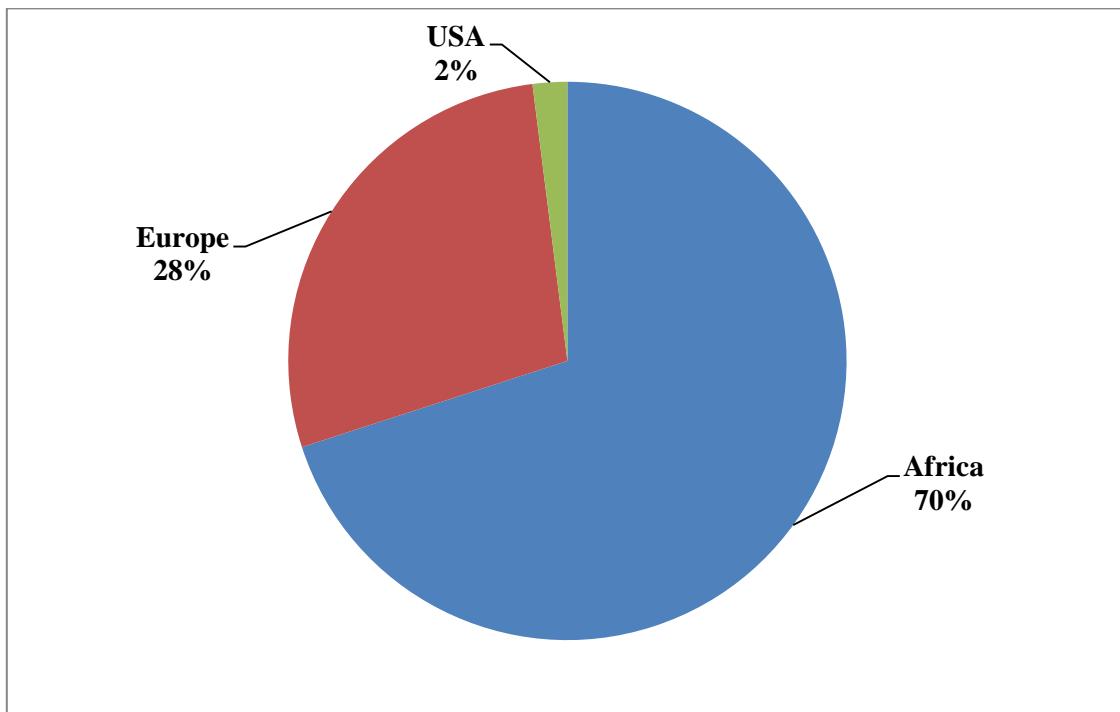
LEA works with a wide partnership at local and international training and research institutions. Research teams within LEA used to publish their research papers in collaboration with national and international scientists (figure 11). At country level, most of the publications were written with researchers from Benin (34 publications out of 50).



**Figure 11:** Diversity in indices of the LEA co-publications in peer review journals at countries scale in 2015

*b) Continental level*

At continental scale, the most important articles were co-published with Africans (35 publications: mainly Beninese), European scientists (14 publications) and American (1 publication) scientists (Figure 12).

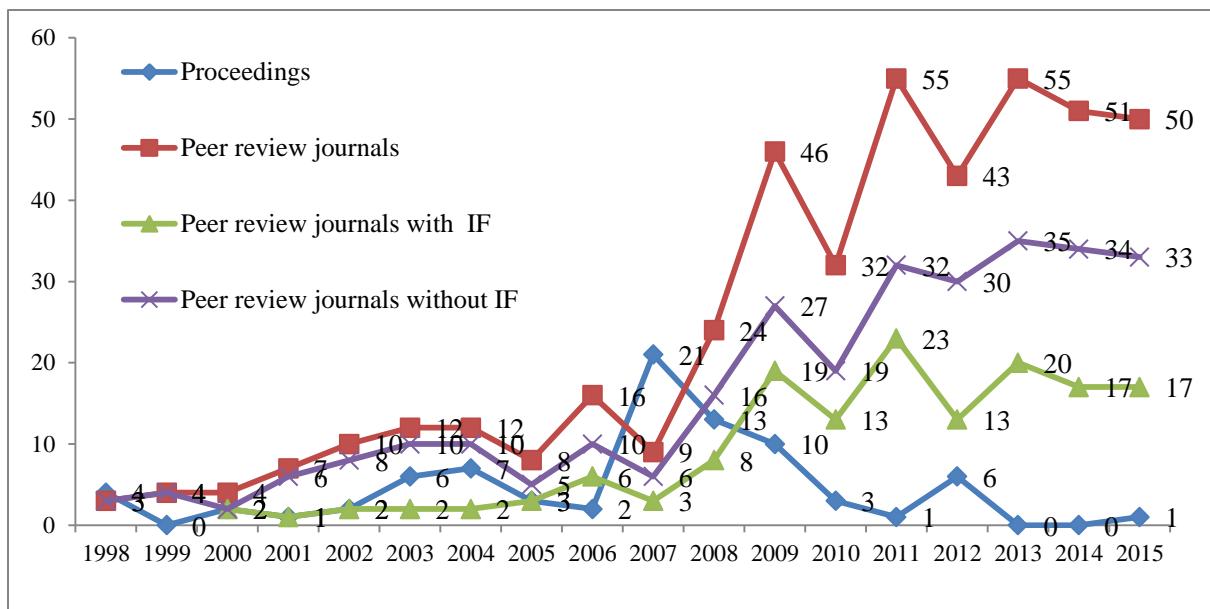


**Figure 12:** Diversity in indices of LEA co-publications in peer review journals at continental level in 2015

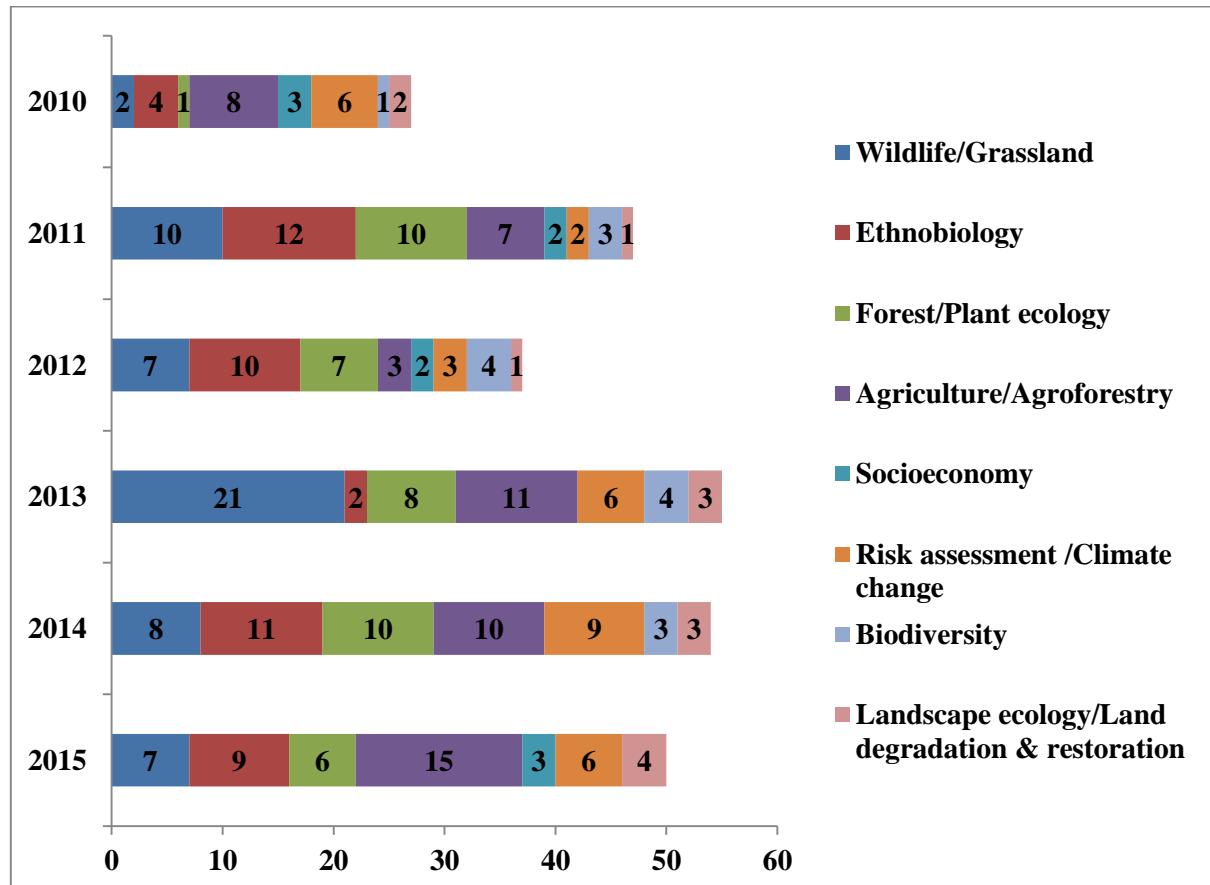
#### **2.2.2.2 Trends of publications in peer review journals and proceedings from 1998 to 2015**

Publications in peer review journals have globally increased from 1998 to 2015 with the highest peak in 2011 and 2013. Publishing in peer review journals with Impact Factor has started in the laboratory in 1994 with 1 to 3 publications per year till 2005. For a given year, the publications in peer review journals with Impact Factor were generally lower compared to the ones in peer review journals without Impact Factor (Figures 13a).

Wildlife and Grassland, Ethnobiology, Forest and Plant ecology, Agriculture and Agroforestry are the research fields in which the most publications are obtained since 2010 at LEA (Figure 13b). This confirms these areas as the main research's field of LEA.



**Figure 13a:** Trends per types of publications from 1998 to 2015

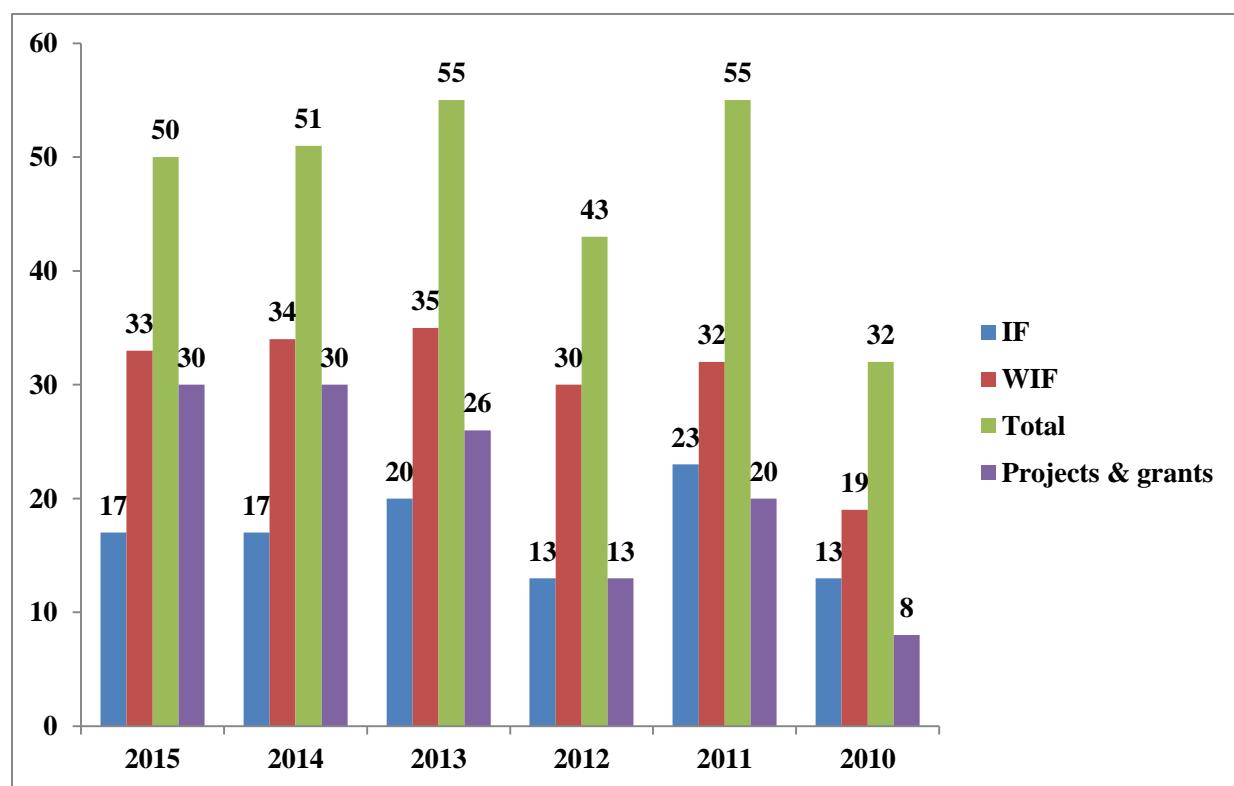


**Figure 13b:** Spectra of publications according to the fields of research from 2010 to 2015

### 2.2.2.3 Trends of research projects, research grants and publications in peer review journals from 2010 to 2015

The research projects and small grants have increased at LEA since 2010 (figure 15). The highest number of research projects and small grants is observed in 2014 and 2015 (30). The same trend is also observed with publications in peer review journals which globally increase since 2010. Thus while the number of project increase, the number of papers published also increase. Moreover, this trend is more observed with the number of papers published in impact factor journal. Indeed, the number of published papers in impact factor journal varied from 13 papers with 8 research projects and small grants to 17-23 papers with 18-30 projects and small grants. With more research projects and small grants, researchers at LEA published more papers in peer review journals particularly in impact factor journals.

The budget per year at LEA from 2010 to 2015 vary from 125 000 Euro to 170 000 Euro. While the budget increase, the cost per publication decrease (table 2). In addition the total impact factor increase with lower cost of publication per impact factor unit. This is due to the increasing number of grantees PhD and MSc students involved in research projects and small grants who have more time for research and publishing. Thus with more funds, more publications are obtained at lower cost.



**Figure 14:** Spectra of publications, projects and small grants from 2010 to 2015

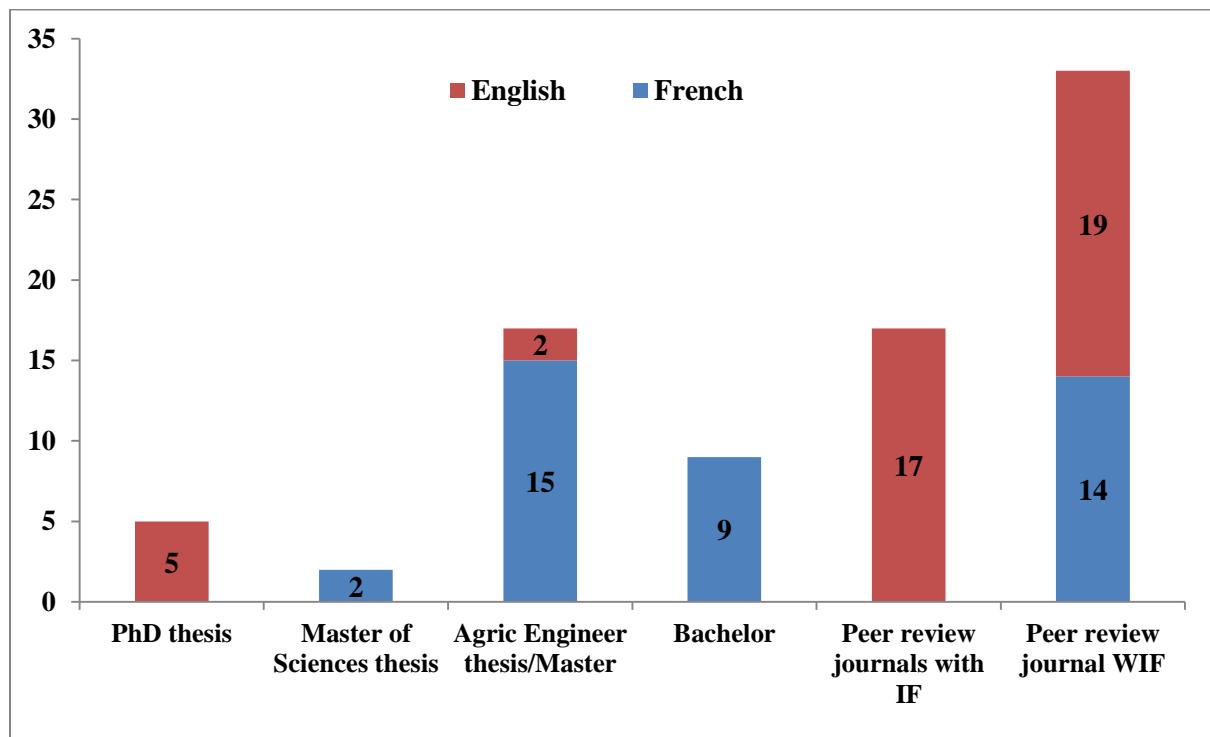
**Table 2:** Estimated cost per publication and per IF unit from 2010 to 2015

Year	Total Publication	Total IF unit	Estimated budget of LEA/year	Cost (Euro)/publication	Cost (Euro)/IF unit
2015	50	20.721	170000	3400	8205
2014	51	23.84	185000	3627	7760
2013	55	19.826	165 000	3000	8322
2012	43	11.6355	155 000	3605	13321
2011	55	27.0247	160 000	2909	5921
2010	32	12.628	125 000	3906	9899
2009	46	21.498	145 000	3152	6745

Mean budget of projects per year  $\approx$  100 000 Euro; Mean budget per grant per year  $\approx$  5000 Euro

#### 2.2.2.4 French/English ratio according to the types of publications

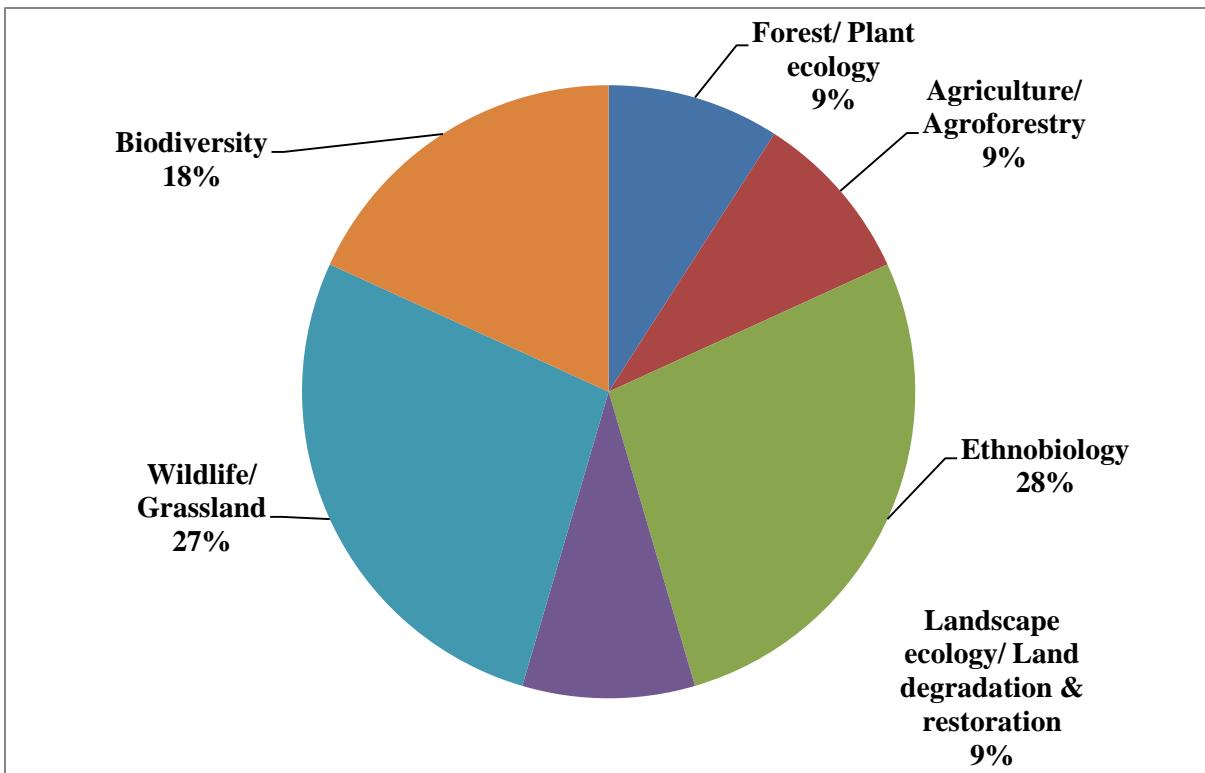
At one side, PhD thesis and many articles in peer journals with impact factor were only written in English. At the other side, master thesis, agro engineer thesis, bachelor and articles published in peer journals without impact factor were written part in French and part in English (Figure 15).



**Figure 15:** French/English ratio for various types of publications in LEA in 2015

#### 2.2.2.6: Abstracts: number of publications and indexes of specialization

A total of 11 abstracts were published in books of abstracts of scientific conferences in 2015. These abstracts were linked to various disciplines (figure 16). Ethnobiology (28%), Wildlife and Grassland (27%), Biodiversity (18%) showed the highest index of publications. Full references of these abstracts are provided in appendix 13.

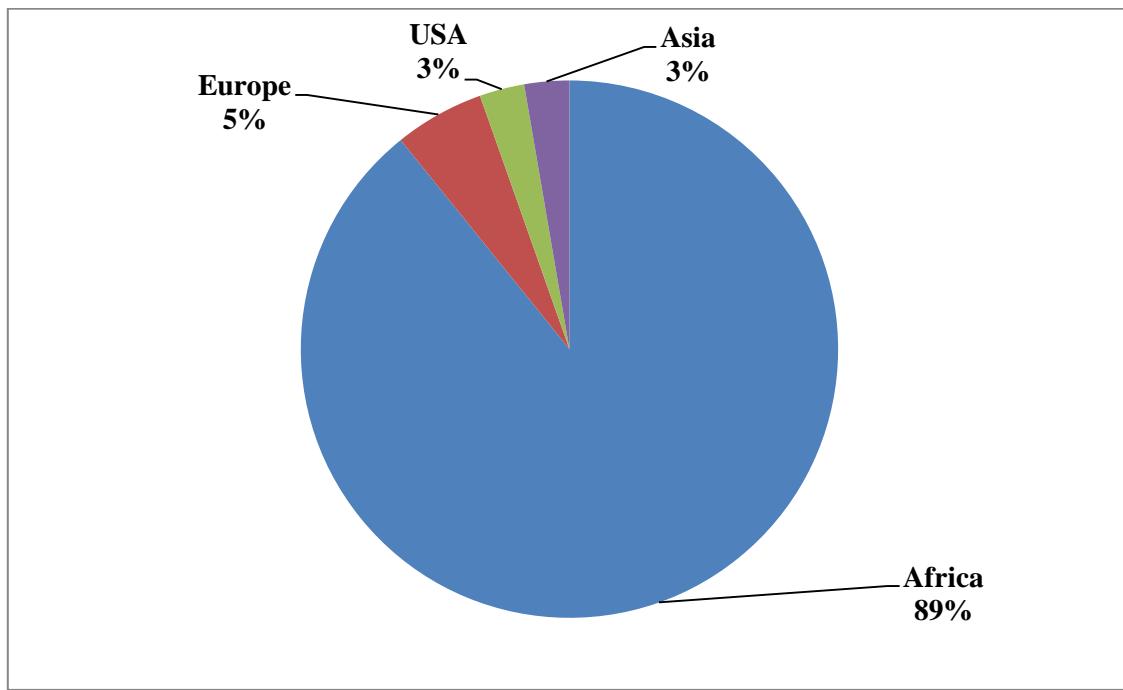


**Figure 16:** Indices of publications specialization in books of abstracts in 2015

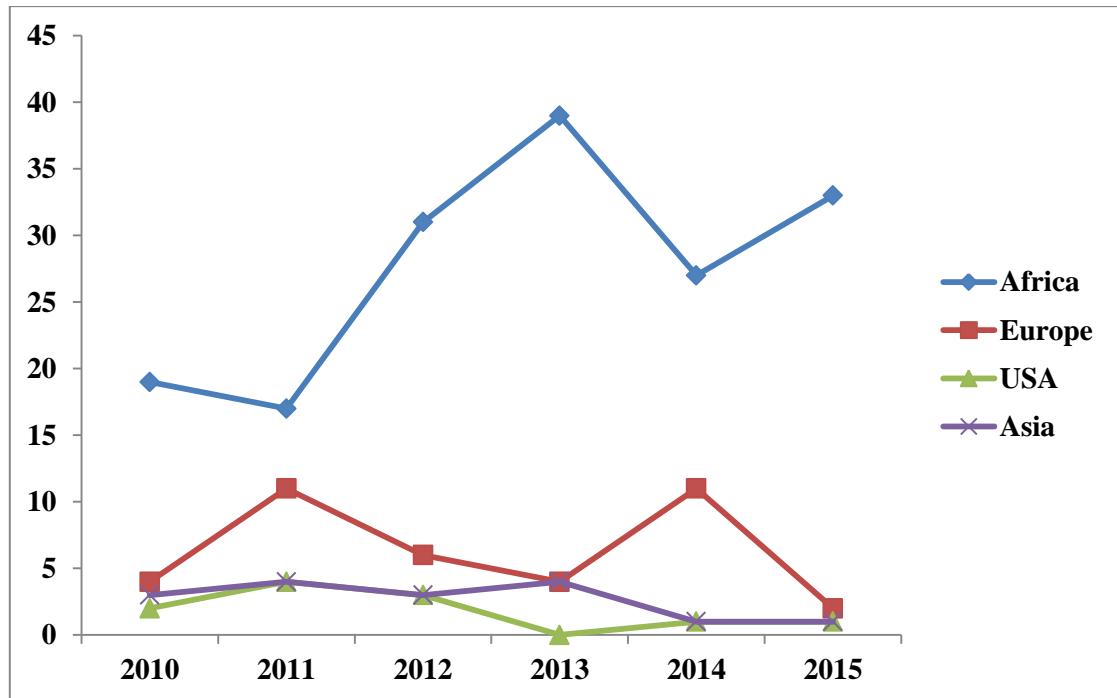
### 3. Conferences and seminars from 2010 to 2015

The participation of researchers at LEA to conferences and seminars has increased from 2010 to 2015 (figure 18) with the highest peak in 2013. The researchers at LEA have participated more to conferences and seminars in Africa than in the others continents. In 2015, researchers at LEA have participated to 37 conferences. About 89% of these conferences were held in Africa, 5% in Europe, 3% in Asia, and 3% in USA (Figure 17). Details related to these conferences/workshops are listed in appendix 15. Most of the conferences and seminars at which the researchers at LEA have participated were financially supported (table 4). The LEA has started internal seminars focusing on scientific information since 2012. Six communications were developed in 2015 during the seminars. These seminars mainly addressed themes related to "Persuasion, negotiation and arbitration" developed by Prof Mike Erdman (Penn State University, USA), "Diversity of the serpent fauna in Central Africa: from field surveys to integrative systematics" developed by Dr Zoltan Tamas Nagy (Researcher - Herpetology and Evolution), "Le plagiat et l'autoplagiat dans les écrits scientifiques" developed by Dr Ir. Guy Apollinaire Mensah; "Organic Agriculture and Food Security in Subsaharian Africa: Assets, Challenges and Perspectives" developed by Professor Aiyeleagbe O. O. Isaac (Pomologist, Federal University of Agriculture of Abeokuta, Nigeria); "African amphibians – fascinating adaptations from rainforest to savanna" developed by PD Dr. Mark-Oliver Rödel (Curator of herpetology at the Natural History Museum in Berlin, and chairman of the IUCN Specialist Group for West and Central African amphibians); "modélisation des

systèmes biologiques dynamiques: vue générale et quelques applications sommaires" developed by M. Wilfried Bonou (PhD candidate in Biometry at Université of Liège, Belgium).



**Figure 17:** Level of participation of LEA's researchers to international conferences in 2015



**Figure 18:** Trends of participation of LEA's researchers to international conferences from 2010 to 2015

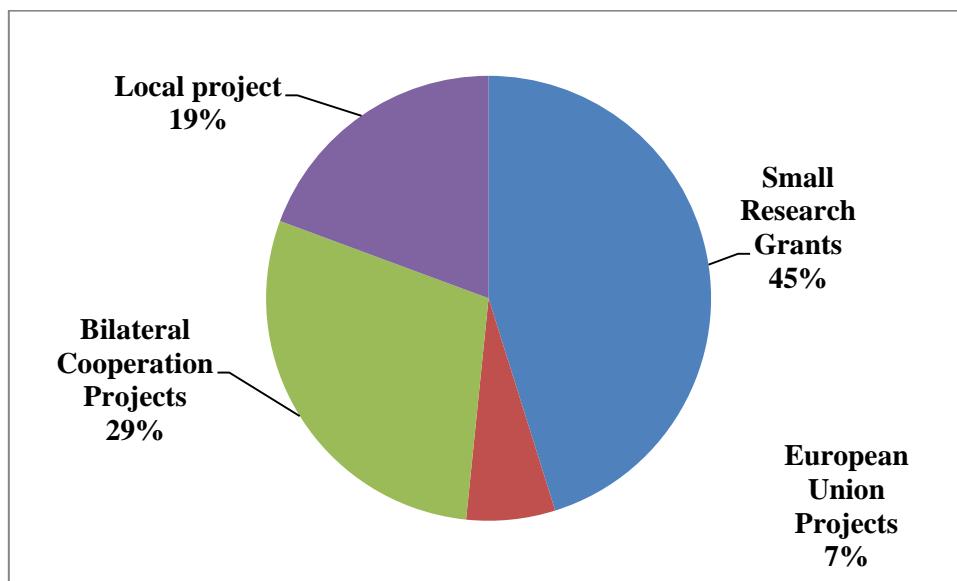
**Table 3:** Cost\* of participation to conferences and seminars from 2010 to 2015

Year	Africa	Europe	USA	Asia	Total	Financial support	Contribution of LEA/UAC
2010	19000	10000	5000	7500	41500	35165	6333
2011	17000	27500	10000	10000	64500	58833	5667
2012	31000	15000	7500	7500	61000	50667	10333
2013	39000	10000	0	10000	59000	46000	13000
2014	27000	27500	2500	2500	59500	50500	9000
2015	33000	5000	2500	2500	43000	32250	10750

\*Cost per conference: Africa ≈ 1000 Euro; International (Europe, USA, Asia) ≈ 2500 Euro

#### 4. Research projects, research grants and prize at the LEA in 2015

The research activities undertaken by LEA were mainly funded by international foundations and institutions (Rufford Small Grants, International Foundation for Science, Elan Postdoctoral research, Organization for Women in Science for the Developing World, and Georg Foster Research Fellowship: 45%), regional and international co-operation projects (IRD, CORAF-USAID, SASACID\_ANAFE, Biovision Africa\_Kenya and Switzerland (SDC), Institut Royal des Sciences Naturelles de Belgique, RUFORUM, and African Union: 29 %), local institution in Benin (University of Abomey Calavi and INRAB: 19%), European Union (UNDESERT, Global Climate Change Alliance: 7%), (Figure 19). Most of the PhD as well as senior scientists at LEA are involved in these projects for their research activities. Details (objectives, beneficiaries, etc.) on these projects and grants are described in appendixes 16 and 17. Moreover, 11 international recognitions have been awarded to the researchers from LEA in 2015 (appendix 18).

