The link between biodiversity and nutrition gains more and more interest from researchers all over the world. Although there is little evidence until now, the assumption that more biodiversity leads to better diets and health is reasonable and compelling.

Tshopo District in the Democratic Republic of Congo has an enormous agricultural potential, but food security remains structurally very precarious. Despite the enormous richness in biodiversity and cultures, WEPs have little been studied in Tshopo District, c.q. DRC. The main objective of this thesis was to contribute to the valorization of WEPs for better nutrition security, higher and more diversified farmer's incomes and sustained cultural well-being.

Ethnobotanical research was carried out within 3 ethnic groups in 3 different territories of Tshopo District to inventory all WEPs known by these populations. A market survey was conducted to assess the actual and future commercialization potential of WEPs in Kisangani markets and finally by means of two multiple-pass 24h recalls we assessed the contribution of WEPs to diet adequacy for 363 urban and 129 rural women in Tshopo District. Even though our results showed that WEPs are currently almost not traded nor consumed, there exists good potential to promote WEP consumption and trade in Tshopo District for better nutrition security and poverty alleviation.

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Wild edible plant use in Tshopo Distrct, Democratic Republic of Congo

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CÉLINE TERMOTE

WILD EDIBLE PLANT USE IN TSHOPO DISTRICT, DEMOCRATIC REPUBLIC OF CONGO

Thesis submitted in fulfillment of the requirements
for the degree of Doctor (PhD) in Applied Biological Sciences

Dutch translation of the title:
Gebruik van wilde eetbare planten in Tshopo District, Democratische Republiek Congo

Illustration on the cover: above from left to right: *Tristemma mauritianum*, *Myrianthus arboreus*, *Grewia louisii*, *Anonidium mannii*; middle: Congo river; below from left to right: *Cola acuminata*; *Tetracarpidium conophorum*, *Maesobotrya longipes*, *Caloncoba subtomentosa*

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The good life is one inspired by love and
guided by knowledge

Bertrand Russell

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Céline Termote

SUMMARY

Since the late 1980s and early 1990s, and in conjunction with an increasing global concern about environmental issues, increased attention for rural poverty and the emergence of the concept 'sustainable development', there has been an increasing support from the scientific community, NGOs and policy makers to address issues of biological conservation and poverty reduction as interrelated and not as mutually exclusive goals. Agricultural biodiversity and its potential as a driver of economic growth, food security and natural resource conservation has gathered an increasing amount of interest since the Convention on Biological Diversity was voted in 1992. Even though the nature of the evidence is still circumstantial, it is a reasonable and compelling assumption that increased agricultural and forest biological diversity leads to a more varied diet, which in turn improves specific health outcomes. Nutrition and biodiversity also feature directly in the Millennium Development goals (MDGs), in Goal 1, Target 2, 'Halve the proportion of people who suffer from hunger'; and goal 7, 'Ensure environmental sustainability'.

Despite the country's high endowment with natural resources, 90% of the 60 million Congolese inhabitants is poor, whereas the majority of them lives in rural areas. 70% of DRC's inhabitants depend on the forest for their daily livelihoods. Valorising wild edible plants (WEP), and non-timber forest products (NTFP) in general, which constitute a particular niche of the poorest, will thus contribute to poverty alleviation and increased nutrition security in a DRC context. Although the potential of NTFPs to contribute to poverty alleviation is recognized in the country's Poverty Reduction Strategy Papers (DSCRP 2006, 2011), both documents deplore the huge gap of knowledge in this sector.

Despite their enormous intrinsic biodiversity, the Congolese forests are the least documented in Africa, not only in terms of their potential for industrial timber exploitation, but also in terms of socio-economic and cultural value to the local populations (firewood, medicine, shelter, tools, game, caterpillars, mushrooms, honey, WEPs, dyes, cultural and spiritual values, etc.). In order to underpin political decisions and to find innovative ways for managing DRC's precious natural resources, there is an urgent need to revitalize forestry and agricultural research in the country.

Until now, and notwithstanding the richness in biodiversity and cultures, WEPs have been little studied in Tshopo District, c.q. DRC. Tshopo District has an enormous agricultural potential, but nevertheless food security remains structurally precarious. Challenged with the consequences of food insecurity in their daily activities and aware of the underutilized potential of WEPs, some local NGOs have put forward that there must be opportunities to valorize local wild foods for better nutrition and health.