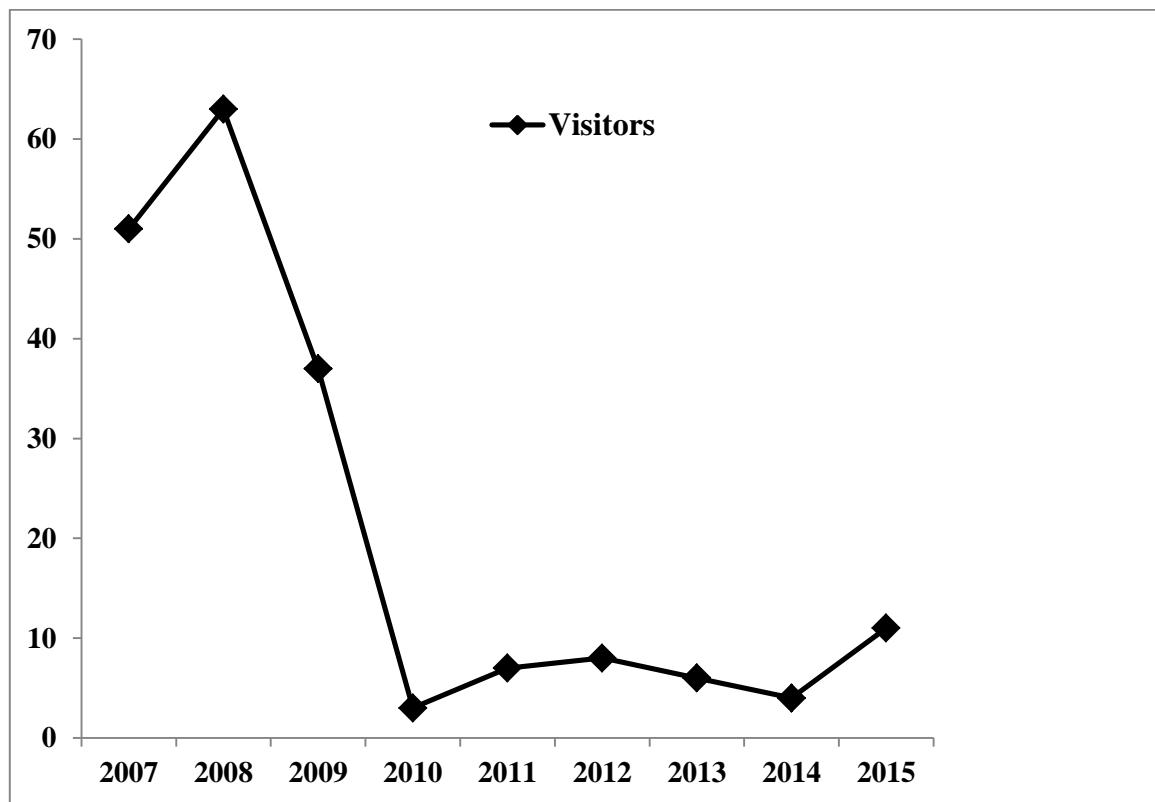


**Figure 19:** Spectrum of research funding in 2015

## 5. Human resources and visiting research in the LEA in 2015

Human resources in LEA during 2015 are about 30 main investigators and senior scientists, 32 PhD students, actively participating to research activities within the laboratory. Moreover, 5 technicians and 3 drivers are used on permanent basis for the fieldworks. Specifically, LEA houses 5 Full Professors (Professeur Titulaire Conseil Africain et Malgache pour l'Enseignement Supérieur CAMES), 20 associate Professors (Maître-Conférences/CAMES), several assistant Professors (Maître-Assistant/CAMES), assistant (PhD) and junior researchers (MSc and BSc students). Details about these human resources are shown on the web site of LEA ([www.leabenin-fsauac.net](http://www.leabenin-fsauac.net)).

Furthermore, in the course of the year 2015, LEA has welcomed 11 researchers as visitors vs. 69 in 2009, 63 in 2008 and 51 in 2007, (Figure 20). The visitors welcomed in the previous years (2007, 2008 and 2009) were mainly students through NGOs while since 2010 the visitors welcomed were Professors through collaboration or project.



**Figure 20:** Trends of visiting researchers welcomed at the LEA from 2007 to 2015

## **6. General discussion and conclusion**

Various types of publications were produced by LEA's researchers in 2015 as it was the case in previous years. It is important to notice that the total number of published papers in peer review journal in 2015 is similar to the published papers in 2014 and 2013. The global trend of published papers in peer review journal in LEA had increased since 1998. This can be explained by the increase of researchers, research projects and grants holding a PhD, PhD students and MSc students since 2006. Indeed, with more projects and grants, more papers are published with lower cost per publication and impact factor unit. The number of published articles in journals with Impact Factor has considerably increased since 2008. This means that researchers are improving their publication skills and the quality of their investigations. Another driver for this is the change in the requirements before defending a PhD thesis at the Faculty of Agronomic Sciences which hosts LEA (having at least two published original research papers). In the other hand, requirements for upgrading academics grades within the CAMES system (*Conseil Africain et Malgache pour l'Enseignement Supérieur*) is another important driver for increasing high quality papers within LEA. As such, the scientific capacity of LEA research teams is increasing. Published articles in 2015 were mostly produced in team at African level (64 % mainly Beninese). Published article in peer journal with impact factor were mostly co-written with international colleagues while published articles in peer journal without impact factor were more likely written by teams at national level. A reason for that could be the requirements for writing in English for original papers to be submitted in most impact factor journals. Field research such as Wildlife and Grassland, Ethnobiology, Forest and Plant ecology, Agriculture and Agroforestry were the most to contribute to original research papers in LEA. This trend is expected to remain the same in 2016.

Publications which have highly contributed to gain the Impact Factor of the laboratory in 2015 were related to Forest/Plant ecology, Landscape ecology/Land degradation & restoration, Ethnobiology, Wildlife/grassland and Agriculture/Agroforestry. These disciplines are then the most important in terms of scientific impact of LEA in 2015.

To date, almost no scientific works was done with the scientists from Latino America, Australia, Middle East China and even Northern Africa. This suggests the need of more and sustainable efforts for building cooperative research networks basically using interactive research topics and funds from these parts of the world. Moreover, since 2007, few scientific papers have been published with scientists at a regional level (West Africa). In 2015, 64% of the articles have been co-published within national team while 28% have been co-published with European and 2% with American scientists. As such, regional scientific collaborations should be developed for the following years since Benin shares with its neighboring countries similar research problems which need regional solutions and then should be solved regionally through research activities involving laboratories in the region.

Based on the findings from the present report, it is suggested that LEA:

- (1) helps for capacity building among its research teams in order to be able to publish more scientific papers in peer review journals having a high IF;
- (2) develop more research collaboration at regional level;

- (3) develop curricula in the fields of applied ecology for regional training purposes;
- (4) continue monitoring biodiversity at continental level;
- (6) develop conservation and domestication strategies for some edible and medicinal forest and savannah resources;
- (7) develop guidelines for fieldwork in applied ecology for para ecologists;
- (8) monitor threatened and endangered plants and animals species at regional level.

## **7. References**

- <http://scientific.thomson.com/products/wos/>
- [www.leabenenin-fsauac.net](http://www.leabenenin-fsauac.net)
- [www.notesdecologie.bj.refer.org](http://www.notesdecologie.bj.refer.org)
- [www.fsa.bj.refer.org](http://www.fsa.bj.refer.org)

Publications in LEA in 2014-2015 (cf. appendices)

Proceedings in LEA in 2014-2015 (cf. appendices)

Theses in LEA in 2015 (cf. appendices: PhD, MSc and agronomist degree).

Publication in UAC in 1998 – 2015.



## **8. APPENDIXES**

## 2015 SCIENTIFIC ACTIVITIES REPORT OF THE LABORATORY OF APPLIED ECOLOGY

*Appendix 1: Ongoing PhD thesis in LEA*

N°	Student full name	Number of year since the start of the PhD	Research topics	Fields of Research
1	ABDILLAHI Mohamed	2 <sup>nd</sup> year	Evaluation de l'efficacité thérapeutique des plantes dites anti-diabètes de la République de Djibouti	<i>Ethnobiology</i>
2	ADJASSE Martin	3 <sup>rd</sup> year	Les îlots de forêts sacrés et communautaires du centre Bénin : écosystèmes marginaux à protéger et conserver pour le maintien en équilibre de la biodiversité biologique	<i>Ecosystems Dynamic</i>
3	AGBANI Onodje Pierre	more than 5 <sup>th</sup> year	Etat de conservation et viabilité des populations de quelques espèces ligneuses soudanaises menacées du Bénin.	<i>Plant Ecology and Management</i>
4	AGBOMAHENAN Saturnin	4 <sup>th</sup> year	Erosion et Dynamique des états de surface dans la Basse vallée de l'Ouémé	<i>Ecosystems Restoration</i>
5	AGONYISSA Didier	more than 5 <sup>th</sup> year	Species diversity variation in sudanian <i>Isoberlinia doka</i> and <i>Isoberlinia tomentosa</i> woodland in relation to plot sizes and landuse pressure in Benin.	<i>Plant Ecology and Management</i>
6	AHOUDJI Myrèle	3 <sup>rd</sup> year	Grasslands ecosystem functioning: patterns of establishment of dominant plant species, grass tussock growth, ecology and fire impacts on grassland dynamics	<i>Grassland Ecology</i>
7	ÄITONDJI Akouavi Léa	3 <sup>rd</sup> year	Evaluation des impacts écologique, socio-économique et paysager des carrières non sableuses au Bénin	<i>Desertification and Land Degradation</i>
8	AVAKOUDJO Julien	more than 5 <sup>th</sup> year	Donga valuation: Processes, Management and valorized Opportunities in Karimama District (Northern Benin)	<i>Desertification and Land Degradation</i>
9	AZIZOU El-Hadj Issa	more than 5 <sup>th</sup> year	Facteurs déterminants de cogestion pour la conservation des ressources naturelles de la réserve de biosphère transfrontalière du W/Bénin.	<i>Wildlife /Protected areas Management</i>
10	BIO Anselme	3 <sup>rd</sup> year	Ethnobotanique, distribution spatiale et écologie des plantes entrant dans le traitement de l'hypertension artérielle au Bénin	<i>Agroforestry/NTFPs</i>
11	EDON Aderomou Tinuadé Solange	more than 5 <sup>th</sup> year	Baobab regeneration in Benin	<i>Forest/Plant Ecology and Management</i>
12	GBAÏ N. Innocent	4 <sup>th</sup> year	Impact des systèmes d'exploitation des ressources naturelles sur les écosystèmes dans le Bassin de la Beffa	<i>Ecosystems restoration</i>
13	GOUSSANOU A. Cedric	3 <sup>rd</sup> year	Estimation, fluxes and monitoring of changes in carbon stock of tropical forest ecosystems: Case study of dense semi-deciduous moist forests in Benin	<i>Forest and Climate change</i>
14	HAMADOU Moussa	1 <sup>st</sup> year	Stratégies d'adaptations aux changements climatiques : Valorisation des potentialités fourragères d'écotypes de mil ( <i>Pennisetum. glaucum</i> (L) R. Br) cultivés au Niger pour l'élevage sédentarisé d'ovins de race locale.	Agrostologie et Systèmes d'élevage

N°	Student full name	Number of year since the start of the PhD	Research topics	Fields of Research
15	HEDJI Carine Christiane	3 <sup>rd</sup> year	Valorisation d'aliment à base de <i>Azolla</i> Spp, de feuilles de <i>Moringa oleifera</i> , de son agro-alimentaire	<i>Nutrition</i> <i>agro-alimentaire</i>
16	HOUNDANTODE Justin	more than 5 <sup>th</sup> year	Problématique de gestion et valorisation des eaux usées du Bénin en cultures maraîchères : cas de l'amarante dans la commune de Sème Kpodji.	<i>Horticulture</i>
17	KOMBIENOU Pocoum Damé	5 <sup>th</sup> year	Impacts des systèmes agricoles et de l'occupation des terres en zone montagneuse de la chaîne de l'Atacora au Nord-Ouest du Bénin	<i>Agroforestry/NTFPs</i>
18	OKOU Farris Aurlus Yissegnon	4 <sup>th</sup> year	The Atacora mountain under the drivers of land use and their impacts on species establishment	<i>Desertification and Land Degradation</i>
19	TCHIBOZO Vital	2 <sup>nd</sup> year	Evaluation of zooeconomics performances of pigs and rabbits feed with different foodstuffs based on maize and corn bran varieties in Benin	<i>Animal Nutrition and Feeding</i>
20	SARE Baké Adissatou	5 <sup>th</sup> year	Climatic variability and dynamic of agroforesterie parks in the W Transboundary of biosphere reserve in Benin.	<i>Agroforestry/NTFPs</i>
21	SEWADE Clément	3 <sup>rd</sup> year	Gestion rationnelle des lieux fourrager dans les terres de parcours pour la conservation de la biodiversité au Bénin	<i>Grassland Ecology</i>
22	SINASSON Sanni Kouampamba Gisèle	4 <sup>th</sup> year	Distribution, structure and dynamics of <i>Mimusops andongensis</i> Hiern in Benin	<i>Forest/Plant Ecology and Management</i>
23	SINSSIN C. A. Franck	more than 5 <sup>th</sup> year	Tree Ring Analysis; Population Structure and Sustainable Forest Management: Investigation of Selected Tropical Tree Species in Three Phytogeographical Regions of Benin.	<i>Plant Ecology and Management</i>
24	TODAN Appolinaire	3 <sup>th</sup> year	Implications des mutations agraires et socio-démographiques sur la gestion des ressources ligneuses sur le plateau adja au Bénin	<i>Agrarian changes, Ecosystems dynamics</i>
25	TOUDONOU A. S. Christian	more than 5 <sup>th</sup> year	Utilisation and conservation of snakes: case study from ball python ( <i>Python regius</i> ) in Benin.	<i>Wildlife / Protected areas Management</i>
26	ZAKARI Soufouyane	4 <sup>th</sup> year	Vulnérabilité des parcours de transhumance aux changements climatiques dans le bassin versant de la Sota (Bénin)	<i>Grasslands Dynamics and Vulnerability</i>

*Appendix 2: Completed bachelor degree in 2015*

N°	Student full name	Research topics	Fields of Research
1	ADJE Floentia K. Eléonore	Analyse de l'efficacité du contrat de prestation de service entre les transporteurs privés et l'ONASA pour l'approvisionnement en produits vivriers	<i>Agriculture/Agroforestry</i>
2	ATCHOU-AHINON Eric	Production de cultures maraîchères intégrées à l'élevage de poules pondeuses à Glo-Djigbé, Commune d'Abomey-Calavi	<i>Agriculture/Agroforestry</i>
3	DAH-GOUNON Marc Sémani	Production et Commercialisation de poissons tilapias dans la Commune de Ouidah	<i>Agriculture/Agroforestry</i>

N°	Student full name	Research topics	Fields of Research
4	DINA Abdou Gafari	Création d'une unité de polyculture vivrière de maïs, de niébé et de manioc dans la commune de Kétou	Agriculture/Agroforestry
5	FAGBEMI M.A.A. Sayindath Pobé	Création d'une entreprise de production d'huile de palme et ses dérivés dans la commune de Kétou	Agriculture/Agroforestry
6	KOUAKANOU Sèna Hermine	Analyse de la gestion des ressources humaines des exploitations agricoles au sud-Bénin : Cas de la ferme Bénin Poisson Grâce à Jésus, Commune d'Adjara	Agriculture/Agroforestry
7	OGOUDIKPE Augustin	Projet d'élevage de poules pondeuses intégré à la production de grande morelle à Illara-Kanga dans la commune de Kétou	Agriculture/Agroforestry
8	SEKLOKA Jean-Myriam Elysée L. W.	Analyse de l'organisation institutionnelle des Coopératives d'Aménagement rural du Bénin : cas de la Coopérative d'Aménagement Rural d'Agony (CAR-Agony)	Agriculture/Agroforestry
9	WINSOU Raoul	Création d'une unité de production d'anacarde ( <i>Anacardium occidentale</i> ), de maïs, de soja et de manioc intégrée à l'élevage d'aulacodes à Ossokodjo, Commune de Kétou	Agriculture/Agroforestry

*Appendix 3: Completed master or agronomist engineer degree in 2015*

N°	Student full name	Research topics	Fields of Research
1	AHOU ANDJINOU Ange Perpétue	Evaluation ethnobotanique de <i>Borassus aethiopum</i> Mart. (Arecaceae) dans la zone Soudano-Guinéenne au Bénin	Ethnobiology
2	AKAKPO Bokon Alexis	Evaluation écologique et socio-économique des systèmes agroforestiers le long du bassin versant de l'Ouémé : cas du versant de Bétécouou (Commune de Dassa-Zoumé)	Agriculture/Agroforestry
3	ASSOGBA Liliane P.	Modeling past, current and future potential habitats of the threatened Red-bellied monkey ( <i>Cercopithecus erythrogaster erythrogaster</i> ) in Dahomey-gap: Implications for conservation in climate change context	Wildlife
4	ASSOGBA DELÉKE Gnido Amandine	Etude des caractéristiques écophénotypiques, structurales et ethnobotaniques de <i>Bombax costatum</i> Pellegr. & Vuillet dans la Réserve de Biosphère de la Pendjari (RBP) au Bénin	Forest/Plant Ecology
5	ATINDEHOU Massogblé Marc Lucrèce	Distribution, évaluation socioéconomique et écologique de <i>Hyphaene thebaica</i> (L.) Mart. au Bénin	Forest/Plant Ecology
6	AZONGNITODE Hans Aurèle	Evaluation écologique et socio-économique des systèmes agroforestiers le long du bassin versant de l'Ouémé : cas du versant de Samiondji (Commune de Zagnanado au sud Bénin)	Agriculture/Agroforestry
7	BOURAIMA Raoudath A. O.	Distribution et évaluation ethnoécologique des espèces du genre <i>Raphia</i> au Bénin	Forest/Plant Ecology
8	DJONLONKOU Spéro Fréjus Bidossessi	Etude Ethnobotanique, Socio-économique et Modélisation de l'impact potentiel des changements climatiques sur la distribution des habitats favorables aux fruitiers sous-utilisés : Cas de <i>Synsepalum dulcificum</i> Daniell (Sapotaceae) au Sud-Bénin	Forest/Plant Ecology
9	HOUNDELO ATTINDEBAKOU Loetitia F. H.	Evaluation ethnobotanique et modélisation de l'impact potentiel des changements climatiques sur la distribution des aires favorables à <i>Synsepalum dulcificum</i> Schumach & Thonn ; Daniell (Sapotaceae) au Sud du Bénin	Forest/Plant Ecology
10	KAKORE Dama Lamatou	Problématique et effets de la transhumance sur les ressources naturelles et les relations sociales dans la commune de Gogonou au Bénin	Gestion des ressources naturelles Ecologie

N°	Student full name	Research topics	Fields of Research
11	KORA GADO Chakiratou	Evaluation écologique et socio-économique des systèmes agroforestiers le long du bassin versant de l'Ouémé : cas du versant de Bétérôu (Commune de Tchaourou)	Agriculture/Agroforestry
12	LOKONON Séraphin	Diversité et usages endogènes des espèces végétales dans le traitement du diabète: Cas des Phytodistricts Pobè et Plateau au Sud-Bénin	Ethnobiology
13	MENSAH Ezeckiel	Biological and agronomic responses of <i>Cynhopygon Schoenanthus L. Spreng.</i> , sudanian fodder grass species grown under compost and urea in southern Benin	Organic Agriculture/Agroforestry
14	NTIRANDEKURA Jean Bosco	Caractérisation morphométrique des noix et mode de reproduction des espèces de raphia ( <i>R. Hookeri</i> et <i>R. Soudanica</i> ) au Bénin	Forest/Plant Ecology
15	OUEDRAOGO Korotimi	Diversité et évaluation ethnobotanique des plantes utilisées dans le traitement du diabète par les populations riveraines de la forêt classée de Bérégaougou au Burkina Faso	Ethnobiology
16	OKOMA Michelle Pamela	Les aspects d'évaluation du statut écologique et ethnobotanique de deux espèces de <i>Garcinia : G. kola</i> et <i>G. afzelii</i> en Côte d'Ivoire.	Ethnobiology
17	SAWADOGO Mamounata	Diversité et évaluations ethnobotaniques des plantes utilisées dans le traitement du diabète par les populations riveraines du Parc National du W du Burkina Faso	Ethnobiology

*Appendix 4: Completed Master of Sciences degree in 2015*

N°	Student full name	Research topics	Fields of Research
1	ESAIÉ Waya	Facteurs écologiques et anthropogéniques déterminant la structure et la régénération du baobab ( <i>Adansonia digitata L.</i> ) dans la Réserve de Biosphère de la Pendjari au Bénin	Plant Ecology
2	HAIDARA Mohamed	Déterminants de l'évolution des fronts agricoles et leurs impacts sur les formations végétales dans la Forêt Classée de Nafadjî au Mali	Land use

*Appendix 5: Completed Doctorate thesis in 2015*

N°	Student full name	Diploma (Doctor, PhD, etc..)	Research topics	Institution/Specialisation
1	NAGO Sédiyo Gilles Armel	PhD	Savannah amphibians along a disturbance gradient	University of Abomey Calavi / FSA / Wildlife ecology
2	KOURA Tatiana	PhD	Sustainable uses of palm oil mills wastes and organic vegetables production through composting in southern Benin republic, west Africa and Horticulture	University of Abomey Calavi / Biological Agriculture
3	KOURA Bossima Ivan	PhD	Improvement of livestock productivity through the promotion of products and by-products of soybean, peanut and corn from integrated production systems	University of Abomey-Calavi/ Grassland Ecology
4	KPERA Gnanki Nathalie	PhD	Understanding complexity in managing agro-pastoral dams ecosystem services in Northern Benin	The graduate school of the Wageningen Institute of Animal Sciences (WIAS) and the Wageningen School of Social Sciences (WASS)
5	PADONOU Elie Antoine	PhD	Knowing bowalization, its impact on biodiversity, soil and human livelihoods in Benin (West Africa)	University of Abomey Calavi / Desertification and land degradation

**Appendix 6: Articles published in peer-review journal with Impact Factor (IF) in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Agriculture/Agroforestry	1	Akpona TJD, Akpoma HA, Djossa BA, Savi MK, Dainou K, Aiyhouenou B, Glele Kakai R	Impact of land use practices on traits and production of shea butter tree ( <i>Vitellaria paradoxa</i> C.F. Gaertn.) in Pendjari Biosphere Reserve in Benin.	<i>Agroforestry Systems</i> 89(5): 1-9.	1.215
Agriculture /Agroforestry	2	Koura TW, Dagbénonbakin G.D, Kindomihou V, Sinsin B	Farmers' background and diversity of uses of Palm oil Wastes for sustainable agriculture in Southern Benin Republic.	<i>Biological Agriculture and Horticulture Journal</i> 31(1): 35-44 http://dx.doi.org/10.1080/01448765.2014.964316 (2015)	0.581
Agriculture /Agroforestry	3	Koura T, Kindomihou V, Dagbénonbakin D, Janssens M, Sinsin B	Quantitative assessment of palm oil wastes generated by mills in Southern Benin	<i>African Journal of Agricultural Research</i> 0.546	
Ethnobiology	4	Boedeker J, Termote C, Assogbadjo AE, Van Damme P, Lachat C	Dietary contribution of Wild Edible Plants to women's diets in the buffer zone around the Lama forest, Benin – an underutilized potential	<i>Food Security</i> 6(6): 833-849.	1.495
Ethnobiology	5	Gbedomon RC, Fandohan AB, Salako VK, Idohou AFR, Glele Kakai R, Assogbadjo AE	Factors affecting home gardens ownership, diversity and structure: a case study from Benin.	<i>Journal of Ethnobiology and Ethnomedicine</i> 11:56 DOI 10.1186/s13002-015-0041-3.	2.00
Ethnobiology	6	Yaoitcha AS, Houehanou TD, Fandohan AB, Houinato MRB	Prioritization of useful medicinal tree species for conservation in Wari-Maro Forest Reserve in Benin: A multivariate analysis approach.	<i>Forest Policy and Economics</i> 61: 135–146	1.856
Forest/Plant Ecology	7	Gbedomon RC, Floquet A, Mongbo R, Salako KV, Fandohan AB, Assogbadjo AE, Glele Kakai R	Socio-economic and ecological outcomes of community based forest management: A case study from Tobé-Kpobidon forest in Benin, Western Africa	<i>Forest Policy and Economics</i> 64: 46-55.	1.856
Forest/Plant Ecology	8	Idohou R, Assogbadjo AE, Houéhanou T, Glele Kakai R, Agbangla C	Variation in <i>Hyphaene thebaica</i> Mart. Fruit: physical characteristics and factors affecting seed germination and seedling growth in Benin (West Africa)	<i>The Journal of Horticultural Science and Biotechnology</i> 90(3): 291-296	0.54
Forest/Plant Ecology	9	Salako VK, Assogbadjo AE, Adomou AC, Agbangla C, Glele Kakai RL	Latitudinal distribution, co-occurring tree species and structural diversity of the threatened palm <i>Borassus aethiopum</i> (Arecaceae) in Benin, West Africa	<i>Plant Ecology and Evolution</i> : 148(3), 335-349.	0.986
Forest/Plant Ecology	10	Salako V, Azihou A, Kassa B, Houehanou T, Assogbadjo A, Glele kakai R	Elephant-induced damage drives spatial isolation of the dioecious palm <i>Borassus aethiopum</i> Mart. (Arecaceae) in the Pendjari National Park, Benin	<i>African Journal of Ecology</i>	0.82
Landscape Ecology/Land Degradation & Restoration	11	Padonou EA, Bachmann Y, Glele Kakai R, Lykke AM, Sinsin B.	Spatial distribution of bowel and differences in physicochemical characteristics between bowel and woodland soils in West Africa (Benin)	<i>Catena</i> 124: 45-52	2.820
Landscape Ecology/Land Degradation & Restoration	12	Padonou EA, Teka O, Bachmann Y, Schmidt M, Lykke AM, Sinsin B	Using species distribution models to select species resistant to climate change for ecological restoration of bowé in West Africa	<i>African Journal of Ecology</i> : 1-10.	0.824
Risk assessment /Climate change	13	Fandohan AB, Oduor AMO, Sode A I, Wu L, Cuni-Sánchez A, Assede E, Gouwakinnou GN	Modeling vulnerability of protected areas to invasion by <i>Chromolaena odorata</i> under current and future climates	<i>Ecosystem Health and Sustainability</i> 1(6): 1-12.	1.041

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Wildlife/Grassland	14	Akpouna HA, Djagoun CAMS, Harrington LA, Mensah GA, Kabré AT, Sinsin B	Conflict between spotted-necked otters and fishermen in Hlan River, Benin	<i>Journal for Nature Conservation</i> 27: 63–71	1.046
Wildlife/Grassland	15	Musco N, Koura BI, Tudisco R, Awadjihé G, Adjolohoun S, Cutrignelli MI, Mollica MP, Houinato M, Infascelli F, Calabro S	Nutritional Characteristics of Forage Grown in South of Benin	<i>Asian-Australasian journal of animal sciences</i> 29(1): 51	0.541
Wildlife/Grassland	16	Kindomihou V, Sinsin B, Holou RYA, Ambouta J-M K, Gruber W, Adjolohoun S, Houinato M, Herbauds J, Lejoly J, Meerts P	The effect of seasonal variations, covariations with minerals and forage value on Itchgrass' foliar silicification from Sudanian Benin.	<i>Silicon DOI</i> 10.1007/s12633-015-9355-y	1.069

**Appendix 7: Articles published in peer-review journal without IF in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture /Agroforestry	1	Agoyi E.E., Assogbadjo A.E., Padonou E.A., Glèè Kakai R., Sinsin B.	Morphological variation, cultivation techniques and management practices of <i>Moringa oleifera</i> in southern Benin (West Africa)	<i>International Journal of Agronomy and Agricultural Research</i> 6: 97-105.
Agriculture /Agroforestry	2	Dagga RA, Missithoun AA., Adoukonou-C, Sagbadja H, Savi MK., Ahanhanzo C, Agbanga C	Agromorphological variability of Pearl Millet ( <i>Pennisetum glaucum</i> (L.) R. Br.) cultivars grown in Benin.	<i>Journal of Experimental Biology and Agricultural Sciences</i> 3(5): 394:406
Agriculture /Agroforestry	3	Dedehouanou H, Kpanou BV, Koura BI, Bakary S, Houndonougbo F, Houngnandam P	Performance des Systèmes Intégrant Agriculture et Elevage (SIAE) endogènes au Bénin	<i>Bulletin de la Recherche Agronomique du Bénin</i> (BRAB), Numéro spécial Economie et Sociologie Rurales
Agriculture /Agroforestry	4	Hedji CC, Houinato M, Houndonougbo F, Fiogbé ED,	Assainissement de l'environnement par la valorisation des ressources non conventionnelles en alimentation de porcs en croissance	<i>International Journal of Biological and Chemical Science</i> 9(4): 1929-1936
Agriculture /Agroforestry	5	Hedji CH, Houndonougbo MF, Tougan PU, Houinato MRB, Fiogbé ED	Technological, sensorial and nutritional meat quality traits from pig fed with conventional and unconventional diets	<i>Food and Nutrition Sciences</i> 6: 1514-1521
Agriculture /Agroforestry	6	Koura BI, Dedehouanou H, Dossa HL, Kpanou B, V, Houndonougbo F, Houngnandam P, Mensah GA, Houinato M	Determinants of crop-livestock integration by small farmers in three agro-ecological regions of Benin	<i>International Journal of Biological and Chemical Sciences</i>
Agriculture /Agroforestry	7	Koura BI, Dedehouanou H, Visssoh P, Houndonougbo F, Houinato M	Improving small-scale farmers' endogenous crop-livestock practices in rural, peri-urban, and urban areas of Benin	<i>Journal of Animal &amp; Plant Sciences</i>
Agriculture /Agroforestry	8	Koura T, Dagbénoubakin D, Kindomihou V, Sinsin B	Effect of co composting of palm oil mill wastes and cow dung or poultry manure on <i>Amaranthus hybridus</i> growth and yield	<i>Journal of Applied Biosciences</i> 86: 7918-7927
Agriculture /Agroforestry	9	Koura T, Dagbénoubakin D, Kindomihou V, Sinsin B	Effect of composting of palm oil mill wastes and organic manure on tomato ( <i>Lycopersicon esculentum</i> Mill.) growth and yield	<i>Journal of Organic Agriculture and Environment</i> 3: 56 – 64
Agriculture /Agroforestry	10	Padonou EA, Ahossou,OD, Okou FOY, Assogbadjo AE, Glèè Kakai R, Lykke AM, Sinsin B	Impact of climate on seed morphology and plant growth of <i>Caesalpinia bonduc</i> L. in West Africa	<i>International Journal of Agronomy and Agricultural Research</i> . 6: 86-96.