The main objective of this PhD study was to contribute to the valorization of local WEPs for improved food security and livelihoods in Tshopo District, DRC. Therefore, we used a multidisciplinary approach including the domains of ethnobotany, market analysis and nutrition, with WEPs at the centre. As a long-term vision, we see the most interesting WEPs being promoted, domesticated, integrated into farmers' fields and commercialized for 1) improved nutrition and health; 2) increased and diversified farmers' income; and 3) sustained cultural well-being without compromising preservation of natural resources. This work presents information on WEP uses, present and future commercialization possibilities, and current and potential contributions of WEPs to local diets, nutrient intake and dietary adequacy. Because further in-depth study of all WEP species documented in this work is almost impossible, we paid, special attention to the prioritization of species. The results of this work can then constitute the basis for further study, participatory domestication and value chain development of priority WEP species, i.e. species with highest nutritional and socio-economic potential, and cultural acceptance.

We started our investigations with a thorough ethnobotanical study to inventory the indigenous knowledge on WEPs in 3 ethnic groups (Turumbu, Mbole and Bali) in 3 different territories of Tshopo District. WEPs were collected in 3 villages per ethnic group to constitute a reference herbarium and their properties recorded during focus group discussions. In total, we documented 166 WEP species and 2 varieties in 71 plant families from which 198 plant parts are used for 228 different specific food uses. Compared to available literature, 72 species reported in our study were cited for the first time as WEP in the region. In addition, 136 of the 166 WEP species were shown to be used for other purposes such as medicines, materials and arts, cultural uses, construction, fuels, bait, fodder or poison. Moreover, we compared inter- and intra-ethnic differences in WEP knowledge and found that only 21% of the species were known and used by all 3 ethnic groups. Further inventorying WEP knowledge in the other ethnic groups of Tshopo District would thus certainly add new species

and uses to our WEP list. Besides differences in cultural habits and preferences for WEPs, we observed that the various ethnic groups in Tshopo District are faced with different opportunities and constraints such as market access. Consequently, we should make a distinction between species with overall regional importance and ethnospecific species when it comes to priority setting for further study, participatory domestication and/or conservation.

Preferences in taste and commercial, nutritional and cultural value of both wild fruits and wild vegetables, were discussed during participatory ranking exercises within the Turumbu, Mbole and Bali ethnic groups. Results show that, for all ethnic groups considered together, overall liking was highest for *Anonidium mannii*, followed by *Landolphia owariensis* and *Tetracarpidium conophorum* in the wild fruits category, and *Megaphrynium macrostachyum* in the wild vegetables category. We did not perform any separate preference ranking exercises neither for spices nor for stimulant nuts. However, the ethnobotanical inventories showed that the wild spices *Piper guineense* and *Scorodophloeus zenkeri* together with the stimulant nuts *Cola acuminata* and *Garcinia kola* are used in all three ethnic groups for a great number of purposes, whereas they are also highly embedded in traditional culture. According to us, they should thus be added to the list of most-preferred species.

Subsequently, we analyzed WEP markets in Kisangani in relation to number and socio-economic characteristics of sellers, WEP species and quantities offered, prices and periodicity in offer. From the 166 WEPs known by the Turumbu, Mbole and Bali ethnic groups in Tshopo District, only 15 WEPs were seen to be sold on Kisangani markets by a small number of 'ad hoc' traders, who often switch easily to other products when they become available. The September-October period and 'Marché Central' are most important for WEP trade in Kisangani. Added values and net incomes generated through WEP sales highly vary, even between traders of a same species. Until now, most WEPs are harvested for autoconsumption. As a consequence WEP markets in the region remain underdeveloped, although, a certain form of organization was found in the *Gnetum africanum* trade with Kinshasa as main destination. In general, traders mentioned lack of transport and market infrastructure, lack of storage space, (il)legal taxes, lack of credit facilities, insufficiency of WEPs to purchase and low purchasing power of consumers, as the main constraints in WEP trade.

Based on the nature of species sold as well as on the socio-economic characteristics of our interviewees, we identified four types of traders: subsistence traders, traders diversifying in

number of WEPs sold, traders diversifying in number of income activities, and specialized traders. This typology provides valuable insights for further market chain organization and development, especially because selling particular WEPs seems to be linked to particular trader socio-economic characteristics.

International, national as well as local markets exist for *Gnetum africanum* leaves, *Piper guineense* fruits, and nuts of *Cola acuminata* and *Garcinia kola*. The species which has the highest demand and also the most dynamic traders is undoubtedly *G. africanum*. However, for long-term sustainability of successful NTFP commercialization, (participatory) domestication and integration of *G. africanum* into agroforestry systems is urgently needed. Wild spices (*P. guineense, C. acuminata* and *G. kola*), on the other hand, are so far only locally sold, mainly in micro-quantities by extremely poor, elderly widows. Organizing the wild spices market chains for more efficiency will require special strategies to protect these elderly (widow) women. Otherwise, the chances are that they will not be able to compete with the more dynamic traders that may enter the market when value chains become more efficient.

From the market study, it further follows that *Landolphia owariensis* and *Tetracarpidium conophorum* are priority wild fruits for *local* market development. They are both easier to transport and less perishable than the very big *Anondium mannii* fruits, whereas they are also sold by a relatively higher number of traders. Although the latter fruit had the highest score in the preference ranking exercises performed during our ethnobotanical investigations, better transport, processing and/or conservation of *A. mannii* will be necessary for its market to expand. Local market development for wild vegetables will require additional nutritional education and sensitization about the many advantages of diversified diets and wild vegetables for good health in order to stimulate demand side.

To assess the contribution of WEPs to dietary quality, we estimated the usual dietary intake from 2 multiple-pass 24h dietary recalls of 363 urban (Kisangani) and 129 rural (Yaoseko) women within the period of highest WEP availability. Contrarily to what was expected, only 15 WEPs were found to occur and then only in a marginal number of 24h-recalls. The most noteworthy contribution came from the semi-wild safou fruit (*Dacryodes edulis)*, reported in 30.1% of all recalls and contributing 4.8% of total energy intake in Yaoseko village and this within the safou season (about 3 months per year). We further found that total energy intake of the interviewed women was rather low, with a high percentage energy coming from fats.

The micronutrients of major concern were niacin, folate, vitamin B-12, iron, zinc and calcium with more than 75% of women having intakes below the recommended dietary allowances. Despite the precarious nutrition security, urban as well as rural inhabitants in this highly biodiverse region do not valorize their knowledge on WEPs to complement their diets. Overall consumption of WEPs in the sample was too low to achieve adequate dietary intake or nutrition security. So, it is wrong to assume that biodiverse-rich environments automatically lead to better diets. However, this does nót mean that WEPs and agrobiodiversity, in general, could not contribute to better nutrition security.

It is clear that, in the given situation, promotion of WEPs alone will not solve all underlying causes of nutrition insecurity and poverty in the region, but they can at least contribute more to better local diets and incomes then they currently do. A lot of WEPs with proven nutritional qualities, such as *Gnetum africanum* and *Treculia africana* (and others of which the nutritional qualities are not yet known by science), are present in the region. Before getting indefinitely lost, indigenous knowledge on wild edible species and their dietary use need further research to capture the potential of biodiversity and ameliorate diet adequacy.

Research into agrobiodiversity and agroforestry starting from local needs and indigenous knowledge, and backed up by sound scientific research principles will be indispensable to create innovative, resilient agricultural models able to produce healthy foods in a sustainable way while at the same time conserving biodiversity for future generations. In line with this, we could e.g. consider the promotion and integration of indigenous fruits, vegetables, tubers, spices, etc. in home gardens and agroforestry systems. Nonetheless, participatory domestication of indigenous fruit (and medicinal) trees and the integration of them into agroforestry systems together with value chain development for these species, belongs to the core activities of ICRAF's work in West and Central Africa. A partnership was established and since 2009 ICRAF extended its activities in Tshopo District. At present they are working with three local farmer groups, one local NGO and the local universities, UNIKIS and IFA-Yangambi.