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture /Agroforestry	11	Padonou EA, Assogbadjo AE, Glele Kakai R, Lykke AM, Sinsin B, Axelsen J	Investigations of on farm seedling productivity of the rare and declining <i>Caesalpinia bonduc</i> in Benin (West Africa) by aid of simulation modelling	<i>International Journal of Agronomy and Agricultural Research</i> 6: 116-131.
Ethnobiology	12	Bio A, Yoka J, Toyi MS, Djego GI, Sinsin B	Contribution à la connaissance des principales plantes antihypertensives utilisées en médecine traditionnelle au Bénin (Afrique de l'Ouest)	<i>Annales des Sciences Agronomiques</i>
Ethnobiology	13	Honfo H, Tovissodé CF, Gnanglé C, Mensah S, Salako VK, Assogbadjo AE, Agbangla C, Glèè Kakai R	Traditional Knowledge and Use Value of Bamboo in Southeastern Benin: Implications for sustainable management	<i>Ethnobotany Research &amp; Applications</i> 14:139-153
Ethnobiology	14	Houédjissin SS, Azokpota P, Assogbadjo A, Ahanhanzo C, Houhouigan JD	Traditional Classification, Perception, and Preferences for Tallow Tree ( <i>Pentadesma butyracea</i> Sabine) Organs in Benin: Implications for domestication and conservation	<i>Ethnobotany Research &amp; Applications</i> 14 (0): 491-503.
Ethnobiology	15	Idohou R, Ariño AH, Assogbadjo AE, Glele Kakai R, Sinsin B	Knowledge of diversity of wild palms (areceaceae) in the Republic of Benin: finding gaps in the national inventory by combining field and digital accessible knowledge	<i>Biodiversity Informatics:</i>
Ethnobiology	16	Laleye FOA, Mensah S, Assogbadjo AE, Ahissou H	Diversity, Knowledge, and Use of Plants in Traditional Treatment of Diabetes in the Republic of Benin	<i>Ethnobotany Research &amp; Applications</i> 14 (0): 231-257.
Ethnobiology	17	Yaoitcha AS, Houehanou TD, Dan BSC, Adoukpe JG, Arbonnier M, Houinato M	Medicinal tree species in Benin (West Africa). Literature review and perspective researches	<i>Annales des sciences Agronomiques</i> 19 (2-Special): 089-106
Forest/Plant Ecology	18	Fandohan AB, Gouwakinnou NG, Deleke Koko KIE, Glele Kakai R, Assogbadjo AE	Domesticating and conserving indigenous trees species: an ecosystem Based approach for adaptation to climate change in sub-Saharan Africa.	<i>Revue CAMES</i> 03(01):55-60.
Forest/Plant Ecology	19	Fandohan B, Dééké Koko IYE, Avocèvou-Ayiso C, Gouwakinnou GN, Savi MK, Assogbadjo AE, Glèè Kakai R	<i>Lantana camara</i> (Verbenaceae): A potential threat to the effectiveness of protected areas to conserve flora and fauna in Benin.	<i>Agronomie Africaine</i> 27 (2): 115 - 126
Landscape Ecology/Land Degradation & Restoration	20	Avakoudjo J, Mama A, Toko I, Kindomihou V, Sinsin B	Etude de la dynamique de l'occupation du sol et des facteurs de dégradation du couvert végétal dans la commune de Karimama	<i>International Journal of Biological and Chemical Sciences</i> 8 (6): 2608-2625
Landscape Ecology/Land Degradation & Restoration	21	Sambiéni KR, Toyi MS, Mama A	Perception paysanne sur la fragmentation du paysage de la Forêt classée de l'Ouémé Supérieur au nord du Bénin.	<i>VeritO – la revue électronique en sciences de l'environnement</i>
Risk Assessment /Climate change	22	Ahoudji MC, Houinato MRB, Axelsen J, Sinsin AB	Climatic variability and spatial distribution of herbaceous fodders in the Sudanian zone of Benin (West Africa).	<i>International Journal of Engineering Research and Applications</i>
Risk assessment /Climate change	23	Avaloudjo J, Kouélo AF, Kindomihou V, Ambouta K, Sinsin B	Effet de l'érosion hydrique sur les caractéristiques physico-chimiques du sol des zones d'érosion (Dongas) dans la Commune de Karimama au Bénin	<i>Agronomie Africaine</i> 27 (2) : 127-143
Risk assessment /Climate change	24	Saliou ARA, Oumorou M, Sinsin BA	Modélisation des niches écologiques des ligneux fourragers en condition de variabilité bioclimatique dans le moyen-Bénin (Afrique de l'Ouest)	<i>Revue d'Ecologie (Terre et Vie), Vol. 70 (4), 2015 : 342-353</i>

Disciplines	N°	Authors' Names	Title of the article	Journals
Risk assessment /Climate change	25	Saliou ARA, Oumorou M, Sinsin BA	Variabilités bioclimatiques et distribution spatiale des herbaées fourragères dans le Moyen-Bénin (Afrique de l'Ouest)	<i>Int. J. Biol. Chem. Sci.</i> 8(6): 2696-2708
Risk Assessment /Climate Change	26	Sare BA, Totin Vodounou SH, Houssou CS, Sinsin B	Variation of rainfall regime in the W Transboundary biosphere reserve(BENIN)	AIC AIChE Journal
Socio-economics	27	Houngbo NE.	Diversité et critères d'adoption des cultivars de maïs ( <i>Zea mays L.</i> ) dans le village Zounou, Centre Bénin,	<i>Journal of Applied Biosciences</i> 96 : 9094-9101.
Socio-economics	28	Houngbo NE	Approvisionnement et obstacles domestiques à la compétitivité de l'oignon ( <i>Allium cepa</i> ) au Bénin, taro ( <i>Colocasia esculenta</i> ) au sud-Bénin,	<i>International Journal of Biological and Chemical Sciences</i> 9 (5): 2414-2422.
Wildlife/Grassland	29	Houngbo NE, Abiola A, Adandonon A.	Contraintes liées au développement de la culture du Habiat Use by White-thighed Colobus in the Kikélé Sacred Forest: Activity Budget, Feeding Ecology and Selection of Sleeping Trees.	<i>International Journal of Neglected and Underutilized Species (IJNUS)</i> 1: 1-9.
Wildlife/Grassland	30	Djègo JG, Huynen MC, Sinsin B	Typologie, productivité, capacité de charge et valeur pastorale des pâturages des parcours transhumants au Nord Est de la République du Bénin	<i>International Journal of Innovation and Applied Science</i> 14(1):132-150
Wildlife/Grassland	31	Lesse P, Houinato M, Azihou F, Djenontin J, Sinsin B	Transhumance en République du Bénin: états des lieux et contraintes	<i>International Journal of Biology and Chemical Sciences</i> , 9(5): 2296-2708.
Wildlife/Grassland	32	Lesse P, Houinato MRB, Djenontin J, Dossa H, Yabi B, Toko I, Tente B, Sinsin B	Cartographie et gestion des principaux points d'abreuvement aménagés des troupeaux transhumants au Nord Est du Bénin	<i>Annales des Sciences Agronomiques</i> 1 (19) : 19-41
Wildlife/Grassland	33	Lesse P, Djenontin J, Yabi B, Toko I, Tente B, Houinato M		

**Appendix 8: Articles in press in peer-review journal with IF in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Agriculture /Agroforestry	1	Awohoudji DYG, Babatounde S, Zoffoum AG, Hounzangbe-Adote S, Houinato M, Alkoiert IT, Mensah GA	<i>In vivo digestibility of Boerhavia diffusa and Khaya senegalensis</i> in West African Dwarf sheep in the Sudano-Guinean zone in Benin.	<i>South African Journal of Animal Science</i>	0.504
Forest/Plant Ecology	2	Assédé ESP, Azihou FA, Adomou AC, Oumorou M, Sinsin B	Effet du relief sur la régénération des espèces ligneuses en zone soudanienne du Bénin	<i>Bois et Forêts des Tropiques</i>	0.192
Forest/Plant Ecology	3	Djossa B, Toni H, Adekambi I, Tognon F, Sinsin B	Do flying foxes limit flower abortion in African baobab ( <i>Adansonia digitata</i> )? Case study in Benin, West Africa	<i>Fruits</i> (70) 281-287	0.804
Wildlife/Grassland	4	Ahouadjji MC, Houinato MRB, Toyi MS, Houessou LG, Sinsin B	Effects of land cover change on rangeland vegetation in W Biosphere Reserve, Benin (West Africa).	<i>Journal of Research in Forestry, Wildlife and Environment</i>	0.066

**Appendix 9: Articles in press in peer-review journal without IF in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture /Agroforestry	1	Koura BI, Houndonougbo F, Houinato M	Effect of incorporation of cowpea and soybean pods in diets on feed intake, feed digestibility and growth performances of rabbit.	<i>Revue CAMES, Science de la Vie, de la Terre et Agronomie (SVT-A).</i>

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture /Agroforestry	2	Kpéra GN, Mensah GA, Arts N, Van Der Zijpp AJ	Water quality as an indicator of health status of the agro-pastoral dams ecosystem in Benin: an ecosystem services study	<i>Aquatic Ecosystem Health and Management</i>
Biometry	3	Glèlè Kakai R, Salako VK, Padonou EA, Lykke AM	Méthodes statistiques multivariées utilisées en écologie.	<i>Annales des Sciences Agronomiques</i> 19(1): 9-26.
Biometry	4	Mcghee W, Saigle W, Padonou EA, Lykke AM	Méthodes de calcul de la biomasse et du carbone des arbres en Afrique de l'Ouest	<i>Annales des Sciences Agronomiques</i> 19(1): 29-48.
Biometry	5	Strandberg B, Lykke AM, Padonou EA	Méthodes d'estimation objective du recouvrement de la Végétation et de la biomasse herbacées.	<i>Annales des Sciences Agronomiques</i> 19(1): 1-7.
Ethnobiology	6	Houeuanou DT, Assogbadjo AE, Chadare FJ, Zanvo S, Sinsin B	Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical	<i>Annales des sciences agronomiques</i>
Risk Assessment /Climate Change	7	Avakoudjo J, Akponikpè PBI, Latibi R, Kindomihou V, Sinsin B	<i>Dongas</i> formation and evolution in W National Park and its periphery in Northwestern Benin	<i>African Geoscience</i>

**Appendix 10: Articles under review in peer-review journal with IF in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals	Impact Factor
Agriculture /Agroforestry	1	Christensen SN, Barfod AS, Sambou B, Niang-Diop F, Diop M, Padonou EA, Lykke AM	Tree density, diversity and decline in Senegalese farmlands	<i>Agroforestry system</i>	1.215
Forest/Plant Ecology	2	Goussanou CA, Guendehou S, Assogbadjo AE, Kaire M, Sinsin B, Cuni-Sanchez A	Specific and generic stem biomass and volume models of tree species in a West African tropical semi-deciduous forest	<i>Silva Fennica</i>	1.500
Forest/Plant Ecology	3	Ahoudji MC, Houinato MRB, Azihou AF, Sinsin B	Change in plant communities' composition, diversity indicators and structure in the last decade: study case of hunting zone of Djona (Benin).	<i>IOSR Journal of Engineering</i>	1.645
Forest/Plant Ecology	4	Sinasson GKS, Shackleton CM, Glèlè Kakaï RL, Sinsin B	Impact of Forest Degradation and Invasive Species on the Population Structure of <i>Minurops andongensis</i> (Sapotaceae)	<i>Biotropica</i>	2.084
Landscape Ecology/Land degradation & restoration	5	Houessou LG, Padonou EA, Lykke AM, Kindomihou VM, Sinsin B	Land use impacts on the population structure of fodder trees in a semi-arid savanna in Benin (West Africa)	<i>Land use Policy</i>	2.631
Landscape Ecology/Land degradation & restoration	6	Padonou EA, Bachmann Y, Lykke AM, Sinsin B	Land use land cover change mapping and prediction of future extension of <i>boué</i> in West Africa (Benin)	<i>Land Use Policy</i>	2.631
Landscape Ecology/Land Degradation & Restoration	7	Toyi M, Andre M, Sikuzani YU, Bogaert J, Sinsin B	Trente-trois ans d'anthropisation des paysages de forêts dégradées au sud du Bénin (Afrique de l'Ouest)	<i>Bois et Forêts des Tropiques</i>	0.192
Wildlife/Grassland	8	Djagoun CAMS, Codron D, Sealy J, Mensah GA, Sinsin B	Stable isotope niche segregation and overlap amongst bovid species from a West African savanna	<i>Mammalian Biology</i>	1.301
Wildlife/Grassland	9	Koura BI, Calabro S, Dossa LH, Musco N, Cutrignelli IM, Houinato M	Nutritional value of crop residues commonly fed to animals in Benin	<i>South African Journal of Animal Science</i>	0.504

**Appendix 11: Articles under review in peer-review journal without IF in 2015**

Disciplines	N°	Authors' Names	Title of the article	Journals
Agriculture /Agroforestry	1	Toni H, Djossa BA	Economic value of pollination services on crops in Benin, West Africa	<i>International Journal of Biological and Chemical Sciences</i>
Ethnobiology	2	Atanasso JA, Padonou EA, Houehanou T, Chadare F, Kouara K, Assogbadjo AE, Sinsin B	Local perception on the habitat and uses of <i>Lippia multiflora</i> Moldenke in West Africa (Benin)	<i>International Journal of Agronomy and Agricultural Research.</i>
Ethnobiology	3	Madohonan D, Toni H, Djossa B, Chougourou D, Amahowe I	Evaluation des potentialités apicoles et des connaissances locales des acteurs dans la commune de Banikoara (Bénin). West Africa	<i>International Journal of Biological and Chemical Sciences</i>
Forest/Plant Ecology	4	Dossa K, Toni H, Azonanhoun P, Djossa B	Caractérisation de quelques peuplements naturels de Baobab ( <i>Adansonia digitata</i> L.) et des pressions subies dans les différentes zones chorologiques du Bénin	<i>Journal of Applied Biosciences</i>
Forest/Plant Ecology	5	Fantodji L, Padonou EA, Assogbadjo AE	Variation phénotypique des organes d' <i>Irvingia gabonensis</i> (Aubrey Lecomte) Baill dans le phylo-district Plateau au Bénin	<i>Annal des Sciences Agronomiques</i>
Forest/Plant Ecology	4	Inoussa MM, Padonou EA, Glèlè Kakai R, Lykke AM, Bakasso Y, Mahamane A, Saadou M	Structural and ecological indicators of <i>Pterocarpus erinaceus</i> and <i>Anogeissus leiocarpa</i> in woodland in the W National Park of Niger, West Africa	<i>Journal of Ecology and the Natural Environment</i>
Wildlife/Grassland	5	Djagoun CAMS, Akpona H, Gichohi N, Muruthi P	Elephant conservation in Benin National Parks: an assessment of human elephant conflict and building stakeholders capacity	<i>IUCN Park Journal</i>

**Appendix 12: Publications in proceedings in 2015**

Field of research	N°	Authors' Name	Title	Full References
Socioeconomics	1	Houngbo NE, Djihinto CA, Sinsin B	Proposition d'une typologie de stratégies adaptées pour la sauvegarde des espèces fauniques protégées à partir du cas du lamantin ( <i>Trichechus senegalensis</i> ) au Bénin West Africa	Actes de la XXI <sup>e</sup> Journées Scientifiques de l'ABePa : Le Pastoralisme et les Sciences Sociales, Université d'Abomey-Calavi, Faculté des Sciences Agronomiques, Laboratoire d'Ecologie Appliquée, Cotonou, Bénin, pp 113-133.

**Appendix 13: Abstracts in books of abstracts in 2015**

Field of research	N°	Authors' Name	Title	Full References
Agriculture /Agroforestry	1	Koura BI, Dedehouanou H, Dossa HL, Houndomougb F, Houinato M	Determinants of crop-livestock integration by small farmers in Benin.	Tropenitag 2015 - "Management of land use systems for enhanced food security – conflicts, controversies and resolutions" – from 16 to 18 September 2015 at Humboldt-Universität zu Berlin, Berlin in Germany, Book of Abstract, ISBN 978-3-7369-9092-0, 338-338.
Biodiversity	2	Assede EPS, Djagoun SMAC, Azihou FA, Koutou DM, Geldenhuys CJ, Sinsin B	Human activities and epiphytic orchid diversity in dry season in the Biosphere Reserve of Pendjari (Benin, West Africa)	
Biodiversity	3	Assede EPS, Gogan Y, Djagoun SMAC, Geldenhuys CJ	Orchid diversity and endogenous knowledge in the Biosphere Reserve of Pendjari (Benin, West Africa)	
Ethnobiology	4	Yaoitcha AS, Houéhanou TD, Zoffoun AG, Houinato MRB, Sinsin B	Perceptions locales de la disponibilité des espèces utilisées en relation avec leur évaluation écologique.	Actes des XXI <sup>e</sup> Journées Scientifiques de l'Association Béninoise de Pastoralisme (ABePa): Le Pastoralisme et les Sciences Sociales. 15 Novembre 2014. Université d'Abomey Calavi, FSA, LEA, Cotonou, Benin. Dépot légal N° 7958 du 19 juin 2015, 2 <sup>ème</sup> trimestre, Bibliothèque Nationale, Bénin, ISBN : 978 – 99919 – 0 – 555 – 6, pp 37-58.

Field of research	N°	Authors' Name	Title	Full References
Ethnobiology	5	Sinasson G, Sinsin B	Local knowledge, diversity and pattern of use of Mimusops species in Benin	Department of Environmental Sciences Annual Research Forum, 8 & 9 October 2015. Rhodes University, South Africa.
Ethnobiology	6	Sinasson G, Sinsin B	Ethnobotanical study of <i>Mimusops andongensis</i> Hiern in Benin (West Africa)	Proceedings of the Indigenous Plant Use Forum (IPUF) & Society for Economic Botany (SBE) Joint Conference on “Global Vision on Indigenous Plants and Economic Botany”. Clanwillian, Western Cape, South Africa, 28 <sup>th</sup> June-2 <sup>nd</sup> July 2015
Forest/Plant Ecology	7	Assédé EPS, Oumorou M, Sinsin B	Understanding natural stands of <i>Pseudocedrela kotschy</i> and <i>Terminalia macroura</i> in order to design planted stands in the sudanian zone	Knowing <i>bowlization</i> , its impact on biodiversity, soil and human livelihoods in West Africa. Book of abstracts of the 5th Workshop of Sciences, cultures and technologies (28.09-03.10. 2015), University of Abomey-Calavi, Benin
Landscape Ecology/Land Degradation and Restoration	8	Padonou EA	Knowing <i>bowlization</i> , its impact on biodiversity, soil and human livelihoods in West Africa	Tropentag 2015 "Management of land use systems for enhanced food security: conflicts, controversies and resolutions. Book of abstracts, Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg and the Humboldt-Universität Berlin, Allemagne, September 16-18, 2015, P568-568.
Wildlife/Grassland	9	Lesse P Djenontin J, Yabi B, Toko I, Tente B, Houinato M	Mapping and management of the main watering points planned for the nomadic cattle in the North East of Benin.	2 <sup>nd</sup> CAMES Conference, Thematic Research Program on Food Safety, UCAD <sub>2</sub> , Université Cheik Anta Diop, Dakar, Senegal. 23 – 25 November 2015
Wildlife/Grassland	10	Ahoudji M, Houinato M, Lykke AM, Teka O, Vissoh P	Perceptions of Fulani herders on rangeland degradation in areas bordering the W Biosphere Reserve in Benin	2 <sup>nd</sup> CAMES Conference, Thematic Research Program on Food Safety, UCAD <sub>2</sub> , Université Cheik Anta Diop, Dakar, Senegal. 23 – 25 November 2015
Wildlife/Grassland	11	Kindomihou V, Sinsin B, Holou R, Meerts P	The potential of <i>Tephrosia pedicellata</i> as Livestock Feeds in Sudanian Benin	2 <sup>nd</sup> CAMES Conference, Thematic Research Program on Food Safety, UCAD <sub>2</sub> , Université Cheik Anta Diop, Dakar, Senegal. 23 – 25 November 2015

Field of research	N°	Authors' Name	Title	References	
Agriculture/Agrofo restry	1	Zoffoun AG, Zannou E, Koudande Mensah AG	EA, DO, EA, DO,	Dépôt légal N° 8328 du 21 décembre 2015, 4 <sup>e</sup> trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978-99919-0-910 - 3, 7 p.	
Agriculture/Agrofo restry	2	Zoffoun AG, Zannou E, Koudande Mensah AG	EA, DO, EA, DO,	Dépôt légal N° 8327 du 21 décembre 2015, 4 <sup>e</sup> trimestre, Bibliothèque Nationale, Bénin, ISBN: 978-99919-0-909 - 7, 5 p.	
Agriculture/Agrofo restry	3	Aboh AB, Coulibaly ON	Zoffoun AG, EA, DO, EA, DO,	Utilisation des épiphytes d'ananas dans l'aliment concentré pour nourrir les lapereaux en croissance au Bénin	Dépôt légal N° 7738 du 27 janvier 2015, 1 <sup>er</sup> trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 - 99919 - 0 - 347 - 7, 4 p.
Agriculture/Agrofo restry	4	Kpanou BV, Koura BI, Houndoungbo Houngnandan P	Dedehouanou H, Bakary S, MF, Houngnandan P	In: Des sols durables. AgriCultures, Edition Afrique Francophone. AGRIDAPE, Revue sur l'Agriculture durable à faibles apports extérieurs, 31(1): 20-21.	

#### Appendix 14: Technical Reports and books in 2015

Field of research	N°	Authors' Name	Title	References
Socio-economics	5	Houngbo NE	Stratégie des « boutiques témoins » contre l'insécurité alimentaire au Bénin : Efficacité et perspectives pour l'Afrique.	In Fok, M., Ndoye, O. & Koné, S. (Eds) : <i>AGRAR-2013: 7<sup>th</sup> Conference of African research on agriculture, food, and nutrition. Yamoussoukro, RCI, June 4-6, 2013, Agriculture and challenges of food and nutrition in Africa: Contributions of research in cotton zone, Les presses agronomiques de Gembloux, Gembloux, pp 113-120.</i>
Wildlife/Grassland	6	Fandohan B, Toyi M, Deleke I, Houessou I, Zoffoun GA	Actes des XXI <sup>e</sup> Journées Scientifique de l'Association Béninoise de Pastoralisme (ABePa) : Le Pastoralisme et les Sciences Sociales. 15 Novembre 2014. Université d'Abomey Calavi, Faculté des Sciences Agronomiques, Laboratoire d'Ecologie Appliquée, Cotonou, Benin.	Dépot légal N° 7958 du 19 juin 2015, 2ème trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 - 99919 - 0 - 555 - 6, 175p
Wildlife/Grassland	7	Zoffoun AG, Abloh AB, Houinato M, Sinsin B	Effet l'âge et de l'intensité de pâture sur la production de biomasse de <i>Brachiaria ruziziensis</i> dans les pâturages artificiels au Bénin, 2015a.	Dépot légal N° 8333 du 21 décembre 2015, 4ème trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 -99919- 0 - 915 - 8, 9 p.
Wildlife/Grassland	8	Zoffoun AG, Abloh AB, Houinato M, Sinsin B	Effet de l'âge et de l'intensité de pâture sur le développement des organes de régénération (plateaux de tallage) de <i>Brachiaria ruziziensis</i> dans les pâturages artificiels au Bénin, 2015b.	Dépot légal N°8332 du 21 décembre 2015, 4ème trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 -99919- 0 -914 - 1, 9 p.
Wildlife/Grassland	9	Zoffoun AG, Abloh AB, Houinato M, Sinsin B	Effet de l'âge et de l'intensité de pâture sur le développement des touffes de <i>Brachiaria ruziziensis</i> dans les pâturages artificiels au Bénin, 2015c.	Dépot légal N° 8331 du 21 décembre 2015, 4 <sup>e</sup> trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 -99919- 0 - 913 - 4, 9 p.
Wildlife/Grassland	10	Adjolohoun S, Houinato M, Sinsin B	Effet du mode d'exploitation sur la production de biomasse de <i>Panicum maximum</i> var. C1 dans les pâturages artificiels au Bénin, 2015f.	Dépot légal N° 8330 du 21 décembre 2015, 4 <sup>e</sup> trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 -99919- 0 -912 - 7, 9 p.
Wildlife/Grassland	11	Adjolohoun S, Houinato M, Sinsin B	Effet du mode d'exploitation sur le développement des plateaux de tallage de <i>Panicum maximum</i> var. C1 dans les pâturages artificiels au Bénin, 2015g.	Dépot légal N° 8329 du 21 décembre 2015, 4 <sup>e</sup> trimestre, Bibliothèque Nationale (BN) du Bénin, ISBN : 978 -99919- 0 -911 - 0, 10 p.

### Appendix 15: Participation at workshops/conferences in 2015

N°	Title and period	Type of presentation (oral, poster...)	Participants from the LEA	Cost
1	IUFRO Symposium: Silviculture and Management of Dryland Forests at Stellenbosch University, 16 to 19 March 2015, Antananarivo, Madagascar.	Oral	Assédé EPS	\$4000
2	6 <sup>ème</sup> édition de la Semaine Nationale des Aires Protégées du Bénin : 16 au 20 Décembre 2015, Cotonou, Benin	Oral	Assédé EPS	\$0
3	5 <sup>e</sup> Colloque des Sciences, Cultures et Technologies de l'UAC 28 Septembre au 3 Octobre 2015, UAC, Bénin	Oral	Assédé EPS	\$45
4	Participation at the FAO expert meeting on creating an enabling environment for the sustainable development of community-based forest enterprises in Africa. Douala (Cameroon), 18-20 November	Attendance	Assocbagdjo AE	Not available

N°	Title and period	Type of presentation (oral, poster,..)	Participants from the IIEA	Cost
5	Participation to the Consultative Ministerial Meeting on Higher Education, Science and Technology, Lilongwe (Malawi), 20 <sup>th</sup> – 22 <sup>nd</sup> October	Attendance	Assogbadjo AE	Not available
6	Participation to the World Forestry Congress. Durban (South Africa); 5-12 September	Attendance	Assogbadjo AE	Not available
7	Participation to the Ruforum General Assembly, Whindeok (Namibia), 25-31 <sup>st</sup> August	Attendance	Assogbadjo AE	Not available
8	Participation to the Consultative Meeting on Scientific Equipment Policy, Nairobi (Kenya), 20-21 August	Attendance	Assogbadjo AE	Not available
9	Participation to the first author meeting – IPBES assessment on biodiversity and ecosystem services for the african region, Pretoria (South Africa) 3-7 august	Attendance	Assogbadjo AE	Not available
10	Participation to the Ruforum Dean and Principals meeting, Khartoum (Sudan), 8-10 June	Attendance	Assogbadjo AE	Not available
11	Morphological Plant Models, a NIMBioS Investigative Workshop, 2-4 September 2015, University of Tennessee, Knoxville, USA	Attendance	Azihou AF	Full support from NIMBIOS
12	5 <sup>eme</sup> Colloque des Sciences, Cultures et Technologies de l'Université d'Abomey-Calavi, 28 Septembre au 3 Octobre 2015, Bénin	Attendance	Azihou AF	Not applicable
13	XXII <sup>ème</sup> Journée Scientifique de l'Association Béninoise de Pastoralisme (ABEPA), 21 Novembre 2015, ISBA, Cotonou, Bénin	Facilitator	Azihou AF	Not applicable
14	IFS Collaborative Research Team Meeting, 8-12 December 2015, Sokoine University of Agriculture, Morogoro, Tanzania	Oral	Azihou AF Assédé E	Full support from IFS
15	6 <sup>eme</sup> édition de la semaine nationale des aires protégées du Bénin, 16 au 20 décembre 2015, Cotonou, Bénin	Facilitator	Azihou AF	Not applicable
16	Spatial stable isotope short course, 14 <sup>th</sup> June to 26th June 2015 Salt Lake City, Utah.	Training	Djagoun CS	8,000 USD
17	12th Annual Meeting of the Science and Technology in Society (STS) forum, from October 4 to 6, 2015, Kyoto, Japan.	Attendance	Djagoun CS	3,000 USD
18	Préparation (membre du comité scientifique) de l'atelier scientifique spécial du Projet de Productivité Agricole de l'Afrique de l'Ouest (PPAAO), INRAB, Abomey-Calavi (Bénin), Septembre 2015	Attendance	Djosou Djègo S, Diègo JG, Glièlé Kakai R	\$0
19	22ème édition de la journée scientifique de l'ABEPA : Champ de Foire, Cotonou (Bénin), 21 Novembre 2015	Attendance	Djosou Djègo S	\$0
20	6 <sup>eme</sup> édition de la semaine nationale des aires protégées du Bénin : Cotonou (Bénin), 16 au 20 Décembre 2015	Oral	Djosou Djègo S	\$0
21	1 <sup>re</sup> édition de l'atelier scientifique en Primatologie ITTA, Abomey-Calavi (Bénin) 7 au 15 Janvier 2016	Oral	Djosou Djègo S	\$0
22	Atelier de partage d'expériences des trois (3) sites pilotes carbone du projet GCCA. 28-31 Octobre 2015, Fada N'gourma, Burkina Faso	Oral	Goussanou CA	Not available
23	Assainissement de l'environnement par la valorisation de ressources non conventionnelles en alimentation de porc. Cinquième Colloque de l'Université d'Abomey-Calavi des Sciences, Cultures et Technologies, 28 Septembre au 02 Octobre 2015. Abomey-Calavi, Bénin	Oral	Hédji CC, Fiogré E Hounnalo M, Houndounougo FH,	30 USD
24	Effet du conditionnement sur la qualité microbiologique des farines de <i>Moringa oleifera</i> et d' <i>Azolla filiculoides</i> . Colloque Panaficain-Paneuropéen en « Chimie et Ressources Naturelles, 13-16 Avril 2015. Cotonou, Bénin	Oral	Hédji ACC, Hounnato M, Yehouénou B, Sobakin S, Fiogbé E	Not available
25	Deuxièmes journées scientifiques de CAMES (23 au 25 Novembre à l'UCAD de Dakar, Senegal	Oral	Houehanou T	Not available
26	SASACID 2015: Strengthening Africa's Strategic Agricultural Capacity Impact for Development. Workshop set for building the partnership platform between Private sector and the FSA. Funded by ANAFE/FSA-UAC. Aouarite Centre, Abomey-Calavi, Benin. 15 – 16 October 2015.	Platform forum fellow	Kindomihou V	500 Euro