Even though nowadays WEPs are not widely traded nor used in Tshopo District, the indigenous knowledge on them is still present and culturally well-defined. It should thus be possible to identify, embrace and build upon local socio-cultural values which are likely to enhance WEP consumption and trade. From our (scientific) side, we should urgently generate

and make available more nutritional and health information on WEPs to validate the existing local knowledge. This seems all the more necessary because the local population itself – being told for decades that only conventional crops are good for health - is requesting this kind of information and would most benefit from it. Through the recognition and valorization of their own knowledge, local populations can reach a sustainable way of living in conjunction with the modern context.

Undoubtedly, a lot of work remains to be done in order to reach the global aim of improving food security, diversifying and increasing farmers' incomes and protecting the rainforest from overexploitation through participatory domestication and improved market chain organization. However, we hope to have set one step into the right direction by making available information on WEP uses, commercialization and consumption, and by providing insight into how local WEPs can be valorized and prioritized for further research. Further research is needed to map the indigenous knowledge and preferences on WEPs in the other ethnic groups in the region; to study into detail the value chains of the priority WEP species in order to define pro-poor strategies for further development of these chains; to analyze and make available nutritional composition data of the WEPs; to study and conceptualize the many links between biodiversity, nutrition, culture and livelihoods in the region; to evaluate domestication possibilities and sustainable harvest techniques; etc.

RÉSUMÉ

Depuis la fin des années 80 et le début des années 90 du 20ième siècle et ensemble avec une attention croissante pour l'environnement et pour la pauvreté rurale et avec l'apparition du concept 'développement durable' il y a, pour ce qui est des hommes de science, des politiciens et des ONG, un support croissant pour considérer la conservation de la diversité biologique et la diminution de la pauvreté comme des objectifs parallèles et qui ne s'excluent pas. L'agrobiodiversité et sa possibilité d'engendrer la croissance de l'économie, la sécurité alimentaire et la protection des richesses naturelles est de plus en plus importante depuis la convention concernant la biodiversité votée en 1992. Même s'il n'existe, jusqu'ici, aucune évidence directe, il est raisonnable et attrayant de supposer qu'une plus grande biodiversité agricole et forestière mène à une alimentation plus variée ce qui influence positivement la santé des populations. Nutrition et biodiversité sont aussi très présentes dans 'Les objectifs du Millénaire pour le Développement'. Il s'agit de l'objectif 1, cible 2: 'Réduire de moitié, entre 1995 et 2015, la proportion de la population qui souffre de la faim' et objectif 7: 'Préserver l'environnement'.

Malgré des ressources naturelles énormes, 90% des six millions de Congolais sont pauvres et la plupart d'entre eux vivent en milieu rural. Environ 70% de la population Congolaise dépend de la forêt pour subvenir à leurs besoins journaliers. Une valorisation améliorée des plantes alimentaires sauvages (PAS) et, par extension, des 'produits forestiers non-ligneux' (PFNL), la niche spéciale des pauvres, devrait donc contribuer à la lutte contre la pauvreté et à une meilleure sécurité alimentaire dans le contexte de la RDC. Le grand potentiel de PFNLs capables de réduire la pauvreté est reconnu dans le DSCRP (Document de Stratégie de la Croissance et de la Réduction de la Pauvreté), mais en même temps on souligne le manque énorme de savoir-faire (*know-how*) dans ce secteur.

La forêt congolaise héberge une énorme biodiversité intrinsèque, mais elle appartient aux forêts les moins étudiées en Afrique, non seulement en ce qui concerne la production industrielle de bois, mais aussi pour ce qui est de la valeur socio-économique et culturelle de la forêt pour la population locale (bois de chauffage, médicaments, hébergement, outils et arts, gibier, chenilles, champignons, miel, PAS, colorants, valeurs culturelles et spirituelles). Il

faudra donc intensifier la recherche scientifique au niveau de l'(agro-)foresterie et de l'agriculture afin de mieux corroborer les décisions politiques et de développer des méthodes innovatrices pour gérer de manière durable les précieuses ressources naturelles congolaises.

Jusqu'à nos jours et malgré l'énorme richesse de biodiversité et de cultures, les PAS ont été très peu étudiées dans le district de la Tshopo et au Congo en général. Le district de la Tshopo dispose d'un grand potentiel agricole mais la sécurité alimentaire dans la région reste structurellement précaire. Confrontées aux séquelles de cette précarité pendant leurs occupations journalières et conscientes du potentiel inutilisé des PAS, quelques ONG locales ont mis en avant qu'il doit y avoir des opportunités pour valoriser ces ressources locales afin d'obtenir une nutrition et une santé meilleures.

L'objectif principal de cette étude était de contribuer à la valorisation des PAS en fonction de la sécurité alimentaire dans le district de la Tshopo en RDC. Nous avons appliqué une approche multidisciplinaire en nous servant de l'ethnobotanique et de l'analyse du marché et de la nutrition avec nos PAS au centre de l'examen. A long terme, notre vision est de voir les PAS les plus intéressantes promues, commercialisées, domestiquées et intégrées dans les champs des agriculteurs afin 1) d'améliorer l'alimentation et la santé ; 2) d'agrandir et de diversifier le revenu des agriculteurs; et 3) de soutenir le bien-être culturel; sans mettre en danger la protection des ressources naturelles. Ce travail présente de l'information concernant l'usage des PAS, les possibilités de commercialisation contemporaines et futures et concernant la capacité des PAS de contribuer à l'alimentation locale et à la qualité des diètes. Une étude prolongée de toutes les PAS inventoriées durant cette étude est presque impossible. Dès lors, nous avions une attention spéciale envers la prioritisation des différentes espèces documentées. De cette façon notre étude pourrait constituer un instrument utile pour de futurs chercheurs, en vue de la commercialisation et domestication participative des PAS à grande priorité, c.a.d. les espèces qui sont culturellement bien acceptées et qui ont le plus grand potentiel socio-économique et nutritionnelle.

L'examen a commencé avec une étude ethnobotanique approfondie pour inventorier les connaissances locales concernant les PAS chez trois groupes ethniques (Turumbu, Mbole et Bali) occupant trois territoires différents dans le district de la Tshopo. Pour chaque groupe ethnique, on a collectionné les PAS dans trois villages afin de constituer un herbier de référence et les caractéristiques des plantes en question ont été enregistrées pendant des

discussions en groupe focus dans les mêmes villages. En total on s'est documenté sur 166 espèces PAS et deux variétés en 71 familles botaniques, dont 198 parties de plantes sont utilisées pour 228 usages alimentaires différentes. Quand nous tenons compte de la littérature disponible, il y a 72 espèces qui ont été citées pour la première fois comme PAS dans le district. En plus, 136 des 166 espèces PAS étaient sujettes à d'autres usages situés dans le domaine médicinal ou dans celui du matériel et art, de la culture, de la construction, des combustibles, des appâts, du fourrage ou même du poison. Des différences intra- ou interethniques concernant la connaissance des PAS ont été examinées et cet examen nous apprend que seulement 21% des espèces inventoriées étaient connues chez les 3 groupes ethniques. Une inventorisation ultérieure de la connaissance des PAS dans d'autres groupes du district de la Tshopo nous mènerait donc sûrement à d'autres plantes et d'autres usages. Non seulement les habitudes culturelles et les préférences pour certaines PAS diffèrent, mais les groupes ethniques sont aussi confrontés à des opportunités ou des restrictions différentes telles que l'accès au marché. Par conséquent nous devons faire une distinction entre les espèces à intérêt régional et celles à intérêt mono-ethniques lors de l'établissement des listes des espèces prioritaires en fonction d'une étude prolongée, la domestication participative et/ou la conservation.

Pendant des exercices participatifs de '*ranking*', on a établi les préférences concernant le goût, la commercialisation et la valeur culturelle et nutritive des fruits et des légumes sauvages chez les groupes ethniques Turumbu, Mbole et Bali. Les résultats ont démontré que, toutes ethnies confondues, *Anonidium mannii* est le plus apprécié suivi de *Landolphia owariensis* et *Tetracarpidium conophorum* dans la catégorie fruits sauvages et *Megaphrynium macrostachyum* dans la catégorie légumes sauvages. Des exercices de '*ranking*' spécifiques pour les épices et les noix stimulantes n'ont pas été faits. Cependant les inventorisations ethnobotaniques ont démontré que les épices *Piper guineense* et *Scorodophloeus zenkeri* ensemble avec les noix stimulantes *Cola acuminata* et *Garcinia kola* sont employés dans tous les groupes ethniques. Elles sont bien intégrées dans les cultures traditionnelles où elles servent à des objectifs très variés. Pour toutes ces raisons, il faudrait, selon l'auteur, les ajouter à la liste des espèces les plus appréciées.