N°	Title and period	Type of presentation (oral, poster,..)	Participants from the ILEA	Cost
27	ICAFE 2015: 17 <sup>th</sup> International Conference on Agricultural and Forestry Engineering. Cape Town Lodge Hotel, 101 Buitengracht St, Cape Town City, Cape Town, South Africa, November 5 - 6, 2015	Scientific Committee member	Kindomihou V	3000 Euro
28	CAMES 2015 : 2 <sup>e</sup> Journées Scientifiques du CAMES, Thematic research program Food Safety, UCAD2 Videoconferencing Room, Université Cheikh Anta Diop, Dakar, Senegal. 23 – 25 November 2015	Oral	Kindomihou V	1500 Euro
29	2015 Global Leadership Summit: Bethel Assemblies of God Church, S.I.C.A.P. Dieupul, Dakar, Senegal. 27 – 28 November 2015	Attendance	Kindomihou V, Agbangba CE	1000 Euro
30	EOA 2015: Strategic Plan Development for the platform of Ecological Organic Agriculture. Funded by Biovision African trust, OBEPAAB, Swiss Cooperation and African Union. Bohicon, Fifatin Hotel, Benin, 21 December 2015	Platform forum fellow	Kindomihou V	250 Euro
31	EOA 2015: Programs and training materials Development for the actors on Ecological Organic Agriculture. Funded by Biovision African trust, OBEPAAB, Swiss Cooperation and African Union. Bohicon, Fifatin Hotel, Benin, 22-23 December 2015.	Platform forum fellow	Kindomihou V	500 Euro
32	3 <sup>rd</sup> Workshop of SSC/CSG/IUCN for West and Central Africa University of Nangui-Abrogoua, Abidjan, Côte d'Ivoire. 8-11 December 2015.	Oral	Kpera GN	Funded by SSC/CSG/IUCN
33	Tropentag 2015 - “Management of land use systems for enhanced food security – conflicts, controversies and resolutions” – from 16 to 18 September 2015 at Humboldt-Universität zu Berlin, Berlin, Germany.	Poster	Lesse P, Houinato M	Not available
34	Mapping and management of the main watering points planned for the nomadic cattle in the North East of Benin, September 16-18	Poster	Lesse P, Djenontin J, Toko I, Tene B, Houinato M	Not available
35	Climate change and animals/Dakar/11 - 16 January 2015	Oral	Lesse P, Ahoudji M	Grant
36	V <sup>e</sup> Colloque Scientifique de l'Université d'Abomey-Calavi/Calavi UAC/28 Septembre - 3 Octobre 2015	Oral	Lesse P, Djenontin J, Toko I, Tene B, Houinato M	30 USD
37	V <sup>e</sup> Colloque des Sciences, Cultures et Technologies de l'UAC 28 Septembre au 3 Octobre 2015, UAC, Benin	Oral	Padonou EA	Not available
38	Variation of rainfall regime in the W Transboundary biosphere reserve(BENIN)	Oral	Sare BA, Vodounou T, Housou SH, Sinsin B	Not available
39	Indigenous Plant Use Forum (IPUF) & Society for Economic Botany (SBE) Joint Conference on “Global Vision on Indigenous Plants and Economic Botany”. Clanwillian, Western Cape, South Africa, 28 <sup>th</sup> June-2 <sup>nd</sup> July 2015	Poster	Sinasson SKG	800 USD
40	Training on “Analysis of tree rings for the study of tree growth dynamics”. ICRAF Nairobi, Kenya, 14 July-13 August 2015	Attendance	Sinasson SKG	3000 USD
41	CAMES 2015 : 2 <sup>e</sup> Journées Scientifiques du CAMES, Thematic research program Food Safety, UCAD2 Videoconferencing Room, Université Cheikh Anta Diop, Dakar, Senegal. 23 – 25 November 2015	Oral	Tchibozo V	1890 USD
42	Climate change impact projection on spatial distribution of <i>Zanthoxylum zanthoxyloides</i> (Lam.) Z & T. in Benin (West Africa): Comparing MaxEnt and MaxLike. XXII <sup>ème</sup> Journées Scientifiques de l'ABePA, Cotonou, 21 Novembre 2015.	Oral	Yaoitcha Gouwakinnou AS, Fandohan AB, Akpo NG, LE, Houinato RBM	Not available

N°	Title and period	Type of presentation (oral, poster,..)	Participants from the LEA	Cost
43	Change in treated diseases and using of related tree species across phytogeographical zones in Benin (West Africa): implication for biodiversity conservation. 5 <sup>e</sup> Colloque de l'UAC du 28 Septembre au 03 Octobre 2015.	Oral	Yaoitcha Houehanou DT, Toyi MSS, Assogbadjo AE, Houinato MRB	AS, Not available
44	Forum de planification de haut niveau sur l'intensification des innovations agricoles en Afrique, organisé par le Forum pour la Recherche Agricole en Afrique (FARA) Nairobi, Kenya: 23 et 24 février 2015	Oral	Zoffoun GA	Not available
45	"Conférence Régionale Observation de la Terre eau et agriculture : Mutualisation et partage de données spatiales dans les bassins africains" conjointement organisé l'Organisation Islamique pour l'éducation, les Sciences et la Culture (ISESCO) et le Centre Régional Africain des Sciences et Technologies de l'Espace (CRASTE-LF), en collaboration avec la Commission Nationale Béninoise pour l'UNESCO (CNBU), 29 avril au 1 <sup>er</sup> mai 2015. INFOSEC, Cotonou	Oral	Zoffoun GA	Not available
46	"3 <sup>e</sup> Session de l'Atelier régional de renforcement des capacités des porteurs d'idée de projet MDP et marché volontaire carbone dans le secteur AFOLU (Agriculture, Forêt et Autres Utilisations des terres) à l'intention des porteurs de projets de l'espace CILSS-CEDEAO" organisé par le CILSS et le Centre Régional AGRHYMET, 20 au 24 août 2015, Lomé, Togo	Oral	Zoffoun GA	Not available
47	Conférence Annuelle 2015 du Regional Strategic Analysis and Knowledge Support System (ReSAKSS), organisée par International Food Policy Research Institute (IFPRI) en partenariat avec la Commission de l'Union Africaine. Addis Abeba, Ethiopie; 1 <sup>er</sup> au 3 septembre 2015	Oral	Zoffoun GA	Not available
48	"Atelier de renforcement des capacités pour la mobilisation de la finance climat dans l'espace de l'Union Économique et Monétaire Ouest Africaine (UEMOA)" organisé par la Commission de l'UEMOA du 13 au 15 octobre 2015 à Lomé, Togo	Oral	Zoffoun GA	Not available
49	Atelier de partage d'expériences des sites pilotes carbone (Bénin, Burkina Faso et Niger) du projet Alliance Mondiale contre le Changement Climatique organisé par le CILSS et le Centre Régional AGRHYMET Fada N'Gourma, Burkina Faso; 28 octobre au 2 novembre 2015	Oral	Zoffoun GA, Guendehou S, Goussanou C	Not available
50	21 <sup>ème</sup> Conférence des Parties de la Convention-Cadre des Nations Unies sur les Changements Climatiques (COP 21) et la 11 <sup>ème</sup> Conférence des Parties agissant comme Réunion des Parties au Protocole de Kyoto (CMP11). Paris, France; 30 novembre au 12 décembre 2015	Oral	Zoffoun GA	Not available

**Appendix 16: Research projects of LEA in which you have been involved in 2015**

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
1	« Dynamiques paysagères en période de crises politico-militaires en Côte d'Ivoire : influences sur la gestion et la disponibilité des terres agricoles et la sécurité Alimentaire » (D2PCPCI).	IRD	- Cartographier le couvert végétal des zones d'étude (Bénin) avant et après la décennie de crises que la Côte d'Ivoire a traversée. - Déterminer les dynamiques spatio-temporelles du couvert végétal, pendant la période de conflits. - Déterminer les transformations spatiales dominant chacune des classes d'occupation du sol pendant la période d'étude au Bénin	Ongoing	Variable according activities and the year. Funds are managed by the team of Ivory Coast (Head of the project)
2	Productivité des systèmes intégrant l'agriculture et l'élevage au Bénin (PROSAEI)	PFCR2/UAC		Ended	Not available

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
3	Sustainable improvement of the productivity of meat value chain for food security in west Africa” (SIMPROMEAT)	CORAF-USAI	- Améliorer les connaissances et à accroître les capacités des différents acteurs sur la dynamique des parcours naturels et la gestion de la transhumance au Bénin dans un contexte de changements climatiques	Ended	Not available
4	Cartographie et modélisation de la dynamique des parcours naturels et gestion de la transhumance dans un contexte de changements climatiques au benin (MDP3C).	UAC	- Etudier les facteurs écologiques, climatiques et ethnopharmacologiques déterminant la priorité pour la conservation des lignieux médicaux de la pharmacopée humaine et animale au Bénin	Ended	Not available
5	Biologie de la Conservation et Ethnopharmacologie des Ligneux médicaux de la pharmacopée béninoise (BIOCEL.)	FNRSIT	- Evaluer les connaissances endogènes des communautés rurales sur les palmiers sauvages du Bénin à travers l'analyse des perceptions sociales et la quantification de leur valeur d'usage ethnobotanique ; - Evaluer la biodiversité (richesse taxonomique et diversité génétique) et la distribution des palmiers sauvages au Bénin ; - Etudier la structure et la dynamique des populations des espèces de palmiers sauvages au Bénin;	Ongoing	Not available
6	WILD PALM	UAC	- Evaluer l'importance économique des palmiers sauvages à travers l'étude des flux de commercialisation et du revenu généré par la vente de leurs produits aux communautés rurales au Bénin; - Evaluer le gap de conservation par rapport aux palmiers sauvages en vue de leur conservation et de leur gestion durable au Bénin	Ended	Not available
7	Projet de partenariat entre le LEA et l'IRSNB	IRSNB	- Renforcer les capacités de l'université d'Abomey-Calavi à répondre aux préoccupations de la DPNP, et des AVIGREFs sur la gestion des feux et leurs impacts sur les habitats et la faune dans la Réserve de Biosphère de la Pendjari, tout en valorisant l'expertise de l'IRSNB.	Ongoing	Not available
8	SASACID (Strengthening Africa's Strategic Agricultural Capacity Impact on Development)	Project SASACID_ANAF E/ESA-UAC	- Informer et sensibiliser les acteurs et les bénéficiaires des services inhérents au parc (entre autres CENAGREF et AVIGREFs) sur les valeurs de ces services écosystémiques, 3. Contribuer au réseau CHM national pour renforcer la coopération scientifique et technique	Ended	Not available

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
			<ul style="list-style-type: none"> <li>- agribusiness program;</li> <li>- Profiling agribusiness companies;</li> <li>- Carrying out agribusiness value chain analysis to identify gaps and opportunities for agribusiness</li> </ul>		
9	Ecological Organic Agriculture (EOA-Bénin)	Biovision Africa_Kenya and Switzerland (SDC)	<ul style="list-style-type: none"> <li>- Ecological and organic agriculture</li> <li>- Organizing and developing value chains in west Africa</li> <li>- Developing local markets and SPG approach with actors</li> <li>- Implementing producers and boost the partnership network</li> <li>- Mainstreaming (EOA) into National Policies, Strategies and Programmes in Africa 2014-2018.</li> </ul>	Ongoing	Not available
10	Impact des chablis dans les plantations domaniales sous gestion de l'ONAB	ONAB	<ul style="list-style-type: none"> <li>- quantifier les types de chablis dans les plantations domaniales sous gestion de l'ONAB ;</li> <li>- identifier les facteurs déterminant les types de chablis dans les plantations domaniales sous gestion de l'ONAB ;</li> <li>- évaluer les dégâts dus au chablis dans les plantations domaniales de l'ONAB ;</li> <li>- évaluer l'impact des chablis sur le recrutement des espèces autochtones de valeur rares dans les plantations domaniales sous gestion de l'ONAB</li> </ul>	Ongoing	6000 USD
11	Utilisation des parents sauvages des plantes cultivées pour améliorer l'adaptation des systèmes de cultures au stress biotique et abiotique dans le contexte des changements climatiques	FNRSIT	<ul style="list-style-type: none"> <li>- cartographier la distribution éco-géographique des 20 espèces prioritaires de parents sauvages des plantes cultivées au Bénin ;</li> <li>- modéliser l'impact des changements climatiques sur la distribution géographique des zones favorables à la culture et à la conservation des 20 espèces de parents sauvages prioritaires;</li> <li>- tester la tolérance aux parasites et au stress abiotique de <i>Manihot glaziovii</i> Müll. Arg. parent sauvage du manioc (<i>Manihot esculenta</i> Crantz).</li> </ul>	Ongoing	24000 USD
12	Renforcement des capacités des acteurs de la conservation pour une mise en pratique des acquis de la recherche scientifique dans la Réserve de Biosphère de la Pendjari (RBP)	Institut Royal des Sciences Naturelles de Belgique	<ul style="list-style-type: none"> <li>- Améliorer l'état des connaissances et l'utilisation des acteurs de la conservation par les acquis de la recherche.</li> </ul>	Ongoing	Not available
13	Graduate Research Grant	RUFORUM	<ul style="list-style-type: none"> <li>- Promoting environmentally friendly practices for sustainable baobab leaves production for food and nutritional security in smallholders farming systems in Benin (West-Africa). Principal Investigator.</li> </ul>	Ongoing	Not available
14	UNDESERT	European Union	<ul style="list-style-type: none"> <li>- Understanding and combating desertification to mitigate its impact on ecosystem services. FP7-ENV-2009-1.</li> </ul>	Ended	Not available
15	CORAF/WECARD	CORAF/ WECARD	<ul style="list-style-type: none"> <li>- Amélioration de la résilience aux changements climatiques des écosystèmes agricoles le long des bassins-versants par le développement participatif de systèmes agroforestiers anti-érosifs et fertilisants dans six pays ouest africains</li> </ul>	Ongoing	Not available

N°	Title of the project	Sources of Funding	Objectives of the project	Status (ongoing or ended)	Estimated fund
16	AFRICAN UNION	African Union	- Projet de mise au point de technologies de production et d'utilisation durables de biocarburant de <i>Jatropha curcas</i> pour une réduction de la pauvreté rurale en Afrique de l'Ouest	Ongoing	Not available

### Appendix 17: Research Grants in 2015

N°	Title of Grant	Beneficiaries	Status (ongoing or ended)	Estimated fund
1	Bourses Postdoctorales Elan	TOYI S. Scholastique Mireille	Ongoing	10,000 euros
2	Ecological Organic Agriculture (EOA-Bénin)	VODOUHE Davo Simplece	Ongoing	Not available
3	Georg Forster Research Fellowship (HERMES) for Postdoctoral Researchers.	KINDOMIHOU Valentin	Ongoing	Not available
4	Georg Forster Research Fellowship (HERMES) for Postdoctoral Researchers.	DJAGOUN CS	Ongoing	Not available
5	International Foundation for Science (IFS)	HOUEHANOU Thierry	Ongoing	Not available
6	IFS research grant n°: B/5863-1.	GOUSSANOU Cedric A.	Ongoing	10000 USD
7	IFS Research Grant n° D/5691-1, Sweden	KOURA Bossima Ivan	Ongoing	12,000 USD
8	IFS Individual Research Grant	NAGO Gilles	Ongoing	11,380 USD
9	IFS Collaborative Research Grant	SINASSON S. K. Gisèle	Ongoing	11,560 USD
10	IFS	AZIHOU Akonian Fortuné	Ongoing	13,500 USD
11	Organization for Women in Science for the Developing World (OWSD) Postgraduate Fellowship and co-supervision in South Africa	ASSEDE Emeline P.S.	Ongoing	12400 USD
12	RUFFORD	SINASSON S. K. Gisèle	Ongoing	19200 USD
13	Rufford Small Grant, Great Britain	ASSEDE Emeline P.S.	Ongoing	5000 USD
14	Rufford Small Grants for Nature Conservation Application	NAGO Gilles	Ongoing	5,000 GBP
15	Rufford Small Grant	PADONOU Elie Antoine	Ongoing	5000 USD
		SAVI Merveille Koissi	Ended	5000 £

### Appendix 18: Prizes and nominations in 2015

N°	Title of prize / nomination	Nominee	Estimated fund
1	Assistant Professor at ENSAGAP-University of Parakou, Benin	Gilles NAGO	N/A
2	Expert for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)	Elie Antoine PADONOU	Not available
3	Fellowship of Global Taxonomy Initiative (GTI)-Belgian National Focal Point, Brussels, Belgium (Renew)	Gilles NAGO	5,000 euros
4	Organization for Women in Science for the Developing World (OWSD) Postgraduate Fellowship Addendum for Conference attendance	Gisèle S. K. SINASSON	1700 USD
5	Member for the XVII <sup>th</sup> International Conferences Committees of the World Academy of Science (WASET)	Valentin KINDOMIHOU	10000 USD
6	Member of Scientific Committee of Agronomic Sciences (FSA/UAC) and UAC Scientific Council (2015-2017)	Valentin KINDOMIHOU	Not available
7	Reviewer for the Elsevier Journal "FLORA" (Morphology, Distribution, Functional Ecology of Plants)	Valentin KINDOMIHOU	Not available
8	Member of Examining Boards for PhD presentations at UAC (Benin) and Université Cheik Anta Diop (Senegal)	Valentin KINDOMIHOU	2000 USD
9	Member of Editorial Board of <i>Journal of Organic Agriculture and Environment</i> (FUNAAB, Nigeria)	Valentin KINDOMIHOU	Not available

N°	Title of prize / nomination	Nominee	Estimated fund
10	Lecturer in the International Summer School on Organic Agriculture, Federal University of Agriculture of Abeokuta, Nigeria.	Valentin KINDOMIHOU	2500 USD
11	Member of Scientific Committee of the 10 <sup>th</sup> International Meeting on Phytolith Research, (10 <sup>th</sup> IMPR), 12 - 14 September 2016, CEREGE, Aix en Provence, France.	Valentin KINDOMIHOU	12500 Euro

#### **Appendix 19: Visitors received in 2015**

N°	Full names of visitors	Provenance	Responsibles in LEA	Topics
1	Pr Mark-Oliver RÖDEL	Germany	Pr Brice SINSIN Dr Gilles NAGO	Amphibians study, PhD Thesis evaluation and project formulation
5	Dr Björn ENCKE	Germany	Prof Brice SINSIN Dr Gilles NAGO	Project formulation
6	Dr Leendert de JONG	Germany	Pr Brice SINSIN Dr Gilles NAGO	Project formulation
2	Pr Karimou AMBOUTA	Niger	Pr Brice SINSIN Dr Elie PADONOU	PhD Thesis evaluation
3	Dr Gabriel SEGNIAGBETO	Togo	Dr Gilles NAGO	Amphibians study
4	Dr Bioudin ONADEKO	Nigeria	Dr Gilles NAGO	Amphibians study
7	Dr Zoltán NAGY	Hungary	Dr Gilles NAGO	Herpetology field work and project formulation
8	Pr Isaac AIYELAAGBE	Federal University of Agriculture of Abeokuta, Nigeria	Dr Valentin KINDOMIHOU Dr Tatiana KOURA	- Board of Koura Tatiana PhD Presentation (12 Nov. 2015) - Conference on "Organic Agriculture and Food Security in Subsaharan Africa: Assets, Challenges and Perspectives"
9	Dr Frimpong KWAME	University of Cape Coast, Ghana	Dr Valentin KINDOMIHOU	- Board of Koura Tatiana PhD Presentation (12 Nov. 2015) Conference on "Organic Agriculture and Food Security in Subsaharan Africa : Assets, Challenges and Perspectives"
10	Dr Geldenhuy's COERT	South Africa	Dr Emeline ASSEDE	REDD+ versus practical silvicultural management for rural society benefits in Miombo woodlands, southern Africa.
11	Dr Anne Mette LYKKE	Denmark	Dr Elie PADONOU	Undesert deliverable

## **9. Abstracts of Publications**

# Articles published in peer-review journal with Impact Factor (IF) in 2015

## 1. Spatial distribution of *bowal* and differences in physicochemical characteristics between *bowal* and woodland areas in Benin, West Africa

Elie A. Padonou<sup>1\*</sup>, Yvonne Bachmann<sup>2</sup>, Romain Glèlè Kakai<sup>1</sup>, Anne M. Lykke<sup>3</sup>, Brice Sinsin<sup>1</sup>

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*Catena* 124: 45-52

### ABSTRACT

*Bowal*, degraded land is ferricrete exposure due to soil surface erosion. This study aims at assessing the spatial distribution of *bowé* in Benin and the physical chemical differences between ferricretes exposed on *bowé* and soil of adjacent woodlands. *Bowé* sites were identified during field exploration in Benin and their geographic coordinates were stored. Soil samples were taken on the *bowé* sites and nearby woodland. Mann-Whitney test was applied to analyze the different physicochemical characteristics of *bowé* and woodland sites. The results show that *bowé* were directly related to ferruginous soils and rainfall regime. *Bowé* showed significantly lower values of electrical conductivity, organic matter, extractable phosphorus, silt and total nitrogen than woodland soils, while its potassium exchangeability was higher. *Bowé* can be expected wherever ferruginous soil is observed in unimodal rainfall regime condition. The disaggregation of *bowé* may improve the soil physicochemical characteristics and sustain the regrowth of forest if the climate becomes more humid.

**Keywords:** *Bowal; bowé; Ferruginous soil; Physicochemical soil characteristics; Phytogeographical district; Benin.*

## 2. Using species distribution models to select climate change resistant species for ecological restoration of *bowé* in West Africa

Elie A. Padonou<sup>1\*</sup>, Oscar Teka<sup>1</sup>, Yvonne Bachmann<sup>2</sup>, Marco Schmidt<sup>2,3</sup> Anne Mette Lykke<sup>4</sup> and Brice Sinsin<sup>1</sup>

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*African Journal of Ecology*: 1-10

### ABSTRACT

*Bowalization* is a particular form of land degradation and leads to lateral expansion of ferricrete horizons. The process occurs only in tropical regions. In this study the most adapted and resistant species towards climate change were identified on *bowé*. The 15 most common *bowé* species of the sub-humid and semiarid climate zones of Benin were submitted together with significant environmental variables (elevation, current bioclimatic variables, soil types) to three ecological niche modeling program (Maxent, Domain and GARP). For future prediction (2050) IPCC4/CIAT and IPCC5/CMIP5 climate data were applied. *Asparagus africanus*, *Andropogon pseudapricus* and *Combretum nigricans* were identified as the most resistant species for ecological restoration of *bowé* in the semiarid climate zone and *Asparagus africanus*, *Detarium microcarpum* and *Lannea microcarpa* in the sub-humid climate zone. The “Pull” strategies were identified as the appropriate for ecological restoration of *bowé* in Benin.

**Keywords:** Benin, *Bowé*, Climate change, Ecological restoration, Resistant species, Sub-humid and Semiarid climate zones.

### 3. Modeling vulnerability of protected areas to invasion by *Chromolaena odorata* under current and future climates

A. Belarmain Fandohan,<sup>1,2,3,8</sup> Ayub M. O. Oduor<sup>3,4</sup> A. Idelphonse Sode<sup>5</sup>, Liang Wu,<sup>3</sup> Aida Cuni-Sanchez<sup>6</sup>, Emeline Assede,<sup>5</sup> and Gerard N. Gouwakinnou<sup>5,7</sup>

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***Ecosystem Health and Sustainability 1(6): 1-12.***

#### ABSTRACT

Invasive plant species and climate change are among the biggest threats to the ecological integrity of many ecosystems, including those of protected areas. Effective management of invasive plants requires information regarding their spatial distributions. Using maximum entropy, we modeled habitat suitability for an invasive plant species *Chromolaena odorata* under current and future climatic conditions (HadGEM2-ES and MIROC5) in protected areas of four West African countries (Benin, Côte d'Ivoire, Ghana, and Togo). Under current climatic conditions, approximately 73% of total land area within the protected areas was suitable for colonization by *C. odorata*. Under future climate projections, the total area of suitable habitats for this invasive plant was projected to decrease by 7–9% (HadGEM2-ES) and 12–14% (MIROC5). Country specific patterns suggest that major protected areas in Côte d'Ivoire and Ghana will be more vulnerable to invasion by *C. odorata* than those in Benin and Togo under both current and future climatic scenarios. To maintain normal ecosystem functioning and provisioning of ecosystem services within the protected areas studied here, locations that have been identified as most vulnerable to invasion by *C. odorata* should be accorded proportionately higher priority when formulating appropriate management strategies.

**Key words:** *Chromolaena odorata*; Climate change; HadGEM2-ES; Maximum entropy; MIROC5; Representative concentration pathways; Risk assessment; Siam weed; West Africa.

### 4. Effects of the relief on the regeneration of woody species in Benin's Sudanian zone

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#### ***Bois et Forêts Tropicaux***

#### ABSTRACT

The regeneration of woody species is of major interest to ecologists in connection with ecosystem renewal. This study aimed (i) to analyse the regeneration potential of vegetation units in Benin's Sudanian zone, (ii) to document the variations in regeneration potential according to the relief. A total of 615 survey plots 25 m<sup>2</sup> in area were marked out in 13 vegetation units in the Pendjari Biosphere Reserve. An inventory of regeneration was made by counting the number of individuals per species in each plot. We used the log-linear model with a Poisson regression to model regeneration density and the number of regenerating species for 4 types of relief. The regeneration potential of vegetation units in the Pendjari Biosphere Reserve closely reflects the species composition of the plant cover. The Poisson regression shows that the relief has a significant effect on regeneration density and on the number of regenerating species. Regeneration potential in floodplains and along rivers is significantly lower than in hilly and plateau areas. Compared to plateau areas (index 1), the indices for observed regeneration density along rivers, in floodplains and in hilly areas are 1.01, 0.67 and 2.1 respectively. The number of regenerating species increases from plateau to hilly areas, but drops from plateau areas to floodplains and riversides. Topographic conditions thus influence the establishment of woody species in Sudanian zones.

**Keywords:** Regeneration potential, Plant community, Poisson regression, Pendjari, Benin.

## 5. The Effect of seasonal variations, covariations with minerals and forage value on Itchgrass' foliar silicification from Sudanian Benin

Kindomihou V<sup>1,2,4,5</sup>., Sinsin B., Holou R.AY<sup>2</sup>, Ambouta K. J-M<sup>3</sup>, Gruber W.<sup>4</sup>, Adjolohoun S.<sup>5</sup>, Houinato M., Herbauts J., Lejoly J.<sup>6</sup>, Meerts P.

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**Silicon DOI 10.1007/s12633-015-9355-y**

### ABSTRACT

Silica ( $\text{SiO}_2$ ) in forage grasses has been found in reducing cell-wall digestibility. This study investigates whether: (i) the seasonal variability affects the silica and minerals accumulation and forage values of leaves of *R. cochinchinensis* and (ii) silica concentration is correlated with minerals and fodder value. In an Itchgrass population selected in the W Biosphere Reserve, leaves were collected on 90 marked plants from May to October 2003 and 2004, at 15 days intervals except May, June and October. Some 300 g of fresh blades from the 3rd most recently expanded leaves were oven dried and analyzed for dry mass,  $\text{SiO}_2$ , ash, N, Na, Ca, P, K, Mg. Digestible Nitrogen Matter (DNM) and Fodder Energetic Value (FEV) were calculated using Demarquilly formula. Apart from  $\text{SiO}_2$ , Ash and forage value, data were log-transformed to restore homoscedasticity before Statistical analyses.  $\text{SiO}_2$  ranges from 5.69 % to 9.95 %, i.e. varying 1.4 fold between May and October, reaching 1.75 fold at mid-September.  $\text{SiO}_2$  positively related to Ca but negatively to K, P, N, DNM and FEV. The negative correlations suggest that  $\text{SiO}_2$  concentration in *R. cochinchinensis* could be reduced with a significant increase in energy and accumulation of important nutrients such as N, P and K. Therefore, leaf silicification and nutritive value relationship should be conclusive in the case of Itchgrass.

**Keywords** - *'Rottboellia cochinchinensis*, Silicification, Minerals, Seasonal variations, Forage value, Covariations, Sudanian Benin

## 6. Farmers' background and diversity of uses of palm oil wastes for sustainable agriculture in Southern Benin Republic

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**Biological Agriculture and Horticulture 31(1): 35-44 (2015) DOI: 10.1080/01448765.2014.964316**

### ABSTRACT

Palm oil mill wastes (POMW) are well known to be rich in phosphorus, nitrogen, calcium, magnesium, sodium and potassium. This study was carried out in 2012 to assess farmers' practices on utilization of POMW in agriculture in the south of Benin. A total of 335 palm oil mills from the Communal Union of Palm Oil Producers were randomly selected and surveyed using a questionnaire. The use of POMW as fertilizers depends highly ( p , 0.001) on the nature of fertilizers used by the farmer. The use of empty fruit bunches (EFB) and fibre as fertilizers depends on the knowledge of the farmer about their application directly in palm plantations or indirectly through composting. These wastes were applied by local application (76.5%) or mulching (33.3%). The use of EFB and fibre produced depends on their use in plantations ( p , 0.001). POMW were composted by heaping, by breeding pigs on POMW and in pits. Breeding pigs on POMW involved placing POMW in a pig pen with added vegetables. The pit method consisted of making a hole. The POMW are put in the pit. After the short rain season, the compost obtained can be used. Composting is a process unknown by 67.5% of mill owners. The difference between those who know about and use composting, and those who know it but do not use it is based on their knowledge of composting advantages. The use of POMW in composting is mostly developed in Ifangni District (Plateau Department).

**Keywords:** Composting; Knowledge; Palm oil mill waste

## 7. Quantitative assessment of palm oil wastes generated by mills in Southern Benin

Koura T.W<sup>1</sup>, Kindomihou V<sup>1</sup>, Dagbenonbakin G<sup>2</sup>, Janssens M<sup>3</sup>, Sinsin B<sup>1</sup>.

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<sup>3</sup>Institute of Crop Science and Resource Conservation INRES, University of Bonn, Germany.

*African Journal of Agricultural Research*

### ABSTRACT

While waste management is given more care for protecting the environment and human health, agro industrial wastes are still a concern, in developing countries. This study quantitatively assesses the palm oil wastes generated by mills and describes their management in Southern Benin. Twenty four out of 335 regional palm oil mills were randomly selected and assessed for waste quantities generated during the oil production season. From 1 ton (t) of full fruit bunches (FFB), each palm oil mill produces an average of 712.1 kg of fruits, 254.7 kg of empty fruit bunches (EFB), and 399.8 kg of palm kernel cake, 114.9 kg of fibre, 240.4 L of palm oil mills effluents (POME) and 152.3 L of crude palm oil. Numeric classification analyses resulted in four groups of palm oil mills following production factors and wastes quantities generated: small, medium, large and very large mills. These groups produced yearly on average respectively 12.4, 31.3, 132.7, and 800.7 t of EFB; 5.6, 13.6, 135.2, and 637 t of fibre and 15.1, 40.9, 233.4, and 572.6 t of POME. They differed in nature, plantations size, and capacity to employ people. About 80% are small producers. The use of all POME generated depend on waste quantity produced.

**Key words:** Palm oil mills, Wastes, Production system

## 8. Variation in *Hyphaene thebaica* Mart. fruit: physical characteristics and factors affecting seed germination and seedling growth in Benin (West Africa)

R. Idohou<sup>1,3\*</sup>, A. E.Assogbadjo<sup>1</sup>, T. Houehanou<sup>2</sup>, R. Glèlè Kakai<sup>3</sup>, and C.Agbangla<sup>4</sup>

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*The Journal of Horticultural Science and Biotechnology* 90(3): 291-296

### ABSTRACT

*Hyphaene thebaica* (dum palm) is an important tree species that grows wild in the semi-arid regions of tropical Africa. Increased knowledge on the effect of stress on the propagation and establishment of these plants is needed to optimize its domestication. This study assessed the physical characteristics of *H. thebaica* fruit harvested from three phytodistricts in Benin. The germinability of the seeds, before and after water-soaking and removal of the seed coat, was tested, and the number and size of the leaves produced in the resulting seedlings were measured. Hierarchical classification of the characteristics of fruit revealed the existence of three morphotypes. A Factorial Discriminant Analysis performed on these morphotypes revealed highly significant differences ( $P \leq 0.001$ ). Morphotype 3 (48 seeds) had the highest rate of seed germination (49.99%) and the widest leaves (28 mm) over the 154 d of the experiment. Seedlings of morphotype 2 and morphotype 3 (48 seeds each) had the highest number of leaves (two per seedling), whereas only morphotype 2 seedlings had the longest leaves (35 mm). Results from Analysis of Variance revealed that the time of germination and water-soaking had significant effects ( $P \leq 0.05$ ) on seed germination. The study also showed that the growth of seedlings differed with the time of germination, and that these differences varied with morphotype. These results may be used to improve current propagation and conservation strategies in this species in its areas of origin.

**Keywords:** Dum palm, Germination, Treatment, Phytochorological zones, West Africa

## 9. Elephant-induced damage drives spatial isolation of the dioecious palm *Borassus aethiopum* Mart. (Arecaceae) in the Pendjari National Park, Benin

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### ABSTRACT

Spatial patterns (SP) of treefall by elephants are known to be clustered across landscapes as a result of food selection and group foraging. Yet, few studies have explicitly elucidated how elephant pressure (EP) alters SP and tree-to-tree distance of tree species especially for dioecious plant species, at stand scale. Using the pair-correlation function and distance to the nearest neighbour on spatial data from five plots of 1–1.5 ha, this article compared SP of damaged and undamaged individuals and tree-to-tree distance of the dioecious palm *Borassus aethiopum* Mart. in stands of low versus high EP in the Pendjari National Park. We tested the hypothesis that high EP would modify SP and results into isolated adults. Nested ANOVAs were used to compare distances. The overall SP of individuals did not vary, but distance among living adults was twofold extended in stands of high EP. The Janzen–Connell escape hypothesis is supported by our data for ungrazed saplings. The study concluded that increasing EP reduces density and induces spatial isolation of adults that may increase pollination failure and threat persistence of *B. aethiopum*.

**Key words:** Benin, *Borassus aethiopum* Mart., Damages, *Loxodonta africana* Blumenbach, Pair-correlation function, Spatial pattern

## 10. Conflict between spotted-necked otters and fishermen in Hlan River, Benin.

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### ABSTRACT

The spotted-necked otter (*Lutra maculicollis*) is believed to be declining across its range and, in Benin, has recently been listed as endangered. In Benin, the spotted-necked otter is largely restricted to the south of the country, where it is threatened by a number of factors, including conflict with fishermen. Understanding the nature and extent of this conflict, and the impact that it has on local fishermen, as well as identifying feasible mitigation strategies, represents a critical challenge for conservation managers. This study documents otter damage experienced by 30 fishermen in the *Hlan* River, in the southern Benin wetlands. We performed hierarchical classification analysis using Ward distances to categorize fish species according to the level of otter damage suffered, and used generalized linear models to identify predictors that best explained otter damage. Our results suggest that of the 16 fish species commonly caught by fishermen in the *Hlan* River, otters favoured the most valuable species (but these were also the most abundant in the catch). However, although otter damage was extensive, monthly total income loss attributable to spotted-necked otter damage (including fish loss and damage to equipment) was estimated at only 9% per fishermen (considerably lower than the 30% reported by a preliminary survey of 163 fishermen in the same area). Our model showed that otter damage increased significantly with the number of adult fish captured by fisherman while the cost of otter damage increased with the length of time that the fishing equipment was left unattended. We suggest that otter damage could be reduced if fishing equipment were checked at least twice a day by fishermen, and recommend a maximum interval between checks of 700 minutes (12hours). Long-term sustainable management of these conflicts will require an integrated approach taking into account socio-economic, political and environmental dimensions.

**Key Words:** Conflict, Otter, Fisheries, Equipment setup duration.

## 11. Nutritional Characteristics of Forage Grown in South of Benin

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*Asian-Australasian Journal of Animal Sciences* 29(1): 51

### ABSTRACT

In order to provide recommendations on the most useful forage species to smallholder farmers, eleven grass and eleven legume forages grown in Abomey-Calavi in Republic of Benin were investigated for nutritive value (i.e. chemical composition and energy content) and fermentation characteristics (i.e. gas and volatile fatty acid production, organic matter degradability). The in vitro gas production technique was used, incubating the forages for 120 h under anaerobic condition with buffalo rumen fluid. Compared to legume, tropical grass forages showed lower energy (8.07 vs 10.57 MJ/kg dry matter [DM]) and crude protein level (16.10% vs 19.91% DM) and higher cell wall content (neutral detergent fiber: 63.8% vs 40.45% DM), respectively. In grass forages, the chemical composition showed a quite high crude protein content; the in vitro degradability was slightly lower than the range of tropical pasture. The woody legumes were richer in protein and energy and lower in structural carbohydrates than herbaceous plants, however, their in vitro results are influenced by the presence of complex compounds (i.e. tannins). Significant correlations were found between chemical composition and in vitro fermentation characteristics. The in vitro gas production method appears to be a suitable technique for the evaluation of the nutritive value of forages in developing countries.

**Key Words:** Grass, Legume, In vitro Gas Production, Nutritive Value, Degradability.

## 12. Prioritization of useful medicinal tree species for conservation in Wari-Maro Forest Reserve in Benin: A multivariate analysis approach

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*Forest Policy and Economics* 61: 135–146

### ABSTRACT

Prioritization of medicinal plant species in conservation schemes is critically important in low income countries. This paper aimed at developing a multivariate prioritization approach to guide conservation of medicinal tree species of Wari-Maro Forest Reserve in central Benin. Ethnobotany surveys were conducted in communities surrounding the forest, using individual semi-structured interviews with 149 people. Additionally, 42 plots were established in the forest to assess the availability of reported species, using mensuration of ecological indicators. Ethnobotanical indices, harvesting risk index, economic importance, threat status, adaptability to climate variations and ecological indicators were computed and pulled into principal components for each species, to yield a compound priority value. Overall, 73 medicinal tree species were reported for 94 traditional medicinal uses. Using our approach, twelve species emerged as priority species for conservation. The most important priority species were *Afzelia africana*, *Khaya senegalensis*, *Milicia excelsa* and *Pterocarpus erinaceus*. Local perceptions on the availability of three of these species were perfectly congruent with ecological indicators. Enrichment planting and assisted rejuvenation were suggested as urgent conservation actions to be taken.

**Key words:** Medicinal plant; Priority conservation; Local perceptions; Multivariate analysis; Benin

### **13. Factors affecting home gardens ownership, diversity and structure: a case study from Benin**

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#### **ABSTRACT**

Home gardens (HG) provide perspectives for conservation of plant genetic resources while contributing to improving livelihoods. However, knowledge of local factors shaping their ownership, plant diversity (PD) and structure is still limited especially in West-Africa, where food insecurity is acute. This is critical to ensure effective mainstreaming of HGs into future biodiversity conservation and food production policies. Socio-economic and PD data were obtained from individual interviews ( $n = 470$ ) and gardens inventories ( $n = 235$ ) spanning humid, sub-humid and semi-arid zones of Benin. Generalised Linear Models, Hierarchical Cluster Analysis, Principal Component Analysis and Simple Correspondence Analysis were performed to examine socio-economic characteristics (age, gender, education level and main economic activity) affecting HGs ownership, and their effect coupled with intrinsic HGs characteristics (size, age) on PD and structure within HGs, across contrasting bio-geographical regions. HG ownership was significantly dependent upon a complex relationship between age, gender and education level of the farmers. The probability to own HG increased with age with an early involvement in home gardening for women. Similarly, with increasing age, it was more likely to find a male owner than a female owner among the uneducated informants and those of primary school. Inversely, it was more likely to find female owner than a male owner among secondary school level or more. PD increased with increasing owner age and size of the HG. Larger and more diversified HGs were found in sub-humid and semi-arid zones while smaller and less diversified HGs were encountered in the humid zone. HGs were multi-layered. Based on the prevailing plant groups, three categories of HG were distinguished: Herb based gardens, Herb and Shrub/Trees based gardens, and Palm and Liana based gardens. Their prevalence was dependent upon bio-geographical zones and HG owner socio-economic characteristics, with herbs based HGs being mainly associated to women. Results suggest effects of complex interactions between socio-economic factors on HG ownership, and influence of these effects combined with intrinsic characteristics of HGs on PD. The early involvement of women in home gardening and their particular interest in herbs and shrubs are important assets for future conservation strategies based on HG and food production. Interventions are required to interfere with declining PD in HG across generations to accommodate multiple ecosystem service benefits.

**Key words:** Home gardens Ownership Plant diversity Socio-economic Conservation West Africa

### **14. Impact of land use practices on traits and production of shea butter tree (*Vitellaria paradoxa* C.F. Gaertn.) in Pendjari Biosphere Reserve in Benin**

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#### **ABSTRACT**

Dendrometric parameters such as tree DBH, height, crown diameter and size characteristics of leaves and fruit production collected from *Vitellaria paradoxa* subsp. growing in three land use types in Pendjari Biosphere Reserve (PBR) were analyzed. A total of 36 circular plots of 15 m diameter were randomly set in the three main land use sites of the PBR. Thus, Shea butter production was estimated from 90 trees (30 trees in each site) selected randomly. Our results revealed a significant difference in trees traits which increase from the park and hunting zone to the farmlands. The highest production of the selected Shea trees was reported from the farmland. Thus, there is high variability between leaf sizes of trees within the sites while for the fruits the greatest variability is between fruits from same tree. The findings of this study showed that the morphological traits and the production of Shea butter trees could be affected by land use systems.

**Key words:** Production Dendrometric parameters Parks *Vitellaria paradoxa*, Benin

# Articles published in peer-review journal without IF in 2015

## 1. Investigations of on farm seedling productivity of the rare and declining *Caesalpinia bonduc* in Benin (West Africa) by aid of simulation modelling

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### ABSTRACT

*Caesalpinia bonduc* is overexploited and threatened due to its importance in medicine. This study aims at on farm seedling productivity of *C. bonduc* by aid of simulation modelling in order to design its appropriate plantation techniques, harvesting intervals, and soil conditions. Data were collected from nursery and field experiments by measuring stem height, collar diameter, number of leaves and tap root length during 180 days. The simulation model was based on a metabolic pool type model calibrated first to simulate the observed growth data from the nursery (calibration). Following it was used to simulate the growth of plants from field experiments, first by an optimization of the utilization of leaves or roots only, and second by an optimization of the utilization of both leaves and roots at the same time at different plant densities and nitrogen levels. The models show that in order to optimize the utilization of *C. bonduc* it should be planted at high densities with high nitrogen levels. Leaves and roots harvesting should take place every 50-60 days, and maximum 15% of the biomass of roots and leaves should be harvested at each harvesting event.

**Key words:** *Caesalpinia bonduc*, Simulation model, Harvesting intervals sustainable use, Plantations.

## 2. Morphological variation, cultivation techniques and management practices of *Moringa oleifera* in Southern Benin (West Africa)

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### ABSTRACT

This study examined the phenotypic variation and the modalities for integrating *Moringa oleifera* in agroforestry systems in southern Benin in order to contribute to sustainable management of the species. Morphological characterization of *M. oleifera* based on measurements taken on the trees, leaves, leaflets and fruits, and ethnobotanical survey on cultivation techniques and management of plantation of the species were performed. The morphological analysis showed significant variation between populations of *M. oleifera* in the phytodistricts considered in relation to tree height, leaf length, petiole diameter, length and width of leaflets ( $P < 0.001$ ); length, median diameter and fresh weight of pods ( $P < 0.01$ ). In the phytodistricts considered in the southern Benin, the culture of *M. oleifera* was mainly by cuttings (92.85 to 97.8%) and row planting (91.83 to 98.03%). The adoption rate of *M. oleifera* varied between 89.79 and 97.05%. There was significant dependence between the management practices and the willing for adoption ( $\Delta G_2 = 5.59$ ,  $P = 0.018$ ), between management practices and the origin of planting materials ( $\Delta G_2 = 5.50$ ,  $P = 0.019$ ).

**Key words:** *Moringa oleifera*, Phenotypic variation, Management practices, Phytodistricts.

### **3. Impact of climate on seed morphology and plant growth of *Caesalpinia bonduc* L. in West Africa**

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*International Journal of Agronomy and Agricultural Research.* **6:** 86-96.

#### **ABSTRACT**

*Caesalpinia bonduc* L. is an important medicinal plant threatened by overexploitation. In the present study, the impact of climate on seed morphology, germination capacity, seedling and plant growth of *C. bonduc* were evaluated. A total of 2000 seeds were collected in Sudanian and Guinean climate zones of Africa and their length, width, thickness, weight and color were recorded. A hierarchical classification and canonical discriminant analysis were applied to the above traits of seeds from the different climatic zones. An analysis of variance with repeated measures was applied to seeds morphotypes identified by the hierarchical classification to test for the effect of these morphotypes on seed germination, seedling and plant growth. Hierarchical classification helped to identify four seed morphotypes. Canonical discriminant analysis performed on these morphotypes revealed highly significant differences. Morphotypes 1 and 3 comprised green seeds mainly from Sudanian zone while morphotypes 2 and 4 gathered grey seeds mainly from Guinean zone. Morphotype 3 had the longest seeds while the shortest seeds were from morphotype 1. The heaviest seeds were found in morphotype 4 whereas the lightest ones were from morphotype 1. Seeds of morphotype 4 were the thickest and widest, while the slimmest and most narrow ones were grouped in morphotype 1. Morphotype 3, consisting of large green seeds mainly from Sudanian zone, was superior in terms of seedling and plant growth among all morphotypes and should be the best choice for planting purposes of the species.

**Key words:** Sudanian and Guinean climate zones, Hierarchical classification, Canonical discriminant analysis, Morphotypes

### **4. Bowalization: Its Impact on Soil, Biodiversity, and Human Livelihoods in West Africa**

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#### **ABSTRACT**

Bowal (plural bowé) is a particular form of degraded land on hardened ferruginous soils (ferricrete) found in tropical regions with unimodal precipitation. It is characterized by ferricrete exposure due to soil surface erosion. The drivers for bowé establishment are deforestation, intensive monocrop production and/or climatic dryness. Bowé are characterized by reduced water retention capacity and electrical conductivity, low organic matter, nitrogen, silt and extractable phosphorus but high amounts of exchangeable potassium and increased soil temperature. Bowalization leads to loss of biodiversity and changes in vegetation structure. The vegetation on bowé is characterized by annual herbaceous plants and trees with impeded roots growth and structural adaptions (e.g. *Combretum nigricans* develops more stems, more branches and larger crown diameter on bowal compared to surrounding soils). Bowalization has negative consequences for crop production. Farmers in West Africa have adopted methods for growing cowpea and groundnut on bowé using a hoe for manual tillage and weed control. Livestock herders exploit the short season with annual grasses and practice transhumance or use food supplies during the dry season. Bowalization is predicted to persist and increase in extent in the future.

**Keywords:** Bowé, Plant biodiversity, Crop production, Livestock rearing, Adaptation practice, Land degradation

## **5. Diversité et critères d'adoption des cultivars de maïs (*Zea mays L.*) dans le village Zounou, Centre Bénin**

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### **RÉSUMÉ**

L'objectif de ce papier est de caractériser les cultivars de maïs et de relever les critères soutenant leur adoption. La démarche méthodologique a inclus une séance focus group et des enquêtes avec questionnaire de 80 producteurs de maïs, dont 32 femmes, dans le village Zounou, centre Bénin. Il se dégage que trois cultivars de maïs sont adoptés par les producteurs. Il s'agit des cultivars Gbadé vôvô, gbadé wewé et Carder. Gbadé vôvô est adopté par 97,5% des producteurs, pendant que Gbadé wewé et Carder sont adoptés respectivement par 75,0 % et 37,5 % des producteurs. Les critères d'adoption des cultivars de maïs sont par ordre de préférence décroissante l'importance du cultivar dans l'alimentation du ménage, la demande sur le marché et la disponibilité des semences. Il s'agit de critères soutenus par la préoccupation de souveraineté alimentaire des ménages et qui amènent les producteurs à protéger une diversité de cultivars. Le critère de rendement élevé n'est pas le plus important à Zounou. La prise en compte des résultats de cette étude permettra de distinguer les cultivars de maïs à fort potentiel d'adoption dans le village et les communautés similaires en vue de l'adaptation aux changements climatiques par le développement d'une agriculture résiliente, fondée sur l'agrobiodiversité et les écosystèmes.

**Mots clés :** Agrobiodiversité, Maïs, Cultivar, Adoption, Bénin.

## **6. Approvisionnement et obstacles domestiques à la compétitivité de l'oignon (*Allium cepa*) au Bénin**

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### **RESUME**

L'oignon fait partie des produits alimentaires qui jouent un rôle essentiel dans la sécurité alimentaire au Bénin. Pourtant, les aspects liés aux facteurs de compétitivité fondée sur le marché demeurent très peu documentés. L'objectif est d'apprécier le champ de l'intégration régionale portée par l'oignon avec le Bénin et les obstacles éventuels à sa compétitivité. L'étude a été focalisée sur la ville de Cotonou, principale ville économique du Bénin, avec un complément d'informations dans la ville de Malanville au nord du Bénin. Au moyen d'une approche participative de collecte et d'analyse des données et informations, les résultats révèlent que la plus grande quantité de l'oignon importé vient du Niger. Bien que plus cher, les consommateurs béninois préfèrent l'oignon de Galmi pour son caractère organoleptique et sa moindre difficulté de conservation. Les Nigériens et les Béninois sont les principaux acteurs commerciaux de l'oignon au Bénin. En plus de ce que l'offre du produit est marquée par une forte saisonnalité, l'oignon importé fait l'objet de surcoûts domestiques qui renchérissent son prix pour les consommateurs. Le montant des surcoûts est estimé à 24,3 FCFA/kg. L'amélioration de l'organisation de la filière est nécessaire, tout comme l'amélioration des techniques de production et de conservation.

**Mots clés :** Oignon, Intégration régionale, Compétitivité, Surcoût, Bénin

## 7. Contraintes liées au développement de la culture du taro (*Colocasia esculenta*) au sud-Bénin

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### RESUME

Malgré l'intérêt nutritionnel et la place non négligeable qu'il occupe dans l'alimentation au Bénin, la production de taro ne décolle pas, alors même qu'il est fortement produit au Nigéria voisin qui demeure le premier producteur en Afrique et dans le monde, avec 4.027.000 tonnes en 2005, suivi du Ghana avec 1.800.000 tonnes. Le taro demeure une culture mineure moins valorisée au Bénin. L'objectif de la présente étude est de relever les entraves au développement de la production du taro au sud Bénin. L'étude a couvert deux Communes au sud-est Bénin : les Communes d'Adjara et de Sakété. L'approche méthodologique utilisée a été à la fois qualitative et quantitative. Une séance *focus group* et une enquête de 32 producteurs de taro réalisées dans chacun des quatre villages retenus ont permis de recueillir les données et informations nécessaires. L'analyse de celles-ci permet de dégager que les contraintes au développement de la culture du taro au sud Bénin sont principalement d'ordre agronomique et économique. Les producteurs ne maîtrisent pas les techniques culturales et ne disposent pas de matériel de reproduction approprié. Les rendements obtenus sont donc faibles, avec un cycle cultural encore long ; de 10 à 12 mois. La conséquence est la cherté du produit sur le marché, de sorte que sa consommation est un luxe pour les consommateurs. Des efforts sont nécessaires pour la sélection variétale du taro à haut rendement et à cycle court, la formation des producteurs sur les techniques culturales et la mise à disposition du matériel de reproduction de qualité.

**Mots clés :** Bénin, *Colocasia esculenta*, Espèces négligées, Racines et tubercules, Taro.

## 8. Effect of composting of palm oil mill wastes and cow dung or poultry manure on *Amaranthus hybridus* growth and yield

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### ABSTRACT

**Objective:** To evaluate the effect of shelter and different type of manure on degradation of palm oil mills wastes during composting and on growth and yield of African spinach (*Amaranthus hybridus*) grown on acrisol .**Methodology and results:** Palm oil mills wastes were composted, with poultry manure or cow dung with and without shelter. The experimental trials used the split-split plot design with composting method as a principal factor, the types of manure and rates of compost as secondary factors. The composting of these wastes with manure under shelter improved their decomposition significantly. The compost made with poultry manure under shelter gave the highest plant growth and yield. The compost application rate of 20t/ha was not enough to increase plant growth but increased its yield (20.1t/ha versus 17.9t/ha). **Conclusion and application of findings:** Palm oils mills waste can be composted and used to grow *Amaranthus hybridus*. However, it is better to compost these wastes with poultry manure than cow dung under shelter. In addition, farmers need to apply at least 20t/ha to have high yields.

**Keywords:** Acrisol; African spinach; Guinean climate; Manure; Shelter

## **9. Effect of composting of palm oil mill wastes and organic manure on tomato (*Lycopersicon esculentum* Mill.) growth and yield**

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### **ABSTRACT**

Compost made of palm oil empty fruit bunches, fibre, poultry manure and cattle dung composted in shelter were applied to tomato [*Lycopersicon esculentum* (Mill.)] to evaluate their effects on its growth and yield. The trials consisted in a split-split plot design with two levels of composting method (without cover or under cover) and the types (no manure, poultry manure, cow dung) and rates of compost application (0t/ha, 5t/ha, 10t/ha, 20t/ha) as secondary factors. The height and stem girth of three plants per plot were measured weekly at 6 weeks after transplanting. The total number of fruits, marketable fruits and fruit weights were collected at production phase. All data collected from the tree trials were put together and the analysis were made with four ways ANOVA with repeated measured to determine if there were significant differences amongst treatments. There were no significant effects between the compost made under cover and those made in the open on tomato plant height at 6 weeks after planting. There was no significant effect of composting method, type of manure and compost rate application on *Lycopersicon esculentum*. The effect of compost application on tomato yields was significant at 10t/ha compost application rate. The total number of tomatoes fruits depended significantly ( $p<0.05$ ) on the compost application rate. The highest number of tomatoes fruits obtained was 19.4 at 20t/ha as compost application rate.

**Keywords:** Aricsol, Compost, Manure, Palm oil mill wastes, Tomato

## **10. Erosion effect on soil properties in Karimama (Northern Benin)**

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### **ABSTRACT**

Water erosion, chemical degradation, wind erosion and physical degradation have been reported as main types of soil degradation in the world. In Karimama district water erosion is a major process for soil degradation. Nevertheless, water erosion can be a consequence of degradation of the soil structure, especially the functional attributes of soil pores to transmit and retain water, and to facilitate root growth. The current study aims to find out water erosion effects on soil physical and chemical characteristics. Pedological soil profiles have been done both in W National Park and its peripheral land use areas. Soil samples are collected for laboratory analyses (i) in three depth  $H_1 : 0 - 20$  cm top soil,  $H_2 : 20 - 50$  cm and  $H_3 : > 50$  cm (ii) in three types of gullies (dongas) from the less deep to the deeper one and on their plateau (nearby and far from donga). Soil acidity, texture, organic carbon, total nitrogen, available and total phosphorous sum of exchangeable bases and cation exchange capacity are the studied parameters. Soil texture is clay-sandy-loamy in the W National Park and its periphery. The soil of the two sites has a clay-sandy loam texture. Water erosion began with the selective removal of fine sand. It significantly affects bulk density and soil porosity. The erosion acidifies the soil because the soil is more acidic in dongas than on plateaus. The organic matter contents on the studied soils are extremely low in the soil and are not significantly influenced by the erosion intensity. However, erosion has significantly reduced the cation exchange capacity of the soil or a loss of soil metal cations (especially Ca<sup>2+</sup>). This decalcification of the soil explains soil acidification as a result of erosion. Nitrogen appears to be deficient element that must be given to the soil in order to increase crop yield in a sustainable way in this part of northern Benin.

**Key words.** Water erosion, Gully (donga), Physico-chemical properties, Physical degradation, Benin.

## 11. Habitat Use by White-thighed Colobus in the Kikélé Sacred Forest: Activity Budget, Feeding Ecology and Selection of Sleeping Trees

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### ABSTRACT

Understanding habitat preference and use is an important aspect of primate ecology, and is essential for setting conservation strategies. This study examined the activity budget, feeding ecology and selection of sleeping trees of a population of white-thighed colobus (*Colobus vellerosus*). A group of 18 was followed during 72 days over a full annual cycle in the Kikélé Sacred Forest of the Bassila administrative region in central Benin (West Africa). Activity budget and diet were determined using scan sampling. The structure of the habitat and the physical characteristics of sleeping trees were determined using plot surveys. Resting, feeding, moving, social interactions and other activities accounted for 56.6%, 26.3%, 13.0%, 3.3%, and 0.7% of the activity budget, respectively. The group spent more time feeding and less time moving in the dry season compared to the rainy season. The diet was composed of 35 plant species belonging to 16 families, with items including leaves, fruits, seeds, buds, bark, flowers, gum, and inflorescences. Only three tree species were used as sleeping trees: *Celtis integrifolia*, *Cola cordifolia*, and *Holoptelea grandis*. Our findings suggest that the monkeys prefer tall ( $22.53 \pm SD 3.76$  m) and large-trunked ( $112.07 \pm SD 14.23$  cm) sleeping trees. The results of this study can be used for sound management of the white-thighed colobus in the study area and elsewhere.

**Key Words:** Activity budget, Feeding ecology, Sleeping trees, *Colobus vellerosus*, Conservation, West Africa

## 12. Improving small-scale farmers' endogenous crop-livestock practices in rural, peri-urban, and urban areas of Benin

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*Journal of Animal & Plant Sciences*

### ABSTRACT

This study aimed at describing indigenous crop-livestock systems used in rural, periurban and urban areas of Benin for their improvement. A socioeconomic survey was conducted in three areas and two hundred and forty (240) farmers were interviewed on their practices. Three integration levels were identified; no integration (NI, 36%), partial integration (PI, 55%) and total integration (TI, 9%) and the obtained groups were characterized. Then, a multiple correspondence analysis was performed to identify partial integration subgroups. Main Integrated Crops Livestock Systems (ICLS) identified ranged from Low external input agriculture (LEIA) to High external input agriculture (HEIA). While rural farmers preferred Mixed Crop-Livestock Farming with enhancement of cereals and legumes residues (PI) and Mixed Crop-Livestock Farming with utilization of manure and crop residues (TI), those from peri-urban area preferred Mixed Crop-Livestock Farming with value ascribed to roots/tubers residues (PI). Urban farmers' practices were Mixed Crop-Livestock Farming with utilization of bought poultry dejections (PI). Improvement of these systems can be done through a better adequacy of production systems to valorise available crop residues and manure. This is a good issue for smallholders' empowerment and nutrients recycling in farms.

**Key words:** Mixed farming, Manure, crop residues, sustainable agriculture, urbanization.

## **13. Performance des Systèmes Intégrant Agriculture et Elevage (SIAE) endogènes au Bénin**

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**Bulletin de la Recherche Agronomique du Bénin (BRAB), Numéro spécial Economie et Sociologie Rurales**

### **ABSTRACT**

Au Bénin, les difficultés des producteurs en rapport avec la fertilité des sols se sont accrues surtout à cause de la pression démographique. Au nombre des solutions qui s'offrent aux producteurs, figure l'intégration entre l'agriculture et l'élevage. L'un des principaux objectifs de l'étude est d'analyser la performance des Systèmes Intégrant Agriculture et Elevage (SIAE) endogènes existants de trois zones agro-écologiques du Bénin que sont le Littoral, l'Atlantique et le Borgou. Une analyse des caractéristiques socio-économiques des enquêtés a été réalisée. Les fréquences, les paramètres de position (moyennes arithmétiques) et les paramètres de dispersion (écart-type) ont été calculés pour décrire les caractéristiques socio-économiques des unités de recherches enquêtées. Une régression Probit ordonnée a été réalisée afin d'analyser les facteurs influençant la performance des SIAE endogènes dans les zones d'étude. De l'analyse des données collectées, les trois SIAE endogènes suivants ont pu être identifiés : le système mixte avec un achat de déjections (maraîchers du littoral) ; le système mixte avec faible introduction de déjection et de résidus (producteurs de l'Atlantique) ; le système mixte avec résidus et déjection produits à la ferme (agro-pasteurs du Borgou). L'analyse de la performance a révélé que plus le niveau d'intégration agriculture-élevage est élevé au sein de l'exploitation plus le niveau de revenu du producteur augmente sous l'effet d'un faible coût de production et de rendements élevés.

**Mots clés :** SIAE endogènes, Revenu, Performance, Zones agro-écologiques, Bénin.

## **14. Medicinal tree species in Benin (West Africa): Literature review and perspective researches**

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### **ABSTRACT**

Several ethnobotanical and ethnopharmacological studies have been carried out on medicinal plants in Benin and other countries sharing the same centers of endemism. A literature review could aid to assess the related data for perspective researches and decision-making for the conservation of those plants. The present work aims to determine the most important medicinal tree species of the study area and those which would be recommended for conservation due to the uses of their sensitive organs for medicinal purposes. Thirty eight (38) published articles were exploited from which about 263 medicinal tree species were recorded. Those medicinal tree species belong to 193 genera and 59 families used in Benin. They are used for 146 medicinal properties categorized into 17 groups, with the highest number of species used for treatment of digestive system diseases, cardiovascular system diseases, skin and cutaneous diseases, and malaria and similarly infectious diseases. Relative importance index has permitted to identify 27 important medicinal tree species among which some are recommended for conservation. This study suggests on the whole that the kind and prevalence of medicinal uses are taken into account in the course of conservation studies of medicinal plants.