Ensuite les marchés des PAS à Kisangani ont été étudiés par rapport au nombre et aux caractéristiques socio-économiques des vendeurs, par rapport aux espèces PAS offertes et quant à la quantité, les prix et la périodicité de l'offre. Des 166 PAS connues par les groupes

ethniques Turumbu, Mbole et Bali du district de la Tshopo, seulement 15 plantes étaient présentées sur les marchés de Kisangani. Ces PAS sont vendues surtout par des commerçants '*ad hoc*' qui, suivant la disponibilité, passent facilement à la commercialisation de différents autres produits. La période septembre/octobre et le marché central sont très importants pour le commerce des PAS. La valeur ajoutée et le revenu généré par la vente des PAS diffèrent très fort même entre les commerçants qui vendent les mêmes espèces. Jusqu'ici la plupart de la récolte des PAS servait à l'auto-consommation. Par conséquent les marchés PAS sont sous-développés dans la région, à l'exception du marché de *Gnetum africanum* avec destination Kinshasa où l'on constate un début de spécialisation. La structure défectueuse des marchés et du transport, le manque de capacité de stockage, les taxes (il)légales, le manque de facilités de crédit, le manque de PAS à acheter et un pouvoir d'achat des consommateurs trop bas sont allégués par les vendeurs en tant que des facteurs majeurs qui entravent le commerce des PAS.

Quatre types de vendeurs PAS ont été identifiés à base des espèces de plantes vendues et aussi à base des caractéristiques socio-économiques des vendeurs. Ce sont des vendeurs de subsistance, des vendeurs qui diversifient quant au nombre de PAS vendues, ceux qui diversifient leurs activités lucratives et ceux qui se spécialisent dans la vente des PAS. Cette typologie nous fournit des éléments clés qui pourront soutenir les actions d'organisation et de développement du marché dans le futur, surtout parce que la vente de certains PAS semble être très liée aux caractéristiques socio-économiques spécifiques des commerçants.

Il existe des marchés internationaux, nationaux et locaux pour les feuilles du *Gnetum africanum*, pour les fruits *Piper guineense* et pour les noix *Cola acuminata* et *Garcinia kola* . L'espèce la plus demandée et disposant des commerçants les plus actifs est sans doute le *Gnetum africanum.* Mais pour réaliser une commercialisation durable à long terme, une domestication (participative) et une intégration dans les systèmes agro-forestiers s'avèrent nécessaire. Jusqu'ici les épices sauvages (*P. guineense, C. acuminata* et *G. kola*) par contre ne sont vendues que localement, généralement en micro-quantités par des femmes âgées et extrêmement pauvres. L'organisation de la vente de ces épices sauvages demandera donc des stratégies appropriées qui devront être à même de protéger ces vieilles femmes qui sont souvent des veuves. Sans ces stratégies, il sera impossible pour ces vieilles femmes de concurrencer les commerçants plus dynamiques qui seront sans doute attirés par des filières de marché plus efficaces.

L'étude du marché nous laisse constater aussi que *Landolphia owariensis* et *Tetracarpidium conophorum* doivent être considérés comme des fruits sauvages prioritaires pour le développement du marché local. Tous les deux sont faciles à transporter et moins périssables que le très grand fruit *Anonidium mannii* et ils sont tous les deux vendus par un nombre de commerçants relativement plus grand. Bien qu'*Anonidium* ait reçu le score le plus haut pendant les exercices participatifs de '*ranking*' dans les villages, il faudra quand même développer de meilleures possibilités de transport, de transformation et de conservation avant que le marché *Anonidium* ne puisse croître. Le développement du marché local de légumes sauvages suppose des actions supplémentaires de sensibilisation et de formation nutritionnelle pour démontrer les avantages nombreux d'une alimentation diversifiée et des plantes sauvages pour obtenir une bonne santé et afin de stimuler la demande de cette façon.