**Keywords:** Medicinal plant, Literature review, Medicinal properties, Conservation, Benin

## 15. Assainissement de l'environnement par la valorisation des ressources non conventionnelles en alimentation de porcs en croissance

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### RESUME

La présente étude s'est intéressée à la comparaison des performances zootechniques et économiques des porcs nourris avec des aliments commerciaux et des aliments non conventionnels. Au total, 90 porcelets métis (race locale X Large white) âgés de 60 à 90 jours dont 45 mâles castrés et 45 femelles, ont été répartis en 15 lots de 6 animaux, à raison de 3 loges de 6 porcelets par traitement alimentaire. Chaque lot a été nourri à volonté avec un aliment commercial et quatre aliments contenant différents taux de Azolla, Moringa, son de riz, viscères de poulet Cobb 500 et de poisson *Oreochromis niloticus*. Une différence significative ( $P < 0,05$ ) a été notée entre les gains moyens quotidiens (GMQ). Après 90 jours d'expérimentation, les GMQ étaient de 197g/j pour les porcs du lot à aliment commercial et de 63 à 101g/j pour ceux soumis aux aliments à base de ressources non conventionnelles. Il ressort des calculs économiques que le coût alimentaire (Ca) par kg de gain de poids (GP) était plus faible pour l'aliment non conventionnel (716 FCFA/kg GP) par rapport à l'aliment commercial (830 FCFA/kg GP). Il est donc possible d'utiliser ces ressources non conventionnelles pour nourrir de façon efficiente des porcs dans un système intégré d'exploitations familiales tout en rendant l'environnement sain.

**Mots clés :** Aliment, Performance, Porcs, Rentabilité économique.

## 16. Technological, sensorial and nutritional meat quality traits from pig fed with conventional and unconventional diets

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*Food and Nutrition Sciences, 6: 1514-1521*

### ABSTRACT

The aim of the study was to evaluate the impact of unconventional food resources on the quality of pig meat. 90 pigs of which 20 were slaughtered at 180 days old for meat quality evaluation. It came out from the study that the highest L\* and b\* were obtained in A<sub>0</sub> commercial feed, while the highest a\* was recorded in A<sub>3</sub> ( $P < 0.05$ ). From 45 minutes to 24 h post-mortem, the highest pork hue value was recorded in A<sub>2</sub>, whereas the highest chromaticity was found in A<sub>0</sub>. The pH 45 and pH 24 of Mld (Muscle *Longissimus dorsi*) were lower in control group than in experimental groups. The cooking loss and water-holding capacity of the meat from A<sub>4</sub> were higher than those of other treatments. Luminance, redness, yellowness, chroma values and pH of the pork had increased during the post-mortem aging time for the both diet treatments while the hue value decreased ( $P < 0.05$ ). Nutritionally, the protein content, the fat content, the dry matter content and the ash content varied respectively from 24.45% to 26.87%, 0.52% to 1.6%, 26% to 27.5% and 1.1% to 1.79% with the highest protein contents found in meat from unconventional feed A<sub>4</sub> ( $P < 0.01$ ) while the highest fat content (1.6%) was obtained from meat of the control group A<sub>0</sub> ( $P < 0.001$ ). The texture of the meat from the control group was better than those of experimental groups ( $P < 0.01$ ). Overall, unconventional diet based on Azolla and Moringa improves technological and nutritional pork quality.

**Keywords:** Pig, Meat Quality, Unconventional Diet, Benin

## 17. Typologie, productivité, capacité de charge et valeur pastorale des pâturages des parcours transhumants au Nord Est de la République du Bénin

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### RÉSUMÉ

Les Départements du Borgou et de l'Alibori à eux seuls détiennent environ 60 % du cheptel bovin béninois qui est estimé à 2.166.000 têtes. L'alimentation de ces animaux étant exclusivement basée sur les pâturages naturels, il est important d'avoir une idée des caractéristiques de ces derniers afin de prendre des décisions. L'étude s'est déroulée dans la partie Nord Est du Bénin et a pour objectif de caractériser les pâturages de cette région. Au total 60 relevés phytosociologiques ont été effectués, 40 placeaux de productivité et 40 relevés linéaires ont été effectués. Les relevés ont été traités au moyen du logiciel CAP et a permis d'identifier les types de pâturage. Quatre (04) types de pâturages ont été identifiés. La biomasse la plus élevée a été obtenue dans les pâturages à *Ficus glumosa* et *Hyparrhenia involucrata* (5,7 t MS/ha) tandis que la valeur la plus faible est obtenue dans les pâturages à *Piliostigma thonningii* et *Stylosanthes fruticosa* (3,46 t MS/ha). La physionomie des groupements végétaux étudiés est dominée par les phanérophytes (55 %) et les thérophytées (35 %). Les espèces soudanaises (58 %) sont dominantes suivies des espèces paléotropicales (12 %). La valeur pastorale la plus élevée a été observée dans le pâturage *Cochlospermum tinctorium* et *Tephrosia pedicellata* (32,6). Il découle de cette étude que les pâturages du milieu d'étude sont dégradés, ont une faible productivité et une valeur pastorale faible. La connaissance de ces paramètres permet d'avoir une idée sur la pression que subit cette région du pays.

**Mots-clés:** Caractéristiques, Pâturage, Elevage, Transhumance, Bénin.

## 18. Transhumance en République du Bénin: états des lieux et contraintes

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### RESUME

L'élevage pastoral joue un rôle prépondérant dans l'économie des pays de l'Afrique tropicale. Au Bénin, l'élevage, surtout celui du gros bétail, est essentiellement transhumant. De nombreuses études et rencontres scientifiques se sont consacrées à sa connaissance en vue de résoudre les difficultés qu'elle génère et de nombreuses dispositions réglementaires ont été adoptées dans ce même objectif. Le but de la présente étude est de faire un état des lieux de ces différents travaux afin d'en sortir les contraintes auxquelles ce système est confronté. Pour ce faire, plusieurs documents qui ont traités de la transhumance au Bénin et dans la sous-région Ouest Africaine ont été consultés. Les données obtenues ont été synthétisées. Ensuite une caractérisation de la transhumance a été faite. L'outil utilisé est la triangulation. Il ressort de l'étude que les premiers écrits sur la transhumance datent de 1905. Les résultats ont également permis de voir qu'elle est confrontée à des problèmes d'alimentation, de variabilités climatiques, des textes réglementaires, de conflits et de disponibilités des infrastructures pastorales. Il ressort également que la transhumance demeure sous la forte influence des systèmes de culture surtout pendant la sécheresse. Mais la contribution des systèmes de culture demeure insuffisante.

**Mots clés :** Système d'élevage, Audit, difficultés, Alimentation, Afrique de l'Ouest.

## **19. Cartographie et gestion des principaux points d'abreuvement aménagés des troupeaux transhumants au Nord Est du Bénin**

P. Lesse<sup>1</sup>, J. Djenontin<sup>2</sup>, B. Yabi<sup>2</sup>, I. Toko<sup>3</sup>, B. Tente<sup>3</sup> & M. Houinato<sup>1</sup>

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### **RÉSUMÉ**

L'élevage, deuxième activité économique après l'agriculture en Afrique soudanienne contribue à la sécurité alimentaire dans les communautés pastorales et agropastorales. Cet élevage est encore extensif et essentiellement basée sur les ressources naturelles pour l'alimentation et l'abreuvement des animaux. Pour une meilleure connaissance du disponible, un inventaire exhaustif des infrastructures d'abreuvement est fait au Nord-Est du Bénin à travers une revue documentaire, une cartographie participante et enfin la visite de ces points afin de prendre les coordonnées de ces derniers avec un GPS, puis reporter sur une carte avec le logiciel ArcView à partir du répertoire de leurs coordonnées. L'analyse de la gestion des infrastructures d'abreuvement est réalisée à partir des enquêtes adressées aux acteurs déterminés auparavant avec l'outil FFOM à travers un échantillon de 180 personnes. Ces questionnaires d'enquête ont été traités avec le logiciel Sphynx plus. Au total 162 infrastructures d'abreuvement ont été inventorierés dans le milieu d'étude réparties en barrages, retenues d'eau, surcreusements de mare et puits. Les difficultés d'accès à ces infrastructures et les utilisations de l'eau stockée à d'autres fins ont été aussi mises en exergue. Il ressort de ces analyses que l'inexistence de voies d'accès aux points d'eau et la colonisation des eaux par certains végétaux constituent les préoccupations les plus importantes des éleveurs pastoraux. En effet, l'occupation ou l'obstruction des couloirs est source de nombreux conflits entre agriculteurs et éleveurs et les difficultés d'accès aux infrastructures d'abreuvement relativisent leur importance dans les activités d'élevage de la zone d'étude.

**Mots clés :** Bénin, Cartographie, Abreuvement, Gestion, Troupeaux

## **20. Climatic variability and spatial distribution of herbaceous fodders in the Sudanian zone of Benin (West Africa).**

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*International Journal of Engineering Research and Applications (IJERA)*

### **RÉSUMÉ**

This study focused on future spatial distributions of *Andropogon gayanus*, *Loxodera ledermannii* and *Alysicarpus ovalifolius* regarding bioclimatic variables in the Sudanian zone of Benin, particularly in the W Biosphere Reserve (WBR). These species were selected according to their importance for animals feed and the intensification of exploitation pressure induced change in their natural spatial distribution. Twenty (20) bioclimatic variables were tested and variables with high auto-correlation values were eliminated. Then, we retained seven climatic variables for the model. A MaxEnt (Maximum Entropy) method was used to identify all climatic factors which determined the spatial distribution of the three species. Spatial distribution showed for *Andropogon gayanus*, a regression of high area distribution in detriment of low and moderate areas. The same trend was observed for *Loxodera ledermannii* spatial distribution. For *Alysicarpus ovalifolius*, currently area with moderate and low distribution were the most represented but map showed in 2050 that area with high distribution increased. We can deduce that without bioclimatic variables, others factors such as: biotic interactions, dispersion constraints, anthropic pressure, human activities and another historic factor determined spatial distribution of species. Modeling techniques that require only presence data are therefore extremely valuable.

**Key-words:** Bioclimatic variables, Distribution, Fodders, MaxEnt, Model.

## 21. Determinants of crop-livestock integration by small farmers in three agro-ecological regions of Benin

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*International Journal of Biological and Chemical Sciences 8 (6): 2608-2625*

### ABSTRACT

Despite the numerous work conducted on integrated crop-livestock systems, very little is known about factors determining farmers' trend to integrate. Our study aimed at a socioeconomic characterization of endogenous crop-livestock integration in Benin and identification of determinants of farmers' decision to use these practices. Two hundred and forty farmers were surveyed in three agro-ecological regions randomly selected. A semi-structured questionnaire was used to collect information on farmer's characteristics, production factors and agriculture and breeding by-products valorization practices. On the basis of main links between both productions, three integration levels (no integration, NI: 36%; partial integration, PI: 55%; total integration, TI: 9%) were identified and characterized according to socioeconomic characteristics of farmers. Then the multinomial logistic regression technique was used to predict the integration level of a given farmer in function of its socioeconomic characteristics. The three integration levels differ significantly ( $p < 0.001$ ) according to variables such as membership in farmers' association, educational level, weight of agricultural experience, farm equipment and size of herds. The decision by a farmer to choose the total integration type significantly depends ( $p < 0.001$ ) on the size of his cattle herd, his membership in farmers' association, the weight of his agricultural experience and his equipment value. Thus, integration is a practice used by small farmers with good experience in agriculture. Strategies for improving integration of cropping and breeding are to motivated farmers for cattle keeping and membership in an association.

**Key words:** Animal feeding, Integrated Soil Fertility Management, Resilience, Sustainability.

## 22. Perception paysanne sur la fragmentation du paysage de la Forêt classée de l'Ouémedé Supérieur au nord du Bénin

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*VertigO – la revue électronique en sciences de l'environnement*

### RÉSUMÉ

Face à l'échec des politiques variées d'aménagement des paysages forestiers tropicaux dans un contexte de fragmentation croissante, il est pressant de trouver des stratégies de gestion durable des ressources naturelles et de la biodiversité. La présente étude a consisté à analyser la perception des populations de la qualité écologique des habitats du paysage de la forêt classée de l'Ouémedé Supérieur au nord du Bénin et des facteurs déterminants de sa fragmentation. Les données recueillies auprès de 247 enquêtés par des entretiens semi-structurés et des focus group ont permis de réaliser des diagrammes de fréquences de réponses appuyées par un test de Khi2 entre les genres et une analyse factorielle de correspondance entre les catégories socioprofessionnelles. Les résultats indiquent que d'après les populations le niveau de dégradation des habitats du paysage de la forêt classée de l'Ouémedé Supérieur est de fort à moyen et que les déterminants de la fragmentation sont l'exploitation forestière, les feux de végétation et le pâturage. Ces résultats soulignent la nécessité et la pertinence de l'étude des perceptions des populations sur la qualité des habitats des paysages forestiers pour mieux orienter les mesures d'aménagement à prendre dans une approche paysagère.

**Mots - clés:** Perception paysanne, Fragmentation, Paysage forestier, Aménagement durable, Approche paysagère, Ouémé Supérieur, Bénin

## **23. *Lantana camara* (Verbenaceae): a potential threat to the effectiveness of protected areas to conserve flora and fauna in Benin**

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*Agronomie Africaine* 27 (2): 115 – 126

### **ABSTRACT**

Invasive plant species are today among the biggest threats to integrity of many ecosystems including that of the protected areas. Climate change may exacerbate the negative effects of invasive plant species. Here, we used the Maximum Entropy model to project habitat suitability for *Lantana camara* L., an invasive plant species under current and future climates in the national protected areas network of Benin. The models were run using bioclimatic data and data on soil type. Nineteen percent of the total land in the protected areas network was highly suitable for *L. camara* under current climate. Highly suitable areas under current and future climates cover about 65 % of the Pendjari Biosphere Reserve, the major wildlife sanctuary in Benin. Other bio-reserves such as W National Park, Lama, Agoua, Dogo-Kétou, Atchérigbé, Mékrou and Kouandé Forest Reserves were also suitable for the species. Presence of *L. camara* in the protected areas represents a great potential threat to the global food webs being conserved. Based on these results, areas with highly suitable habitats are at high risk of invasion by *L. camara*, and should be accorded high priority when formulating appropriate management strategies.

**Key words:** Invasive species; Climate change; Habitat suitability; Protected areas; West Africa

## **24. Agromorphological variability of pearl millet (*Pennisetum glaucum* (L.) R. Br.) Cultivars grown in Benin**

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### **ABSTRACT**

The agromorphological variability between various pearl millet cultivars was evaluated to examine the structure of millet in Benin Republic. Therefore, Forty-two (42) cultivars of pearl millet were collected from four agro-ecological areas viz North Extreme Zone (AEZ<sub>1</sub>), cotton Zone of northern (AEZ<sub>2</sub>), Food Zone of South-Borgou (AEZ<sub>3</sub>) and West-Atacora Zone (AEZ<sub>4</sub>) of Benin Republic. The experimentation was conducted on Ahossougbéta farm in the town Abomey-Calavi by using alpha lattice design in order to access thirty-three (33) agromorphological characters (seventeen (17) quantitative and sixteen (16) qualitative characters). The canonical discriminant analysis, principal component analysis and hierarchical ascendant classification has identified three morphological classes based on 16 quantitative traits and 8 qualitative discriminating Wilks' Lambda ( $P<0.0001$ ). According to vegetative cycle, agroecological zones and botanical race, the distribution of cultivars has regrouped the three classes in two great groups of importance for the improvement of the millet resources. The first one group established with the early cultivars (58.33%) to yellow grain (83.33%), long candle (58.23 cm Valeur test +5.23) with low seed production characteristics ( $P1000 = 8.68 \text{ g Vt} - 4.64$ ). It results from ZAE<sub>1</sub> (83 %) and ZAE<sub>2</sub> (17%) and belong to *globosum*, *typhoides* and *leonis* races. The second group is trained of late cultivars (90% class 2 and 94.12% class 3) to grey and dark grey grains (72.73%), short candle (21.12 cm Vt -2.33 and 22.38 cm Vt -2.77) offering the best vegetative development characteristics (Class2 and Class3) and the seed yield (Class 3). Results of the study revealed the trade routes between agroecological zones and millet producer ethnic groups of Benin. These results are significantly important for the definition of strategies for improvement and conservation of millet genetic resources in Benin.

**Keywords:** Pearl millet; Botanical race; Genetic resources; Conservation strategies; Benin

## **25. Effet de l'érosion hydrique sur les caractéristiques physico-chimiques du sol des zones d'érosion (dongas) dans la Commune de Karimama au Bénin**

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### **RESUME**

L'érosion hydrique et éolienne, la dégradation chimique et physique ont été signalées comme étant les principaux types de dégradation du sol dans le monde. L'érosion hydrique est un processus majeur de dégradation des sols à Karimama au nord du Bénin. Elle entraîne la dégradation de la structure du sol, en particulier, les attributs fonctionnels des pores du sol, permettant de transmettre et de retenir l'eau afin de faciliter la croissance des racines. L'objectif de la présente étude est de faire ressortir les effets de l'érosion hydrique sur les caractéristiques physiques et chimiques du sol. Pour atteindre cet objectif, des profils pédologiques ont été ouverts, aussi bien dans le Parc National du W que dans les terroirs. Des échantillons du sol ont été prélevés pour des analyses en laboratoire (i) à trois profondeurs du sol H<sub>1</sub> : 0-20 cm (surface du sol), entre 20 et 50 cm (H<sub>2</sub>) et au-delà (H<sub>3</sub> : > 50cm), (ii) dans trois types de ravins (*donga*), du moins profond au plus profond, sur leur plateau proche et plateau éloigné. Les paramètres étudiés ont été l'acidité du sol, la granulométrie, le taux de carbone organique du sol, l'azote total, les phosphores assimilable et total, la somme des bases échangeables du sol et la capacité d'échange cationique. Le sol des deux sites a une texture argilo-sablonneuse. L'érosion hydrique a commencé par le prélèvement sélectif de sables fins. Elle a significativement affecté la densité apparente et la porosité du sol. L'érosion acidifie le sol car il est plus acide au niveau des *dongas* qu'au niveau des plateaux. Au niveau des sites étudiés, la matière organique, déjà très faible dans le sol, n'est pas significativement influencée par l'intensité de l'érosion. Cependant, l'érosion a réduit de façon significative la capacité d'échange cationique du sol soit une perte du sol en cations métalliques (Ca<sup>2+</sup> surtout). Cette décalcification du sol explique son acidification sous l'effet de l'érosion. L'azote est aussi déficient, un élément nutritif qu'il convient d'apporter si l'on veut accroître les rendements agricoles de manière durable dans cette partie du nord Bénin.

**Mots clés :** Erosion hydrique, Ravin (*donga*), Caractéristiques physico-chimiques du sol, Dégradation physique, Bénin

## **26. Variation of rainfall regime in the W Transboundary Biosphere Reserve (BENIN)**

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### **ABSTRACT**

This study aims to highlight change on rainfall rhythm at monthly and annual scale. Study data are monthly precipitations over the period 1965-2010, of the three Municipalities Banikoara, Kandi and Karimama bordering of Benin reserve of the complex W of Niger. Statistical methods of standardized rainfall index; calculation of 10 years moving average and graphical representation help to highlight change on rainfall regime in time and space. Annual total rainfall varies between -42.2 % with a very dry regime and +47.5 % with the very wet regime. This rainfall regime variation affects water availability and a life cycle of biological diversity in this area. This complicates socio-economic activity in the exploitation area around W Biosphere Reserve in Benin.

**Keys words:** Monthly rainfall, average Movement, W biosphere reserve, Benin.

## 27. Domesticating and conserving indigenous trees species: an ecosystem based approach for adaptation to climate change in sub-Saharan Africa

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### ABSTRACT

The current food production systems in Africa geared towards alleviating poverty and eliminating hunger, in accordance with Millennium Development Goal number one, are faced with many challenges. These challenges include among others i) the identification of plant species that will best suit specific environmental conditions under climate change ii) the need to sustainably feed people and improve their livelihoods while conserving native ecosystems iii) Loss of local capacities and know-how to sustainably manage local resources due to decades of external decision making on which crop to grow (mainly exotic plants). To date, there is agreement that domestication of indigenous plant species for the diversification of subsistence agriculture could play a big role in the achievement of the Millennium Development Goals. These species can be conserved and used to halt and reverse the increasing degradation of ecosystems while providing economic opportunities, particularly in African countries. Integration of these indigenous species into formal production systems could help establish an ecosystem based development path in African countries. To ensure the sustainability of such a new development pathway, it is important to guarantee availability of sufficient scientific information to guide decision making especially within the context of climate change and socioeconomic vulnerability. In addition, policy makers will need scientific information on market incentives and other policy instruments that can facilitate both conservation and development goals considering the MDGs. Moreover, paradigm shift in the development concept, education and capacity building will also be needed.

**Key words:** Prioritization, Indigenous species, Socio-economic importance, Resistance to climate aggressiveness

## 28. Habitat Use by White-Thighed Colobus in the Kikélé Sacred Forest: Activity Budget, Feeding Ecology and Selection of Sleeping Trees

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*Primate Conservation (29):97-105.*

### ABSTRACT

Understanding habitat preference and use is an important aspect of primate ecology, and is essential for setting conservation strategies. This study examined the activity budget, feeding ecology and selection of sleeping trees of a population of white-thighed colobus (*Colobus vellerosus*). A group of 18 was followed during 72 days over a full annual cycle in the Kikélé Sacred Forest of the Bassila administrative region in central Benin (West Africa). Activity budget and diet were determined using scan sampling. The structure of the habitat and the physical characteristics of sleeping trees were determined using plot surveys. Resting, feeding, moving, social interactions and other activities accounted for 56.6%, 26.3%, 13.0%, 3.3%, and 0.7% of the activity budget, respectively. The group spent more time feeding and less time moving in the dry season compared to the rainy season. The diet was composed of 35 plant species belonging to 16 families, with items including leaves, fruits, seeds, buds, bark, flowers, gum, and inflorescences. Only three tree species were used as sleeping trees: *Celtis integrifolia*, *Cola cordifolia*, and *Holoptelea grandis*. Our findings suggest that the monkeys prefer tall ( $22.53 \pm 3.76$  m) and large-trunked ( $112.07 \pm 14.23$  cm) sleeping trees. The results of this study can be used for sound management of the white-thighed colobus in the study area and elsewhere.

**Key words:** Activity budget, Feeding ecology, Sleeping trees, *Colobus vellerosus*, Conservation, West Africa

# Articles in press in peer-review journal with IF in 2015

## 1. In vivo digestibility of *Boerhavia diffusa* and *Khaya senegalensis* in West African Dwarf sheep in the Sudano-Guinean zone in Benin

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*South African Journal of Animal Science*

### ABSTRACT

Nutritional values of two anthelmintic forage species namely *Boerhavia diffusa* and *Khaya senegalensis* were determined by in vivo digestibility tests. The study was performed on 12 non-castrated rams sheep with an average weight of  $23 \pm 0.6$  kg vaccinated, dewormed, divided into two homogeneous groups of six subjects for each plant and housed individually. The experiment lasted 25 days divided into two phases: adaptation and data gathering which is about food, refusals and faeces samples weighing. Chemical analyzes and bromatology of all samples collected were made. The forages' net energy was calculated from the organic matter constituents' digestibility according to the INRA system. Phytochemical screening of leaves of *B. diffusa* and *K. senegalensis* shows the presence of secondary metabolites. On the other hand, galenic tannins's level is much higher in *K. senegalensis* than in *B. diffusa*. That negatively affects its water's level, its intake, its nitrogen's, fat's, and energy's digestibility coefficient cross-check to *B. diffusa* ( $p < 0.1$ ). Indeed, *B. diffusa*'s net energy level for growth and feeder were higher than *K. senegalensis*'s ( $p < 0.1$ ). *B. diffusa*'s leaves had a better nutritional value than *K. senegalensis*'s and could improve ovines's growth by appropriate supplementation.

**Key words:** Anthelmintic plants; Forage; Nutritional value, Phytochemical screening.

## 2. Effects of land cover change on rangeland vegetation in W Biosphere Reserve, Benin (West Africa).

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*Journal of Research in Forestry, Wildlife and Environment*

### ABSTRACT

Due to the rapid increase of population demography, land cover changed. In this situation, the management approach adopted by most African developing countries for biodiversity conservation was the development of protected areas. But these areas were located where poverty and insufficient employment opportunities determine population's needs and activities. In this context, protected areas vulnerability increased. Thereby, this study focused on land cover change evaluation inside the W Biosphere Reserve (WBR) in Benin during these last decades. For this purpose, three serial times of maps, taken in 1989, 2000 and 2013 were interpreted using the software Arc Gis 10.1. Dynamics areas proportions values were calculated and Transition matrices were elaborated. Results showed that land cover has changed considerably and these changes were mostly observed in the periphery of the hunting zone where settlements, farms and fallows were noticed and in high proportions in 2013 than in 1989 and 2000. Concerning natural vegetations, savannahs increase from 1989 to 2000 and were the most represented land cover type in 2013 while dense forests, gallery forests and woodlands decrease in the same period. Our results highlights, the necessity to study dynamic in floristic composition of this area in order to assess change in floristic composition and to redefine with actors the best management practices which will allow the protected areas to assume their main role of biodiversity conservation.

**Key-words:** Land cover, Maps, Dynamics, Change, Benin

# Articles in press in peer-review journal without IF in 2015

## 1. Méthodes d'estimation objective du recouvrement de la végétation et de la biomasse herbacés

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### RÉSUMÉ

L'estimation du recouvrement de la végétation herbacée peut être obtenue en utilisant la méthode de point d'interception. L'échantillonnage des données a lieu dans les points de grilles dans un quadrat. A chaque position, une tige est abaissée verticalement sur le sol et la première interception avec une espèce de plante est enregistrée. Le recouvrement d'une espèce végétale est défini comme la fréquence relative du nombre de fois que la tige touche l'espèce dans la grille. Le recouvrement est calculé pour chaque espèce. Ce nombre est multiplié par 100 pour obtenir le recouvrement en pourcentage. Dans la savane herbeuse, six quadrats de 0,5 sur 0,5 m sont suffisants pour obtenir une bonne description de la végétation. La biomasse aérienne d'une espèce végétale peut aussi être estimée de façon non destructive en utilisant une modification du procédé de point d'interception. Au lieu d'enregistrer seulement la première interception de la tige et l'espèce de plante, chaque contact entre la tige et la plante est enregistrée. La méthode de point d'interception est rarement utilisée dans les systèmes savanicoles mais constitue une alternative par rapport aux méthodes destructives.

**Mots clés :** Méthode de point d'interception ; Points-quadrats ; Méthode pin-point ; Estimation du recouvrement de la végétation herbacée ; Estimation de la biomasse herbacée.

## 2. Méthodes de calcul de la biomasse et du carbone des arbres en Afrique de l'Ouest

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### RÉSUMÉ

Le présent chapitre aborde les méthodes de calcul de la biomasse et du carbone des arbres. Les différentes étapes de ce calcul sont dans un premier temps le choix de l'approche à utiliser (utilisation des équations allométriques ou générales), ensuite la détermination de la densité du bois de chaque espèce d'arbre et la définition des réservoirs de carbone à considérer. Il faut ensuite calculer la moyenne de la biomasse vivante et morte de chaque strate au sein des placettes, supposer la fraction de carbone dans les arbres puis calculer le carbone à partir de la biomasse, calculer également l'incertitude et enfin convertir le carbone en dioxyde de carbone. L'estimation de la biomasse et du carbone a pris une importance croissante dans le monde. L'augmentation de la quantité du carbone au niveau des forêts va permettre l'établissement des petites exploitations agroforestières et des projets REDD +.

**Mot clés :** Biomasse ; Carbone ; Equation allométrique et générale; Incertitude

### 3. Méthodes statistiques multivarié utilisées en écologie

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#### RÉSUMÉ

Cet article aborde les méthodes statistiques multivariées telles que les méthodes d'ordination et les méthodes de classification qui font partie des méthodes multivariées couramment utilisées en écologie. Les méthodes d'ordination constituent un groupe qui résume l'information contenue dans la matrice de données en minimisant la déperdition. Il s'agit de l'analyse en composantes principales ; de l'analyse en coordonnées principales; de l'analyse factorielle des correspondances simples ; de l'analyse factorielle des correspondances multiples; de l'analyse factorielle des correspondances redressées; de l'analyse canonique de redondance; de l'analyse canonique des correspondances ; du positionnement multidimensionnel non métrique ; et de l'analyse factorielle discriminante. Les méthodes de classification ont pour objectif de constituer des groupes d'individus aussi similaires que possible. Ces méthodes sont entre autre la classification agglomérative (encore appelée classification hiérarchique ascendante) ; l'analyse typologique ; l'analyse discriminante décisionnelle; et de l'analyse de la variance multivariée (MANOVA). Ces méthodes ont l'avantage de permettre de tirer la principale information contenue dans une matrice à plusieurs variables.

**Mots clés :** Méthodes statistiques multivariées ; Méthodes d'ordination ; Méthodes de classification.

### 4. Approches méthodologiques synthétisées des études d'ethnobotanique quantitative en milieu tropical

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*Annales des Sciences Agronomiques*

#### RESUME

Le souci de rendre comparable et reproductible les résultats en ethnobotanique par des inférences, a entraîné l'apparition de beaucoup d'outils quantitatifs dans les recherches en ethnobotanique quantitative ces deux dernières décennies. Ainsi ce travail de synthèse bibliographique vise à identifier les approches méthodologiques les plus utilisées en ethnobotanique quantitative à travers (i) les questions de recherche (ii) les techniques d'échantillonnage et de collecte de données et (iii) les outils quantitatifs d'analyse de donnée. La démarche méthodologique a consisté à utiliser des mots clés dans le moteur de recherche Google scholar afin de sélectionner les articles qui ont fait une synthèse bibliographique et/ou ceux qui ont fait des analyses critiques d'approches méthodologiques en ethnobotanique quantitative. Cette investigation a été faite de décembre 2014 à Janvier 2015. Trois catégories de questions de recherche ont été les plus investiguées en ethnobotanique quantitative : les questions de recherche des études ethnobotaniques descriptives, des études ethnobotaniques de causalité et des études ethnobotanique de diagnostic. Bien que l'échantillonnage n'a pas été considéré de façon prioritaire dans beaucoup d'études ethnobotaniques, d'autres ont commencé par accorder d'importance à la technique d'échantillonnage aléatoire avec une estimation de la taille de l'échantillon. Cinq indices ethnobotaniques ont été repérés comme étant les plus utilisés dans les études ethnobotaniques quantitatives : le Facteur Consensuel de l'Informateur (FCI), le Niveau de Fidélité (NF), l'Indice Relatif d'Importance (IR), la Valeur d'Usage (VU), l'Indice Culturel d'Importance (IC). Cette synthèse d'approches méthodologiques des études ethnobotaniques quantitatives, est un outil d'aide pour les étudiants et jeunes chercheurs des pays d'Afrique francophone.

**Mots clés :** Ethnobotanique, Méthodes, Indice, Biodiversité, Afrique francophone

## 5. Effect of incorporation of cowpea and soybean pods in diets on feed intake, digestibility and weight gain performances of rabbit

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### Revue CAMES

#### ABSTRACT

We carried out an experiment to compared performances (feed intake, feed digestibility and weight gain) of rabbit fed ration containing cowpea and soybean pod shells. Sixty rabbits of 06 weeks old were used for the trial in a completely randomized block with 3 treatments and 5 replications, with 4 rabbits per replication. The treatments consisted of a rabbit feed ordinary used in farms (as control) and two other feeds, CP10 and SB10, where cowpea and soybean pods has been incorporated at 10%, respectively. Feed intake was significantly higher ( $p<0.001$ ) in CP10 (70g/d) and lower in SB10 (59g/d). The intakes of DM and N was higher in CP10 (respectively 62g/d and 12g/d) than that in SB10. Also, cellulose intake in CP10 (8.6g/d) was higher than in the two others diets. Dry matter, Nitrogen and cellulose digestibility was higher in the diet with 10% of cowpea pods and low in that with 10% of soybean pods. The higher live weigh gain were fund in CP10 (22.10g/d) and the lowest in SB10 (12.13g/d). However, performance in the control diet was not significantly different from the two treatments CP10 and SB10. The feed conversion ratio, the feed cost as well as economic feed efficiency were not different ( $p>0.05$ ) between the treatments. However, profit can be increased through reduction of production cost by using crop residues in rabbit feed. This is a good issue for smallholders in urban and peri-urban areas in Africa.

**Key words:** Animal nutrition, Cellulose, Crop residues, Non-conventional resources, Benin.

## 6. Water quality as indicator of the health status of the agro-pastoral dams ecosystem in Benin: an ecosystem services study

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### *Aquatic Ecosystem Health and Management*

#### ABSTRACT

Ecosystem services are a lens through which we can understand human relationships with the environment. Based on a study in three agro-pastoral dams (APDs) in Nikki, Sakabansi, and Fombawi in northern Benin, this paper aims to characterize APD physical, chemical, and microbiological water quality. The ecosystem services framework underlies this paper. The water of the three APDs were sampled and analysed at the Laboratory for physical, chemical, and microbiological composition. The means of variables were compared with standard values (norms) for drinking water set by both Benin and the World Health Organization. APD water quality is problematic because of the significantly high levels of nitrite, nitrate, iron, and chemical oxygen demand. The water in APDs is unsuitable for both human and livestock consumption because it is contaminated with harmful bacteria (Coliforms, *Enterococcus faecalis*, *Escherichia coli*, spore of Clostridium, *Salmonella typhi*, *Campylobacter jejuni*, and so forth). The study concludes that one solution for maintaining APD ecosystem health consists of watershed management based on monitoring ecosystem services such as water quality.

**Key Words:** Ecosystem services, Pollution, crocodiles, Sustainable water resources management

# Articles under review in peer-review journal with IF in 2015

## 1. Mapping land use land cover change and prediction of future extension of *bowé* in West Africa (Benin)

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### *Land use policy*

#### **ABSTRACT**

Desertification and land degradation are worldwide problems affecting soil, vegetation and thereby livelihood of the rural population. *Bowal* (plural *bowé*) is a particular form of degraded land that occurred in tropical region and leads to ferricrete exposure unusable for farming. *Bowé* are more frequent in farmland and degraded savanna. Land use land cover change analysis was used to map the land cover of 1975, 1990 and 2010. The changes observed during these periods (1975-1990, 1990-2010 and 1975-2010) were considered to predict occurrence of *bowé* towards 2050 with the Markovian chain. The results showed considerable change in land use land cover maps of the three periods (1975, 1990 and 2010). The land cover on which *bowé* occur (farmland and degraded savanna) have persisted, and increased at the rate of 0.0542 ha/year, 0.0952 ha/year during the periods 1975-1990, 1990-2010 respectively; while the natural vegetation (forest, woodland and tree savanna) have decreased at the same rate. The future scenarios also predict the same trend. A total of 26% (1286346 ha) and 31% (1293693 ha) of the area cover with natural vegetation would be converted to farmland and degraded savanna towards 2050 if we assume the dynamic recorded respectively from 1975-1990 and 1990-2010. Thus *bowalization* would persist and increase towards 2050. Promotion of the best practices developed by the farmers to prevent and cope with *bowalization* would help to refrain land degradation in this zone.

**Key words:** Land use/cover change, Natural vegetation, *bowé*, Ferricrete, West Africa.

## 2. Population structure of *Pterocarpus erinaceus* and *Anogeissus leiocarpa* in woodlands of W National Park in Niger (West Africa) assessed by structural and ecological indicators

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### *South African Journal of Botany*

#### **ABSTRACT**

This study aims to assess population structure and ecological indicators of woodland vegetation dominated by *Pterocarpus erinaceus* and *Anogeissus leiocarpa* as a basis for sustainable conservation strategies. We sampled 34 plots each of 30 m × 30 m in W National Park in Niger and analyzed structural parameters (tree density, basal area, Lorey's mean height and size class distribution) and ecological indicators (species richness, Shannon diversity index, Pielou evenness index and Importance Value Index) of woodland in general and the two key species. The result show that mean density of tree and basal area were respectively 1139 stems/ha and 833 m<sup>2</sup>/ha in the woodlands including 242 stems/ha and 479 m<sup>2</sup>/ha for *A. leiocarpa* and 63 stems/ha and 24.3 m<sup>2</sup>/ha for *P. erinaceus*. The mean diameter of both species was higher (24 cm and 47 cm for *A. leiocarpa* and *P. erinaceus* respectively) than the mean diameter in woodlands (16 cm). A "reverse J" shape distribution was found for woodland in general and for *A. leiocarpa* but *P. erinaceus* showed a left dissymmetric distribution. The woodland was composed of 59 tree species belonging to 34 genera and 17 families. *A. leiocarpa* had the highest IVI value (0.93), whereas *P. erinaceus* was among species with the lowest IVI value (0.03). Findings of this study showed that urgent actions are needed for sustainable conservation of some key species especially *P. erinaceus*.

**Key words:** Forest inventory, Regeneration, Size class distribution, Woody vegetation.

### 3. Land use impact on population structure of fodder trees in semi-arid savanna in Benin (West Africa)

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#### *Land use Policy*

#### **ABSTRACT**

In arid and semi-arid regions of sub-Saharan Africa, fodder trees play a vital role for cattle breeding in dry seasons. However, rapid extension and intensification of agricultural lands and fodder tree harvesting have impact on tree population dynamics. We analyzed diversity and local people's preference of fodder trees and the impact of land use type on population structure of four major fodder tree species. Data were collected through interviews and field inventories. Tree population distributions were compared to the Weibull distribution. Among 18 species recorded as woody fodder, *Afzelia africana*, *Pterocarpus erinaceus*, *Khaya senegalensis* and *Stereospermum kunthianum* emerged in this order as the four most frequently used species. In the protected area, the trunk diameter at breast height (DBH) distributions displayed right-asymmetric distributions for the four species indicating populations with high regeneration potential. In communal lands, *A. africana* and *K. senegalensis* species displayed left-asymmetric distributions indicating populations with low regeneration potential. Populations of *S. kunthianum* and *P. erinaceus*, however, displayed right-asymmetric distributions in communal lands although less expressed than in the protected area. For successful long term conservation, tree planting and protection of the most frequently used fodder species in communal lands is needed in order to prevent a decline.

**Key words:** *Afzelia africana*; *Khaya senegalensis*; *Pterocarpus erinaceus*; *Stereospermum kunthianum*; Size class distribution; Tree pruning.

### 4. Tree density, diversity and decline in Senegalese farmlands

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#### *Agroforestry systems*

#### **ABSTRACT**

Trees are rapidly disappearing from agrarian landscapes in many tropical countries, a severe problem to rural populations, who depend on wood and non-timber forest products for their livelihoods. The aim of this study is to determine woody diversity, biomass and carbon stock and to gain insight in the socio-economic determinants of woody vegetation in farmlands in Senegal. A total of 235.5 ha were investigated in 15 sampling plots of 15.7 ha each. In total, 25 tree species were recorded with an average density of 1.6 tree ha<sup>-1</sup> and a canopy cover of 1%. The average above ground biomass (AGB) was 8.9 ton ha<sup>-1</sup> corresponding to 4.45 t carbon ha<sup>-1</sup>. A single species, *Cordyla pinnata*, accounted for 50% of all the trees censured. We developed an allometric model to estimate AGB based on satellite measurements of canopy cover. Satellite images showed considerable change in tree density during the investigated periods (2004, 2009 and 2013). The tree density has decreased at the rate of 3% per year<sup>-1</sup> and 6.4% per year<sup>-1</sup> from 2004-2009 and 2009-2013, respectively. All the trees would be lost towards 30 years (from 2009) and 16 years (from 2013) if this trend continues. Tree planting was not considered an option by the landowners, since livestock damage on young trees was too big and fencing not an option without support from outside. Informants were generally interested in increasing the number of fruit trees. On average, they were willing to allocate 19% of their land for planting of new trees.

**Key words:** Africa, Forest resources, Deforestation, Local management, Woody biomass.

## 5. Impact of Forest Degradation and Invasive Species on the Population Structure of *Mimusops andongensis* (Sapotaceae)

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### *Biotropica*

#### ABSTRACT

Non-Timber Forest Product (NTFP) harvesting can threaten the target species, especially those with limited distribution and density. Simultaneously, exploited species are also often facing threats from other pressures like habitat fragmentation, fire and invasive species. We assessed the impact of human disturbances and invasive alien species on the population structure of a key multipurpose NTFP species, *Mimusops andongensis*, in Lama Forest reserve (Benin). Densities of adult trees and regenerative stems decreased from low pressure sites to high pressure sites. The proportional contribution of *M. andongensis* to total tree density decreased with increasing human pressure and disturbance. There was a significant negative relationship between the cover of the invasive alien *Chromolaena odorata* and the number of *M. andongensis* recruits, whereas the number of recruits was positively related to the number of mature trees. Diameter size class distributions showed dominance of small diameter individuals in sites with low and medium pressure while in sites with high pressure, the structure showed a negative exponential trend with the density of small diameter individuals being lower than 2 trees/ha. Also, individuals with dbh > 20 cm are rare in sites with high pressure. The density of sexually mature trees and seedlings was low in degraded sites and this may undermine the long-term viability of *M. andongensis*, despite current levels of protection against NTFP harvesting and other anthropogenic pressures. Thus, particular management attention may be given to seed availability, human-assisted natural regeneration and control or elimination of *C. odorata*.

**Key words:** Anthropogenic pressure; Benin; Biological invasion; Demographic structure; Diameter class distribution; Non-Timber Forest Products (NTFP)

## 6. Stable isotope niche segregation and overlap amongst bovid species from a West African savanna

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### *Mammalian Biology*

#### ABSTRACT

Understanding the mechanisms of species coexistence within local assemblages can play a crucial role in conservation of a species. There is little understanding of how large mammalian bovid species from West Africa partition diet resources, and to what extent they may vary their diet and habitat selection seasonally in order to coexist. Here we studied an assemblage of eleven bovid species in Pendjari Biosphere Reserve, West Africa and used faecal stable isotopes of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) to test diet segregation at a seasonal scale. We found a significant positive relationship between isotopic niche similarity and body size similarity both in dry and wet season. Partitioning of carbon isotope niches is at least partly due to interactions amongst species rather than historical effects. Our findings also show numerous patterns in resource partitioning amongst the 11 bovid species studied, suggesting that different species used dietary resources in contrasting ways. In practice, actual resource competition between bovid species is difficult to demonstrate, but there exists much overlap in diet along the stable carbon isotope axis for most of the studied species. However we conclude that in our study area, especially in the wet season, niche breadth and diet overlap remain large. Abundant resources and low herbivore densities mean there is no need for herbivores to specialize, because they do not have to compete over scarce resources.

**Key words:** Diet breadth, Body mass, Browser, Grazer, Competition, Coexisting

## 7. Effect of incorporation of cowpea and soybean pods in diets on feed intake, digestibility and weight gain performances of rabbit

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*South-African Journal of Animal Sciences*

### ABSTRACT

The nutritive value of crop residues (cereal and legume) commonly used in ruminant feeding in Benin was determined to provide recommendation for their enhanced. The samples, collected in two agro-ecological regions areas of the country, were screened for their chemical composition and energy content, as well as for their in vitro fermentation characteristics (i.e. gas and volatile fatty acid production, organic matter degradability). Compared to legume residues, cereal residues showed lower energy (5.86 vs. 10.89 MJ/kg DM) and crude protein (4.16 vs. 11.77% DM) level and higher cell wall content (NDF: 84.98 vs. 56.12% DM), respectively. For both cereal and legume residues, the in vitro fermentation parameters were highly influenced by the residue type, while the study area significantly affected mainly cereal residues. Organic matter degradability ranged between 55.4 and 57.5% in cereal whereas between 53.2 and 89.6% in legume. The in vitro method utilized was helpful to evaluate the nutritive value and describe the fermentation kinetics of crop residues studied.

**Key words:** Degradability, Fermentation kinetics, In vitro gas production, Volatile fatty acids.

## 8. Specific and generic stem biomass and volumes models of tree species in a West African tropical semi-deciduous forest

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*Silva Fennica*

### ABSTRACT

The quantification of the contribution of tropical forests to global carbon stocks and climate change mitigation requires availability of data and tools such as allometric equations. This study made available volume and biomass models for eighteen tree species in a semi-deciduous tropical forest in West Africa. Generic models were also developed for the forest ecosystem, and basic wood density determined for the tree species. Non-destructive sampling approach was carried out on five hundred and one sample trees to analyse stem volume and biomass. From the modelling of volume and biomass as functions of diameter at breast height (Dbh) and stem height, logarithmic models had better predictive capabilities. The model validation showed that in absence of data on height, models using Dbh only as variable was an alternative. The comparison of basic wood densities to data published in literature enabled to conclude that the non-destructive sampling was a good approach to determining reliable basic wood density. The comparative analysis of species-specific models in this study with selected generic models for tropical forests indicated low probability to identify effective generic models with good predictive ability for biomass. Given tree species richness of tropical forests, the study demonstrated the hypothesis that species-specific models are preferred to generic models, and concluded that further research should be oriented towards development of specific models to cover the full range of dominant tree species of African forests.

**Keywords:** Non-destructive sampling; Basic wood density; Allometric equations; Carbon stock.

# Articles under review in peer-review journal without IF in 2015

## 1. Local perception on the habitat and uses of *Lippia multiflora* Moldenke in Benin (West Africa)

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### ABSTRACT

The present study aims at assessing the ethnobotanical knowledge of *Lippia multiflora* in order to identify its habitats and uses. An ethnobotanical survey was conducted with 180 household distributed in four sociocultural groups in the Sudano-Guinean (Mahi, Bariba, Peuhl) and the Sudanian zones (Boo, Peuhl) in Benin. The habitats of the species were identified with the frequencies of citation. Pearson Chi-square Test was used to analyze the frequency of uses of the species. Correspondence Analysis was used to assess the relationship between organs used and sociocultural groups. The results revealed that *L. multiflora* was abundant in fallow and savanna. A total of 62% of the informants in the study area used the inflorescences of the plant for food, 32% used the leaves for health care and 6% used the stems for artisanal activities. The sociocultural group of Mahi used highly the leaves of the plant species for health care, while Boo and Peuhl used highly the inflorescences for food. The group of Bariba used highly the stems for artisanal purpose. The diseases treated by the species were: stomach ache, fever and malaria, toothache, heart illness, hypertension, wound, physical weakness of baby and itch body.

**Key words:** *L. multiflora*, Local knowledge, Bioclimatic zones, Sociocultural groups

## 2. Elephant conservation in Benin National Parks: an assessment of human elephant conflict and building stakeholders capacity

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*IUCN Park Journal*

### ABSTRACT

Human-elephant conflict is a significant problem in Benin's protected areas, as in many other parts of Africa where wild elephant populations persist outside protected areas. This study was conducted to gain more knowledge about the elephant conservation in Benin's National Parks. Detailed data on human elephant conflict were collected through participatory field work with the local communities and Park administration. We found fidelity in the traditional knowledge and the scientific data as the kernel density map generated from the elephant bio-monitoring data overlap perfectly with the elephant concentration zones and the zone identified by the local communities as high conflict zones. Elephant off take from poaching is high and thus a major concern to the conservation fraternity. The elephant conservation stakeholder as well as local community pointed out that patrol efficiency will remain limited and the fragile link between population and Park will be broken. Finding solutions to human-elephant conflict and poaching problems is absolutely necessary to improve the professionalism of these people who really deserve to be recognized by administration. The study enabled decision makers to determine priority areas where elephant populations are more liable to become vulnerable as a result of human-wildlife conflict, since elephants are mostly migratory.

**Key words:** Protected areas, Elephant, Conflict, Crop raiding

### 3. Dongas formation and evolution in W National Park and its periphery in Northwestern Benin

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*African Geoscience* (under review)

#### ABSTRACT

This study evaluates the process of formation and development of *dongas*. The specific objectives were: (i) to map the spatial distribution of *dongas*, (ii) to characterize these *dongas* from soil determinants and (iii) evaluate the formation process and the mechanisms of their evolution. Data were collected using individual and group interviews, field visits and observations, longitudinal and transversal soil profile and the measurements and analysis of soil moisture and water infiltration capacity into the soil. Erosion and *donga* phenomenon in this part of Benin have anthropogenic and natural causes. Natural factors such as slope, rainfall aggressiveness and wind come to accentuate the phenomenon. The *dongas* mainly come from the multiple interactions of natural and anthropogenic factors. *Dongas* occurrence is the result of the physical characteristics of soil and vegetation clearing. The crusting of soil surface is the first phenomenon by the combined effect of rain and wind. The transversal slopes are low and induce sheet erosion. Three main processes determine *dongas* evolution after their appearance namely water erosion, wind erosion and erosion due to animals.

**Key words :** *Donga* processes, Water erosion, Wind erosion, Erosion due to animals, W National Park in Benin.

## Completed Doctorate thesis in 2015

### 1. Amphibian ecological patterns and habitat disturbance in savanna ecosystem: implications for biomonitoring and conservation issues

Ir. Gilles NAGO

#### ABSTRACT

In the actual context of worldwide amphibian decreasing, several explanations are given stretching from habitat alteration or degradation, overharvesting, water quality to diseases. Most scientific studies are regionally or geographically restricted to forest ecosystems in the tropics. However, Africa harbours drier habitat amphibian species than forestdwelling ones. Moreover, savannas are at least under equal human pressure as forests. This lack of exploration limits our global comprehension of effects of human land-use on these taxa. We investigated these issues with taxonomical, ecological and parasitological aspects to assess local patterns in amphibian responses to land-use modification and discussed the biomonitoring and conservation implications in a protected area of Northern Benin, West Africa. Through potential habitats and vegetation of temporary puddles, we survey amphibian fauna with various methods. We report 32 species for the Pendjari Biosphere Reserve and succeed in adding 17 species to the countries'amphibian list. Those species are *Bufo pentoni*, *Hildebrandtia ornata*, *Pyxicephalus* cf. *edulis*, *Ptychadena bibroni*, *P. cf. schillukorum*, *P. tellini*, *P. tournieri*, *P. trinodis*, *Phrynobatrachus latifrons*, *P. francisci*, *P. gutturosus*, *Arthrolepsis* sp., *Kassina cassinooides*, *K. senegalensis*, *K. fusca*, *Leptopelis bufonides* and *Hyperolius nasutus*. Pendjari Biosphere Reserve ranks within the most diverse African savanna regions. The found species are mainly composed of typical West African savanna frogs, especially those that are restricted to drier habitats. However, especially along the mountainous Atakora chain in the South of the area, rare and unusual species are recorded and they are dependant on higher humidity, e.g. *Arthrolepsis* sp. and *Hyperolius* sp. The single endemic frog of the Volta basin, *P. francisci*, is also present in the reserve. Within these local amphibian fauna, belong two for which clutch and larvae are not described yet. They are *Leptopelis bufonides* and *P. cf. schillukorum*. After captured an amplexant couple of them in the field, a clutch is received from both. Larval stages were obtained in captive breeding for the latter pair. Based both on living and preserved specimens, its tadpole is described. The concern tadpole is a typical West African *Ptychadena* tadpole and can potentially be mistaken with its congeners. Across three ecological parts of the reserve, we studied a land-use modification gradient stretching from pristine area, buffer zone to agricultural region in Pendjari Biosphere. We determined species richness, abundance and diversity indexes in all habitat types. For this study, in general, occurrence and abundance of larval and adult stages differ among species and between habitat types from the undisturbed places to the most preserve areas.

Diversity in tadpoles is in a favour of the pristine area but abundance patterns are contrary. Concerning adults, some of the species (*Ptychadena tournieri*, *Phrynobatrachus gutturosus*, *Kassina cassinooides* and *Hildebrandtia ornata*) are found exclusively in undisturbed savanna whereas others (*Leptopelis bufonides* and *Pyxicephalus cf. edulis*) live predominantly in pristine zone of Pendjari. It highlights the role of the reserve in the region concerning biodiversity conservation. On parasitological way, amphibians from the undisturbed zone, generally, seem to be more infected than those from the altered sites. This is perhaps due either to a strong impact of land use on parasite transmission or to the small samples of amphibians. Finally, through this study, an evidence for the negative link exists between human land use and individual and population characteristics of frogs in the savanna breeding pools. Also amphibians prove their sensitivity to edge-effects. Then amphibians can be considered as valuable bio-indicators in savanna ecosystems.

**Keywords:** Amphibians, species distribution, Tadpole assemblage, Savanna, Agriculture, Biosphere reserve, Land-use change, Bio-indicator species, Edge-effect, Amphibian parasites, Prevalence and intensity of infection rates, Pesticide contaminants, Benin, West Africa

## 2. Knowing *bowalization*, its impact on biodiversity, soil and human livelihoods in Benin (West Africa)

**Ir. Elie Antoine Padonou**

### SUMMARY

Desertification and land degradation are worldwide problems affecting soils, vegetation and especially the life of the rural population. *Bowal* (plural *bowé*) is a particular form of degraded land that occurs in tropical regions. It is the result of ferricrete exposure due to soil surface erosion. Few research have addressed this specific form of degraded land. The present work aimed at increasing the understanding of how *bowalization* affect biodiversity, soil and human livelihoods. The main objectives were to (i) analyze the spatial indicators of *bowé*; (ii) analyze the cause and effects relationships to assess past and future changes in distribution pattern of selected species and plant diversity on *bowé* and (iii) assess the risk on the consequences of different land use on *bowalization*. Nine chapters composed this work.

**Chapter 1** was an introduction and established the rationale and objectives of the thesis.

**Chapter 2** described the study area which covered the whole country of Benin Republic.

**Chapter 3** focused on the farmers' perception and coping strategies on *bowé*. This was done using semi-structured interviews and questionnaires with 279 households of nine ethnic groups in the semiarid (Peulh, Bariba, Dendi, Nagots and Mocolé) and the sub-humid zone (Fon, Mahi, Holli and Adja) of Benin. Pearson Chi-square Test and simple correspondence analysis were performed to analyze the perceptions on the causes, consequences and coping strategies with *bowé* in the two climate zones and according the ethnic groups. *Bowalization* was reported to be induced by non-adapted land use and soil erosion. *Bowalization* leads to loss of biodiversity in the two climates zones and reduced water retention capacity in soils. It also induced rooting difficulties for crops and increase soil temperature. Farmers in the semiarid zone have adopted planting of cowpea and groundnut on *bowé* with hoe instead of animal traction. Ethnic groups of both climate zones that depend mainly on livestock herding have to practice transhumance and use food supply for the animals.

**Chapter 4** determined the spatial distribution of *bowal* and the differences in physicochemical characteristics between *bowal* and woodland soils. *Bowé* sites were mapped and soil samples were taken on *bowé* and nearby woodland. The results show that *bowé* are directly related to ferruginous soils and rainfall regime. *Bowé* soils are characterized by significantly lower values of electrical conductivity, organic matter, extractable phosphorus, silt and total nitrogen than woodland soils, while potassium exchangeability of *bowé* soils was higher. *Bowé* can be expected wherever ferruginous and/or ferricretes soils are observed in unimodal rainfall regime condition.

**Chapter 5** focused on the impact of *bowalization* on phytodiversity, life forms and plant morphology in the sub-humid zone of Benin using *Combretum nigricans* as a case study. Morphological variables of *C. nigricans* (height, number of stems, number of branches, diameter at breast height, and crown diameter) and the plant communities were determined on sand-clay soil, concretion soils and *bowal*. The results showed that plant communities were more diversified on sand-clay and concretion soils compared with those described on *bowal*. *C. nigricans* developed more stems ( $3.6 \pm 1.4$  stems vs.  $1.3 \pm 0.4$  stems), more branches ( $5.9 \pm 2.4$  branches vs.  $3.2 \pm 0.6$  branches) and large crown diameter ( $5 \pm 1.48$  m vs.  $3.4 \pm 1.2$  m) on *bowal* than on sand-clay soil. The best adapted life forms on *bowal* were therophytes.

In **Chapter 6**, the following questions were addressed: what are the vegetation characteristics on *bowé*? How vegetation pattern varies on *bowé*? Which species, life forms, chorological types and plant families are characteristics of *bowé*? Which species, life forms, chorological types and plant families are impacted by *bowé* in their extension? The study revealed that *bowé* were characterized by grassland and savanna. The species composition on *bowé* varies according to the climate zone. Woody species were more frequent on *bowé* in sub-humid than in semiarid. Geophytes, hemicryptophytes and phanerophytes were more frequent on *bowé* in the sub-humid than in the semiarid climate zone. The difference between the two climate zones on the occurrence of therophytes on *bowé* was not significant. The frequency of chamaephytes was higher on *bowé* sites in the semiarid zone. Afro-tropical, Afro-Malgache, Pluri regional African and Pantropical chorological types were more frequent on *bowé* than in woodland in each climate zone while the opposite was found for Guineo-Congolian and Sudano-Zambesian chorotypes. Plant families such as Amaranthaceae, Zingiberaceae, Chrysobalanaceae, Connaraceae, Loganiaceae, Moraceae and Ochnaceae were only found on *bowé* in the sub-humid climate zone, while Convolvulaceae, Loganiaceae, Rhamnaceae, Araceae, Colchicaceae, Cucurbitaceae, Olacaceae, Pedaliaceae, Amaranthaceae, and Cyperaceae were only found on *bowé* in the semiarid zone.

**Chapter 7** identified the resistant species towards climate change for ecological restoration of *bowé* by submitting the most common *bowé* species together with significant environmental variables (elevation, current bioclimatic variables, and soil types) to the ecological niche modeling program (Maxent, Domain and GARP). For future prediction (2050) IPCC4/CIAT and IPCC5/CMIP5 climate data were applied. *Asparagus africanus*, *Andropogon pseudaprucus* and *Combretum nigricans* were identified as the most resistant species for ecological restoration of *bowé* in the semiarid climate zone, while *Asparagus africanus*, *Detarium microcarpum* and *Lannea microcarpa* were the most resistant for ecological restoration of *bowé* in the sub-humid climate zone.

The following questions were addressed in **chapter 8**: How land cover changes with *bowalization*? What factors govern land cover change and *bowalization*? Are there proofs of *bowé* occurrence due to agricultural practices? How many year of land use make occurrence of *bowé*? What would be the extension of *bowé* in the future? Land use land cover change analysis was used to address these questions based on the land cover maps of 1975, 1990 and 2010 of the municipality of Banikoara. Markovian chain was used to predict occurrence of *bowé* towards 2050. The results showed considerable change in land use land cover maps of the three periods (1975, 1990 and 2010). The land cover on which *bowé* occur (farmland and degraded savanna) have persisted, and increased at the rate of 0.0542 ha/year, 0.0952 ha/year during the periods 1975-1990, 1990-2010 respectively; while the natural vegetation (forest, woodland and tree savanna) have decreased at the same rate. The future scenarios also predict the same trend. A total of 26% (1286346 ha) and 31% (1293693 ha) of the area cover with natural vegetation would be converted to farmland and degraded savanna towards 2050 if we assume the dynamic recorded respectively from 1975-1990 and 1990-2010. Thus *bowalization* would persist and increase towards 2050.

**Chapter 9** synthesized the overall findings of this research project, and identified areas for further research and makes management recommendations. *Bowalization* is the result of ferricrete exposure due to non-adapted land use and soil surface erosion on ferruginous soil in unimodal rainfall regime condition. The important drivers of *bowalization* in the study were assessed based on soil, geomorphology, climate, and land use practices. However, other spatial indicators like soil parent rock could also be used. *Bowé* are also covered by a number of termitaria. Up to now, the type of termitaria on *bowé* and their role are not yet clearly established. *Bowé* showed significantly lower values of electrical conductivity, organic matter, extractable phosphorus, silt and total nitrogen than woodland soils, while its potassium exchangeability was higher. Knowing the dependence of the physical and chemical characteristics of the soils developed on *bowé* and the different type of parent rocks would help to increase the understanding of the drivers of *bowalization*. The identification of the most important drivers of *bowalization* at regional scale would also help to combat *bowalization*.

*Bowalization* has induced loss of species and modified the morphological structure of *C. nigricans*. The vegetation characteristics on *bowé* are grassland and savanna with dominance of Afro-Tropical, Afro-Malgache, Pluri regional African and Pan Tropical chorological types and therophytes life forms. Some species are suitable for ecological restoration of *bowé*. They are *Asparagus africanus*, *Andropogon pseudaprucus* and *Combretum nigricans* in the semiarid climate zone, and *Asparagus africanus*, *Detarium microcarpum* and *Lannea microcarpa* in the sub-humid climate zone. Additional plant functional traits (vegetative, leaf, stem and regenerative traits) would help to increase our understanding of the effect of *bowalization* on plant diversity. Moreover, the quantification of the impacts of *bowalization* on crops production is needed. Coping strategies were developed by some farmers to reduce the impact of *bowalization*. These strategies need to be tested in order to identify the best to be promoted. It will also be relevant to consider environmental indicators combined with an extensive soil and botanical datasets to spatially predict and analyze the distribution ranges of plant species and pattern of plant diversity in relation to the main drivers of *bowalization* at regional scale.

The markovian model used in this study showed that *bowalization* has persisted and increased during the period considered (1975, 1990 and 2010), while the natural vegetation (forest, woodland and tree savanna) has decreased. The same trend

would also prevail towards 2050 if we assume the dynamics recorded for the periods considered. However, the model is not spatial-explicit and assumes that transition probabilities are time homogenous. More detail spatial explicit model on land use land cover change may be used in future analysis to improve the understanding of the locations and pathways of land use land cover change dynamics which induce *bowéization*. In addition, this model has not taken into account the relation between the occurrence of *bowé* and surface erosion processes. Using the universal soil loss equation linked to GIS may improve the understanding of the relation between soil erosion and *bowéization*. *Bowéization* was indirectly assessed in this study base on the land cover with farmland and degraded savanna where they are common. However all the farmland and degraded savanna are not covered by *bowé* thus it was not possible to quantify and predict the exact cover of *bowé*. The limit observed with the method considered for this study should be taken into account for other similar study. Future researchs are needed in order to increase the understanding of *bowéization* and its impacts.