Afin d'analyser la contribution des PAS à la qualité de la diète locale nous avons évalué la prise nutritionnelle habituelle à l'aide de deux '*multiple-pass 24h dietary recalls'* pour 363 femmes dans la ville de Kisangani et 129 femmes à la campagne (village de Yaoseko) pendant la saison avec la plus grande disponibilité des PAS. Dans un nombre très restreint de rappels de 24h on n'a retrouvé que 15 PAS différentes dans les diètes, ce qui était tout à fait contraire à nos attentes. La plus importante contribution venait du fruit sauvage safou (*Dacryodes edulis)* qui était rapporté dans 21% des rappels et qui constituait 4,8% de la prise totale d'énergie au village Yaoseko et ceci pendant la période de disponibilité (environ 3 mois par an). La prise totale d'énergie des femmes interviewées était plutôt basse avec un grand pourcentage d'énergie provenant de graisses. En outre 75% des femmes se situaient en dessous des apports journaliers recommandées de prises de micronutriments tels que pour la niacine, l'acide folique, la vitamine B-12, le fer, le zinc et le calcium. Ni la population rurale, ni celle de la ville ne valorisent leurs connaissances des PAS afin de compléter leur diète et ceci malgré une sécurité alimentaire très précaire dans cette région à grande biodiversité. La consommation de PAS étant trop basse, elles ne réussissent pas à contribuer à une diète adéquate, ni à la sécurité alimentaire. On ne peut donc nullement supposer que la simple présence d'une grande biodiversité de l'environnement mène à de meilleures diètes. Néanmoins cela ne veut pas dire que les PAS et l'agrobiodiversité en général ne sont pas capables d'engendrer une meilleure sécurité nutritionnelle.

Il est clair que dans une situation pareille seul la promotion des PAS ne suffira pas à combattre les causes sous-jacentes de la précarité alimentaire et de la pauvreté, mais les PAS

pourraient au moins contribuer mieux que maintenant à la qualité de la diète locale. Plusieurs PAS disposant de qualités nutritionnelles exceptionnelles telles que *Gnetum africanum* et *Treculia africana* (et d'autres dont les qualités nutritionnelles n'ont pas encore été détectées par la science) sont présentes dans la région. Avant que les connaissances indigènes concernant les PAS ne se perdent complètement, il faut inventorier le savoir-faire local concernant les PAS et étudier leur usage dans la diète de la population pour que le potentiel intégral de la biodiversité disponible soit mieux exploité en vue d'améliorer la qualité de la diète.

Des recherches dans le domaine de la biodiversité et de l'agroforesterie, en partant de besoins locaux et de connaissances indigènes et soutenues par des principes scientifiques assez solides, sont nécessaires pour développer des modèles agronomiques résilients et innovatrices à même de produire d'une façon durable une nutrition salubre et tout aussi en protégeant la biodiversité au service des générations futures. De cette façon nous pourrions par exemple proposer la promotion et l'intégration des espèces locales telles que fruits, épices, tubercules (racines), etc. dans les jardins familiaux ou dans les systèmes agro-forestiers. La domestication participative des arbres fruitiers et médicinaux locaux et l'intégration de ces arbres dans les systèmes agro-forestiers, ensemble avec le développement des filières de marché pour ces espèces, tout cela forme l'activité de base du travail de l'ICRAF en Afrique Centrale et Occidentale. Au cours de nos recherches nous avons établi un partenariat avec ICRAF et depuis 2009 ICRAF a élargi ses activités dans le district de la Tshopo. A ce moment ils travaillent ensemble avec trois groupes de paysans locaux, une ONG et les universités locales UNIKS et IFA-Yangambi.

De nos jours les PAS sont peu commercialisées ou consommées dans le district de la Tshopo, mais la connaissance concernant ces plantes est toujours présente et elle appartient à la culture indigène. Il doit donc être possible d'identifier des valeurs socio-culturelles locales, de se les apprivoiser et de s'y baser pour promouvoir la consommation et la commercialisation des PAS. De notre côté (c.a.d. la science) il faut d'urgence générer plus d'information concernant la valeur nutritionnelle des PAS et concernant leur intérêt pour la santé. Cette information doit être mise à la disposition des populations locales afin de valider la connaissance locale avec une recherche scientifique approfondie. Ceci est d'autant plus important pour la population locale qui, ayant entendu pendant des décennies que seul les cultures conventionnelles garantissent la santé, est avide de cette information concernant ses plantes et elle en profitera

davantage. Grâce à la reconnaissance et à la valorisation de leur savoir-faire local ces populations indigènes peuvent requérir une manière de vivre durable dans un contexte de plus en plus moderne.