**Key words:** Bowalization, Predictive Models, coping strategies, Patterns in land cover, Benin

### 3. Understanding complexity in managing agro-pastoral dams ecosystem services in Northern Benin

**Ir. Gnanki Nathalie Kpéra**

#### SUMMARY

Like several other African countries, the Republic of Benin has been developing an ambitious water policy framework, including an action plan with a focus on Integrated Water Resources Management (IWRM). Agro-pastoral dams (APDs) – water reservoirs constructed to provide water for livestock and for agricultural development – have been constructed all over Benin. These APDs face several conflicts rooted in the multi-functionality of APDs and with this the involvement of different stakeholders, including crocodiles that share APD ecosystem services and influence the management of dams. This thesis aims to understand the multifunctional and multi-stakeholder use and management of APD ecosystem services in Benin. A related aim is to find opportunities for a more optimal and peaceful use and management of APD ecosystem services. The research was conducted as part of the broader Convergence of Sciences – Strengthening Agricultural Innovation Systems (CoS-SIS) Research Programme ([www.cos-sis.org](http://www.cos-sis.org)) that applied multi- and transdisciplinary approaches to address social and technical challenges in agriculture and natural resource management.

**Chapter 1** sketches the general background to the study. It starts with an explanation of the relevance of water reservoirs in Africa, followed by the importance of APDs for the Government of Benin, which has targeted them to improve food security and induce intensification of the agricultural sector. Next, Chapter 1 introduces the integral ecology (IE) framework as the conceptual inspiration for the study. The IE framework provides a comprehensive and inclusive research perspective that can accommodate different disciplinary orientations and methodologies. It thus helps to develop an integral understanding that takes into account institutional, technical, socio-economic, and environmental dimensions of problem situations. Chapter 1 concludes with the choice of a case study approach as an overarching research design and the selection of the Nikki, Sakabansi, and Fombawi as case study areas.

**Chapter 2** provides the diagnostic entry point of this thesis. The chapter identifies stakeholders involved in APD use and management in the three cases, as well as the institutional and technical impediments and opportunities for managing the APDs as Summary 2 perceived by the stakeholders. It describes the multiple functions that APDs provide, such as: drinking water supply for humans, livestock watering place, fish farming, vegetable production, food cropping, cotton farming, cleaning, washing, swimming, cooking, small business water use, and house and road construction. The involvement of human and nonhuman stakeholders (crocodiles and livestock) makes an APD a complex system, impeding agreement on common rules for their management. Instead, the dams have become the scene of competitive claims, resulting in multiple and persistent conflicts and disagreements among stakeholders (farmers versus herders, Nikki Council versus vegetable producers, fishermen versus Nikki Council, fishermen and other APD users versus crocodiles, and so forth). This diagnostic study argues that all stakeholders tend to look at themselves as victims and blame others for violating rules and the sub-optimal use of the APDs. It also shows that existing institutions for managing APDs are differently interpreted and mostly ignored. Chapter 2 concludes by indicating domains for future research to be empirically studied (Chapters 3–5).

With the aim of supporting living peacefully with crocodiles, **Chapter 3** provides an understanding of the way stakeholders frame the presence of crocodile, including the formal and informal institutions they apply to cope with crocodiles. Because of the fear that crocodiles engender and crocodiles' negative effects on local livelihoods and people's tranquillity, all stakeholders frame the presence of crocodiles as problematic. Although incidents with crocodiles are highest in number in

Fombawi (with more than 300 crocodiles), the relative amount of damage per crocodile is lowest there. This may suggest that the crocodiles in Fombawi are less aggressive than those in Nikki and Sakabansi, and/or that the Fombawi inhabitants are more tolerant towards crocodiles because of the embedding of their specific beliefs and cultural realities relating to crocodiles. In Nikki and Sakabansi, stakeholders construct particular informal institutions that allow them to deny formal rules (national and international regulations and laws that consider crocodiles as a protected species) and thus to kill them. In Fombawi, crocodiles are protected by the collective belief that they are holy creatures and thus should not be killed. From this belief, stakeholders in Fombawi have constructed informal rules and socially embedded practices that assist them to live in peace with crocodiles. Chapter 3 suggests that these rules are constructed via intensive communication among stakeholders exchanging experiences and ideas, resulting in a peaceful human–crocodile relationship. Vegetable production has been identified by the Government of Benin as one of the ways to improve food security in the region.

**Chapter 4** examines dry season vegetable production systems around the APDs and identifies constraints that hinder related activities. The traditional vegetables grown include *Amaranthus cruentus*, *Sesamum indicum*, *Abelmoschus esculentus*, *Capsicum frutescens*, *Corchorus olitorius*, *Lycopersicon esculentum*, *Hibiscus sabdariffa*, and *Solanum macrocarpon*; and the exotic vegetables consist mainly of *Lactuca sativa* and *Brassica oleracea*. In Nikki, a significant difference exists between men and women when it comes to plot size and also to soil fertility management practices. In Nikki, the men's cropping system is characterized by large plots, more exotic and marketed vegetables (lettuce, tomato, and cabbage), more use of mineral fertilizers and cotton pesticides, and crop rotation. Constraints affecting vegetable production include: access to water; vegetable and seedling destruction by livestock; pest and disease management; access to markets, land, and credit; lack of equipment, seeds, fertilizers, and pesticides; problems with crocodiles; and theft of vegetables. These vegetable cropping systems around APDs as well as the specific location of Nikki and Sakabansi are perceived by Nikki Council – which is in charge of APD management – as major causes of siltation, erosion, and water pollution. Therefore, the council wishes to relocate the vegetable plots in Nikki and Sakabansi from upstream to a downstream site, and this causes tensions between Nikki Council and the vegetable producers. The chapter ends with the suggestions to change to more organic agricultural practices (using bio-pesticides and organic manure), to realize a more active role for producer associations that support their members, and to organize an exchange visit to Kalalé District by members of the associations and the council with the aim of discussing sustainable vegetable production management and district governance of the APDs.

Given the different complaints about water pollution, **Chapter 5** assesses the health status of the APD ecosystem, with water quality (physical, chemical, and microbiological composition), fish diversity, and fish biomass as indicators. This study shows that dam water quality is problematic because of significantly high levels of nitrite, nitrate, iron, and chemical oxygen demand (COD). This pollution – probably the result of agricultural runoff, dump runoff, and human and animal wastes – may be responsible for the invasion of aquatic plants in the APDs resulting from eutrophication reducing water quality and altering the ecological structure and function of APDs. Moreover, the study substantiates the contamination of APD water with harmful bacteria (Coliforms, *Enterococcus faecalis*, *Escherichia coli*, spore of Clostridium, *Salmonella typhi*, *Salmonella typhimurium*, *Salmonella enteritidis*, and *Campylobacter jejuni*) detrimental for both human and livestock water consumption. Additionally, 20 fish species are spread in the three APDs, of which four large-size species (*Clarias anguillaris*, *Clarias gariepinus*, *Oreochromis niloticus*, and *Tilapia mariae*) – Summary 4 associated with a market value – are targeted for fishing. Although Fombawi dam is home to more crocodiles, its fish biomass is higher than that in Sakabansi and Nikki. The chapter ends by recommending APD management strategies that contribute to the restoration of APD agroecosystem services by means of an appropriate application of fertilizers and pesticides, reforestation of the APD watershed, and prevention of agricultural and urban runoff and erosion. Such requires the collaboration of all stakeholders, including Nikki Council.

Using the IE framework, **Chapter 6** presents the synopsis of the main findings. The results of the empirical studies are integrated from an ecological perspective, a socio-cultural perspective, and an institutional perspective. The ecological perspective discusses how plausible the agricultural intensification in APDs – to meet the Benin Government's needs – is for conserving biodiversity. Furthermore, the importance of maintaining fish biodiversity by spreading fishing activities over more fish species and sizes is discussed. As part of the APD agro-ecosystem, crocodiles play an ecological role in contributing to the regulation of fish stocks and to the deepening of the dams, and by giving insights into ecosystem health. From the socio-cultural perspective, it is argued that the way people interact with crocodiles has a serious impact both on perceptions of crocodiles and on their behaviours. Exchanging experiences and practices for a more peaceful relationship with crocodiles, as happens in Fombawi, would contribute to sustainable APD management. From an institutional perspective, APD users' non-compliance with the informal rules was imputed to the lack of communication between the council and other stakeholders.

The implications of the research for policy and practice should be intensively discussed with all stakeholders involved, including Nikki Council. Promising technical measures to improve the sustainability of APDs should be discussed, including the use of bio-pesticides, soil analysis for the appropriate application of artificial fertilizers, monitoring fish biodiversity and

water quality, and implementing agroforestry in the watersheds. To realize these technical measures, institutional solutions that help change both stakeholders' frames and their practices are also required and are of utmost importance: consider the APD system as an interacting whole, act collectively, develop a collective monitoring system, manage waste in towns and villages, government should accept responsibility for APD infrastructure costs, develop incentives that support negotiations, and define sanctions for those who do not respect rules, and implementing watershed management process. It is pointed out that improvements in watershed management should be accompanied by research/monitoring so that changes in management can be verified and shared with users. It is also suggested that an innovation platform be established in which all 5 stakeholders can participate to discuss changes that should be collectively developed and realized, resulting in optimal APD ecosystem services and management. Finally, a follow-up research agenda is suggested in three domains: - Economic domain (economic evaluation of all activities around the dams; estimation of the economic benefits from the APDs; economic evaluation of crocodile damage to dam infrastructures and to local communities' property); - Ecological domain (assessment of the seasonal variation in physical, chemical, and microbiological water parameters, and of pesticides in APD water, sediments, fish, and crocodiles; inventory of all APDs in Benin and their ecosystem service status; fish diversity and productivity and water quality upstream and downstream over many years; crocodile predation on fish species); - Socio-cultural and institutional domain (crocodile behaviour; human–crocodile interaction; governance of Nikki Council; governance of the river watersheds; developing and monitoring innovation platforms).

The thesis ends by summarizing an integrated set of recommendations: - Improvements in APD use and management should start from system thinking; - Vegetable production should be based on more organic production methods and executed downstream; - Water quality and fish biodiversity should be intensively monitored and adjusted if needed; - Living with crocodiles should be considered part of the APD agro-ecosystem, and people should thus adapt their behaviours towards crocodiles in order to peacefully share APD ecosystem services with them.

**Keywords:** Agro-pastoral, Agro-ecosystem, Dam, Management strategies, Convergence of sciences, Benin

#### **4. Analysis of the mode and palm oil mill wastes utilization technologies and application to production of three traditional vegetables (*Lycopersicon esculentum*, *Amaranthus hybridus* and *Corchorus olitorus*) in southern Benin**

**Ir. Tatiana KOURA**

##### **SUMMARY**

Because of the revitalization of the palm oil sector in Southern Benin, some mills are confronted with wastes mismanagement while many ways exist for their reuse. To assess the wastes management methods, the waste production systems were quantitatively analyzed based on numerical classification, palm oil production factors and quantities of waste using principal component analyses. Semi-structured surveys had been conducted among 335 oil mills. Four extraction methods (EM) had been identified: traditional (T), improved (A), modern (M) and mini industrialized (MI). The amount of wastes generated by each category of oil mill was determined by evaluating that generated by 7 T, 4 A, 4 M and 9 MI oil mills randomly chosen. The study identified four classes of waste production systems: small, medium, large and very large. They average produced a year  $12.4 \pm 22t$ ;  $31.3 \pm 52.8t$ ;  $132.7 \pm 59.1t$ ;  $800.7 \pm 418.1t$  stalks and pods;  $5.6 \pm 10.3t$ ;  $13.6 \pm 23.1t$ ;  $135.2t \pm 95.2$ ;  $637 \pm 312.6t$  fibers and  $15.1 \pm 23.7t$ ;  $40.9 \pm 28t$ ;  $233.4 \pm 172.1t$ ;  $572.6 \pm 90.3t$  sludge respectively. Discrimination was made based on the nature and size of plantations, financial capacity of the mills owners to hire laborers and the quantities of waste produced. The use of all the amount of generated bunches and fibers did not depend on the quantities produced.

Therefore, relationship between the EM improvement and wastes management was analyzed. The effect of the EM, the type of waste and their interaction on the calculated indices (user's percentage, commercial value, Rejection Rate, Importance Value, and Use Value) were assessed using the log linearly analysis. The fidelity level of each use for each mill was calculated. However, inside their category, all mills considered each use at the same level. Whatever the EM, the surplus waste was eliminated either by discharging into the environment or selling. These options were zoomed when the EM was improved. Ethnobotanical indexes helped in evaluating the importance and value of palm oil mill wastes in palm oil production areas. A double Principal Component Analysis was performed to characterize palm oil mill waste uses in link with production areas. Results showed that the sludge has no importance for mills 'owners'. Oil mills' using the whole amount of bunches and fibers produced, were those for which the waste was important for a unique use. Plateau, Couffo and Mono are oil palm sites where the palm oil mill waste mostly contributed to environmental pollution.

In order to find immediate solutions to mills facing waste management problems, this study proposed these solid wastes co-composting and the use of this compost in vegetables production. The analysis of the sustainability of agricultural practices implemented by producers in relation to their knowledge revealed that the use of empty fruits, bunches and fibers depends on

producers' knowledge. These wastes were spread by local application (76.5%) or mulching (33.3%) in plantations or indirectly after composting. Composting is made either by heaping, in combination with pigs breeding or in pits. Composting is a process unknown to 67.5% of mills' owners. The difference between those who know about it and use it, and those who know about it but do not use it is based on their knowledge of composting advantages.

Physical and chemical compositions of waste were assessed using an ion chromatograph and revealed wastes relatively rich in plants nutrients except in phosphorus. The co composting of empty fruits bunches and fibers was tested in eighteen bins installed in a split plot design not repeated. Composting method (No shelters (SA) and under shelter (AL)) was the main factor and the type of manure (without manure (SF), poultry manure (FV) and cow dung (DB)) was the secondary factor. As results, decomposition of waste and compost quality obtained varied significantly ( $p < 0.05$ ) according to the method of composting and type of manure used. The lowest ratio TOC / TN 18.38 was obtained in compost where FV were used and made without shelter. The use of FV had improved the quality of composts in phosphorus content. However, the leachate analysis showed high loss in total nitrogen ( $88.3 \pm 12.6\text{mg/l}$  to  $146.2 \pm 16.4\text{mg/l}$ ), potassium ( $37.2 \pm 0.8$  to  $53.3 \pm 1.2\text{ mg/l}$ ) and phosphorus ( $107.9 \pm 23.7$  to  $187.4 \pm 65.8\text{mg/l}$ ). The high levels of chloride ( $1301.3 \pm 195.8$  to  $1656.7 \pm 147.8\text{ mg/l}$ ), biological oxygen demand ( $3499 \pm 425.8$  to  $6370.7 \pm 1031.7$ ) showed the need to avoid making the compost heap directly on the ground.

The agronomic effectiveness of composts obtained in the production of *Lycopersicon esculentum*, *Amaranthus hybridus* and *Corchorus olitorius* were evaluated through a split-split plot design with composting method as the main factor and the types of manure and composts application rates (0t / ha 5t / ha to 10t / ha and 20t / ha) as secondary factors. There were 24 treatments and 4 replicates per vegetable. The FV-based compost produced with no shelter (SA) increased the amaranth growth and yield (19.2t/ha) compared to others composts. However, in the case of *Corchorus olitorius*, composts made from waste and DB performed AL was recommended. The application of composts increased the yield of *Corchorus olitorius* and *Lycopersicon esculentum* from 10t / ha.

**Keys words:** Palm oil mill wastes, Waste management, Extraction method, Type of manure, Composting method, Vegetables production

## 5. Improvement of animal productivity by using crop residues in integrated crop-livestock systems in Benin

Ir. Bossima Ivan KOURA

### SUMMARY

In sub-Saharan Africa, livestock breeding contribute to food security and constitute an important source of income for farmers in the dry season. In addition, livestock make manure and draught power available for soil fertilization in integrated crop-livestock farms. Although, feeding remained the main constraint in livestock during the dry season, fed available crops residues is a good issue to maintain animal productivities in this period. However, intrinsic nutritional value of residues as well as farmers feeding practices needs to be improved. This thesis explores ways for improving animal performances in integrated crop-livestock systems.

The main objective was to develop strategies and practices for improving the use of crop residues for animal feeding in small scale farms. Hence the study was designed in four parts:

- (1) Identifying axis for improving traditional Integrated crop-livestock systems (ICLS) used in Benin;
- (2) Understanding breeders feeding practices involving the use of crop residues;
- (3) Evaluating nutritional value of some crop residues commonly fed to animal;
- (4) Assessing the effect of mixed crop residues rations on feed intake, feed digestibility and growth performances of rabbit and sheep.

Surveys (Chapter 2, 3 and 4) were undertaken, feed evaluation (Chapter 5) was implemented and experiments (Chapter 6 and 7) were conducted to achieve all these goals.

**Chapter 2** presents results of a survey carried out to identify factors affecting farmers' decision to use endogenous crop-livestock practices. A semi-structured questionnaire was used to collect information on farmer's characteristics, production factors and both agriculture and breeding by-products valorization practices in three agro-ecological regions of Benin. Three integration levels were identified: no integration, NI: 36%; partial integration, PI: 55% and total integration, TI: 9%. Multinomial logistic regression was used to predict the integration level of a given farmer. Results showed that the decision by a farmer to choose the total integration type significantly depends ( $P < 0.001$ ) on the size of his cattle herd, his membership

in farmers' association, the weight of his agricultural experience and his equipment value. This chapter reveals interesting characteristics of farms to be aware of strategies for improving integration of cropping and breeding.

In **Chapter 3**, endogenous crop-livestock systems used in rural, peri-urban and urban areas of Benin are described and axis for their improvement is identified. Farmers surveyed were interviewed on their practices. The tree integration levels; no integration (NI, 36%), partial integration (PI, 55%) and total integration (TI, 9%); were characterized. Then, a multiple correspondence analysis was performed to identify partial integration subgroups. Various integrated systems were identified, ranging from Low external input agriculture (LEIA) to High external input agriculture (HEIA). The improvement of these systems can be done through a better adequacy of production systems to valorize available crop residues and manure. This chapter gives practical information to improve in order to enhance cropping and livestock rearing integration.

For a breeder, crop-livestock integration involves mainly on the use of crop residues for animal feeding. **Chapter 4** results help to understand breeders feeding practices involving the use of crop residues and their perception of factors affecting them. Investigations focused on the sudanian area of Benin where farmers were surveyed in the northern and southern area on their feeding practices. Farms that used residues were characterized for their socio economic characteristics and a bimodal logistic regression was performed on data collected to identify determinants of the use of crop residues for animal feeding. As result, the decision to use crop residues in animal feeding depended on the education level of the head of household and his cultivated area. Crop residues and practices used were diverse and ranged between the two areas. In this chapter valuable information was obtained on the factors influencing the use of crop residues and the needs of farmers to improve their practices.

One of the factors identified in chapter 4, which influence crop residues utilization, is that farmers has little information on the nutritional value of residues. The nutritional value of commonly used crop residues was therefore investigated in **Chapter 5**, using the *in vitro* gas production technique. Samples collected in the two sudanian areas were screened for their chemical composition and energy content, as well as for their fermentation characteristics (i.e. gas and volatile fatty acid production, organic matter degradability). Compared to legume residues, cereal residues showed lower energy content and crude protein and higher cell wall content, respectively. Legume haulms are richer in protein and energy and lower in structural carbohydrates than legume pod shells. For cereal and legume residues, the *in vitro* fermentation parameters were highly influenced by the residue type. This chapter reveals the nutritional potential of crop residues, which can be used in rationing with those residues.

The needs for improving practices, expressed by farmers in **chapter 4**, resumed on methods for residues conservation and their use in animal rations. So, **Chapter 6** and **chapter 7** showed results of experiment conducted to access feed intake, feed digestibility and growth performances of rabbit and sheep, respectively, fed rations with crop residues. Rabbit was chosen as small animal type bred in peri-urban areas and sheep in the rural area. In **Chapter 6** cowpea and soybean pod shells were incorporate at 10% in a conventional rabbit diet. Three rations were tested: The control (conventional diet), CP<sub>10</sub>: ration with 10% of cowpea pods, SB<sub>10</sub>: ration with 10% of soybean pods. Resulted showed that feed CP<sub>10</sub> showed best performances on intakes, DM and nutrient digestibility, live weigh gain (70 g/d) and on economic parameters. Animal performances in SB<sub>10</sub> were less interesting. Thus, the use of cowpea pod shells can improve incomes of rabbit breeders in the peri-urban areas.

In **Chapter 7**, three diets were tests on sheep: Urea Treated Maize Stover ad libitum + 100 g of Maize Bran (UTMS); Urea Treated Maize Stover ad libitum + 100 g of Maize Bran + 500 g of Groundnut haulms (MSGH); Urea Treated Maize Stover ad libitum + 100 g of Maize Bran + 500 g of Soybean pod shells (MSSP). The study showed that only the treatment MSGH showed good performances on intakes and live weigh gain (23 g/d). However the treatment with urea treated maize stovers was very well digested (69%) than that in MSGH (51%) and MSSP (44%). On the other hand, animals lose weight in UTMS and MSSP (30 g and 13 g, respectively). Thus, in the late dry season when resources are really limited, the use of crop residue can reduce weight loss (MSSP) and even improve animal growth performances (MSGH).

**Key-words:** Animal nutrition, Rabbit, Ruminants, sub-Saharan Africa, Sustainable production systems

## Publications in Proceedings in 2015

### 1. Proposition d'une typologie de stratégies adaptées pour la sauvegarde des espèces fauniques protégées à partir du cas du lamantin (*Trichechus senegalensis*) au Bénin

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#### RESUME

La pression démographique dans la zone côtière du Bénin qui héberge plus de 50 % de la population nationale sur les 10 % du territoire national qu'elle représente, engendre une surexploitation des ressources floristiques et fauniques. Au nombre des espèces fauniques menacées figure le lamantin (*Trichechus senegalensis*) qui est un mammifère aquatique herbivore et dont la présence est un indicateur de la santé écologique des écosystèmes où il vit : pullulation des poissons du genre *Chrysichthys* et contrôle de la jacinthe d'eau. La présente étude vise à définir un modèle standard de stratégies appropriées pour la sauvegarde ciblée d'une espèce faunique protégée en fonction des communautés locales. Elle s'appuie sur l'étude de cas appliquée au lamantin (*Trichechus senegalensis*) au Bénin, une espèce faunique protégée, menacée de disparition. Réalisée en septembre 2010 en complément à l'étude effectuée d'avril à mai 2002 sur « la protection des dernières populations du lamantin dans la basse vallée de l'Ouémé », cette étude a porté sur les quatorze (14) villages initiaux répartis dans la zone côtière au sud Bénin. L'analyse des informations recueillies au moyen de séances de discussion *focus groups*, complétées par des interviews de personnes ressources identifiées dans chaque village visité sur la connaissance, l'attitude et les pratiques des populations vis-à-vis de l'animal, a permis de dégager un Gradient d'Agressivité Théorique (GAT) en fonction duquel quatre stratégies de sauvegarde utilisables ont été définies : la promotion d'activités économiques alternatives, la vulgarisation du rôle écologique de l'animal, le renforcement de la sacralisation de l'animal là où elle existe et la vulgarisation des textes réglementaires sur l'animal.

**Mots clés :** Espèces fauniques protégées, Lamantin, GAT, Stratégie, Bénin.

## Technical Reports and Books in 2015

### 1. Stratégie des « boutiques témoins » contre l'insécurité alimentaire au Bénin : Efficacité et perspectives pour l'Afrique

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#### RESUME

Face à la crise alimentaire survenue dans les années 2007-2008, entraînant la raréfaction des stocks de denrées alimentaires de base comme le maïs, le riz et le sorgho, le gouvernement du Bénin a mis en place en juillet 2008 la stratégie des boutiques témoins (BT) qui fonctionnent à ce jour. Les BT sont gérées par l'Office National d'Appui à la Sécurité Alimentaire (ONASA). L'objectif de cette étude est d'analyser l'efficacité de ces BT face à la crise et leur capacité potentielle pour la lutte contre l'insécurité alimentaire et la pauvreté. L'étude a porté sur les cinq boutiques témoins des cinq Communes du Département du Plateau au sud-est Bénin. Les données et informations collectées au moyen de séances de *focus group* sur chaque BT, d'enquêtes structurées auprès de 20 personnes par Commune et d'entretiens informels, permettent de dégager que les boutiques témoins ont été efficaces dans la résolution de la crise. Elles ont permis entre autres une meilleure couverture géographique du territoire national en vivres, la création d'emplois, la promotion de la consommation des produits vivriers

locaux, en l'occurrence le riz, et la facilitation de l'écoulement du riz des producteurs agricoles. Cependant, l'efficacité à long terme de la stratégie des boutiques témoins n'est pas garantie dans les conditions actuelles. L'ONASA a tendance à se comporter en quasi-monopsonie lors de l'achat du riz des producteurs. Le prix qu'il fixe est jugé désavantageux par les organisations de producteurs de riz. De plus, la forte subvention des produits vendus dans les BT n'est plus de nature à encourager la commercialisation et la production locale du riz. L'ONASA devra corriger ces deux faiblesses pour espérer une résolution durable de la question de l'insécurité alimentaire et de la pauvreté rurale au Bénin. Ce faisant, l'initiative pourrait servir de modèle pour d'autres pays africains.

## Abstract of conference/seminar in LEA

### 1. Diversity of the serpent fauna in Central Africa: from field surveys to integrative systematics

Dr Zoltan Tamas NAGY, Researcher - Herpetology and Evolution

#### ABSTRACT

Molecular genetic methods, such as DNA barcoding, DNA sequencing including next-generation sequencing are practical tools in biodiversity research. They complement traditional methods and provide novel type of data. In the presentation, an overview of common techniques will be given. In addition, a case study will be presented. Since 2008, we conducted several herpetological field surveys across Central Africa, mainly focusing on the Democratic Republic of the Congo. We established a large specimen collection of amphibians and reptiles. One of the main targets was to study the diversity of snakes in this vast region. So far we analyzed >700 specimens of ca. 90 snake species, and completed a large-scale DNA barcoding assessment. These data allowed us to update range maps of many species and to provide faunistic checklists for previously unsurveyed regions. We also assessed intraspecific and intrageneric diversity and tested species boundaries, complementary to morphological identification. According to our results, most snake species are easy to distinguish with mitochondrial sequences, and intraspecific divergences appear modest. However, some common and widespread serpent species showed unexpectedly high divergence. Selected snake taxa were further analyzed in an integrative systematic context, benefiting from novel approaches of species tree inference and phylogenomics. Our results may lead to alter current classification and challenge the biogeographic interpretation of apparently widespread Afrotropical taxa.

### 2. Le plagiat et l'autoplégat dans les écrits scientifiques

Dr Ir. Guy Apollinaire MENSAH

#### RESUME

Tout écrit scientifique s'appuie et s'inspire toujours d'autres écrits antérieurs suite à une synthèse ou analyse bibliographique relative au thème ou au domaine. Tout scientifique ou auteur d'un écrit scientifique doit apprendre à citer correctement ses sources et sa publication scientifique en sera valorisée. Le **plagiat**, c'est le fait de s'approprier les idées ou les mots de quelqu'un d'autre en les faisant passer pour les siens<sup>1</sup>. L'**autoplégat** consiste à réutiliser ce qu'on a écrit dans d'autres publications sans les citer<sup>2</sup>. Bergada (2013)<sup>3</sup> a souligné les six points suivants relatifs à l'autoplégat, au plagiat et à la fraude scientifique:

1. Le plagiat est d'abord un vol de la création originale. La sensation de viol du plagié est naturelle, s'agissant du vol d'une œuvre de l'esprit, donc unique : c'est une atteinte grave aux droits de la personnalité. Ces droits de la personnalité sont, par nature, intransmissibles, car rattachés à la personne elle-même. L'autoplégat n'est pas un vol à autrui.

<sup>1</sup> <http://www.univ-angers.fr/fr/formation/anti-plagiat/c-est-quoi-le-plagiat.html>

<sup>2</sup> [www.20minutes.fr/Sciences](http://www.20minutes.fr/Sciences)

<sup>3</sup> Bergada Michelle, 2013. Autoplégat, Plagiat et fraude scientifique. <http://responsable.unige.ch/assets/files/auto-plagiat.pdf>

2. Plagieurs et autoplagieurs s'inscrivent également en faux dans le droit fondamental du lecteur à l'accès à l'origine des sources de la connaissance. Nous devons citer nos sources pour permettre à tout nouveau chercheur qui nous lit de pouvoir se pencher, à son tour, sur nos données de base (quelles qu'en soit la nature), de conduire sa propre analyse, d'émettre de nouvelles hypothèses, de découvrir le « cygne noir » que nous n'avions pas vu parmi les « cygnes blancs » de notre argumentation, de créer, enfin, de nouvelles interprétations et, donc, de faire progresser le savoir.
3. Plagiat, autoplagiat et fraudes scientifiques sont également des fraudes au système, puisqu'ils conduisent l'auteur à bénéficier d'une position sociale et/ou professionnelle dans le système qu'il n'aurait peut-être pas occupée sinon. Ainsi, l'autoplagiat qui consiste à utiliser le même écrit pour démultiplier le nombre de ses publications sur un CV est bien une fraude.
4. Plagieurs, autoplagieurs et fraudeurs scientifiques portent également atteinte à l'image des institutions où ils exercent et aux collaborateurs de celles-ci. C'est à l'institution d'agir en vertu de sa notoriété, de son image de marque et de ses règlements en la matière.
5. Plagiat et autoplagiat sont également la porte ouverte à de nombreuses autres déviances associées. Pourquoi une personne qui n'a pas scrupule à s'approprier des modèles et revues de littérature d'autres chercheurs ou à tricher sur ses propres publications en aurait-elle soudain pour la partie empirique de son travail ? En ce qui concerne les thèses de doctorat, notre conviction est que le directeur de thèse négligent sera au moins deux fois trompé : sur l'écrit et sur les données empiriques.
6. Plagiat, autoplagiat et fraudes scientifiques entraînent des dommages collatéraux importants. Ainsi, la découverte d'un cas de plagiat et/ou autoplagiat et la mise en examen de son auteur entraînent des commissions d'enquête longues et coûteuses. Nul ne pense à chiffrer les salaires des avocats et des enquêteurs associés, le temps perdu par les directeurs de la recherche et autres parties prenantes, alors même qu'il n'y a aucune compensation pour les établissements ayant l'honnêteté de conduire de telles enquêtes. *In fine*, cet argent, c'est bien souvent sur les budgets de la recherche qu'ils sont prélevés.

Le plagiat et l'autoplagiat sont des plaies de la recherche scientifique et dans les écrits scientifiques. Le plagiat et l'autoplagiat peuvent être volontaires ou involontaires. Le plagiat et l'autoplagiat n'ont pas leur place dans les écrits scientifiques.

### **3. African amphibians – fascinating adaptations from rainforest to savanna**

PD Dr. Mark-Oliver RÖDEL

Curator of herpetology at the Natural History Museum in Berlin, and chairman of the IUCN Specialist Group for West and Central African amphibians".

#### **SHORT ABSTRACT**

Fascinating examples of amphibian species across the continent will be presented. Emphasize will particular be on the specific adaptations of various species to very different habitats and their constraints.



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