Pour atteindre l'objectif global d'une meilleure sécurité alimentaire, d'assurer aux agriculteurs un revenu plus haut et diversifié et de protéger la forêt équatoriale contre la sur-exploitation grâce à une domestication participative et une organisation meilleure des filières du marché, il reste encore beaucoup de travail à accomplir. Cependant nous espérons avoir mis un pas en avant avec ce travail en rendant disponible de l'information concernant les usages, la commercialisation et la consommation des PAS et en établissant des modes de valorisation et de prioritisation des PAS en vue de futurs investigations. Une recherche prolongée est nécessaire pour documenter le savoir-faire local sur les PAS et les préférences des populations indigènes dans d'autres groupes ethniques de la région, pour étudier en détail les filières de marché des espèces prioritaires et pour développer ainsi des stratégies d'organisation de ces marchés afin que les pauvres en tirent leur profit, pour analyser la valeur nutritionnelle des PAS et pour mettre ces données à la disposition de la population, pour étudier et conceptualiser le rapport entre biodiversité, alimentation, culture et bien-être, pour évaluer les possibilités de domestication et les techniques de récolte durables, etc.

SAMENVATTING

Sinds de late jaren ‘80 en vroege jaren ’90 van de vorige eeuw, mede door verhoogde aandacht voor het milieu en voor rurale armoede en dankzij de opkomst van het concept ‘duurzame ontwikkeling’, ondersteunen wetenschappers, NGOs en beleidsmakers meer en meer het idee om de instandhouding van biologische diversiteit en de bestrijding van armoede gelijktijdig aan te pakken, eerder dan ze als twee elkaar uitsluitende doelstellingen te bekijken. Landbouwbiodiversiteit als potentiële drijfveer voor economische groei, voedselzekerheid en bescherming van natuurlijke rijkdommen wint nog steeds aan belangstelling sedert het verdrag inzake Biologische Diversiteit in 1992 gestemd werd. Hoewel er tot nu toe geen directe bewijzen bestaan, is het redelijk en aantrekkelijk om te veronderstellen dat een hogere landbouw- en bosbiodiversiteit tot meer gevarieerde diëten leidt, hetgeen dan weer de gezondheid bevordert. Voeding en biodiversiteit komen ook rechtstreeks voor in de Millennium Ontwikkelingsdoelstellingen, in Doelstelling 1, composant twee, ‘Halveer het percentage mensen dat honger lijdt’; en Doelstelling 7, ‘Actief werken aan een duurzaam milieu’.

Ondanks de enorme natuurlijke rijkdommen is 90% van de 60 miljoen Congolezen arm en daarvan leeft het grootste deel in rurale gebieden. Circa 70% van de Congolese bevolking is afhankelijk van het woud om in zijn dagelijks levensonderhoud te voorzien. Een betere valorisatie van Wilde Eetbare Planten (WEP), en meer algemeen ook van ‘*non-timber forest products’*, die een speciale niche van de armen vormen, zou dus moeten bijdragen tot armoedebestrijding en betere voedselzekerheid in een DRC context. Het grote potentieel aan NTFPs die een bijdrage zouden kunnen leveren aan de armoedebestrijding wordt eveneens erkend in Congo’s PRSPs (*Poverty Reduction Strategy Paper*), maar tegelijkertijd worden de enorme tekorten aan kennis in deze sector onderstreept.

De Congolese wouden herbergen een enorme intrinsieke biodiversiteit, maar behoren tot de minst bestudeerde wouden in Afrika, niet alleen in termen van industriële houtproductie, maar ook in termen van socio-economische en culturele waarde van het woud voor de lokale bevolking (brandhout, medicijnen, onderdak, werktuigen, wild, rupsen, paddenstoelen, honing, WEPs, kleurstoffen, culturele en spirituele waarden, etc.) is weinig geweten. Om

politieke beslissingen beter te ondersteunen en om nieuwe, innovatieve manieren te ontwikkelen om Congo's waardevolle natuurlijke rijkdommen duurzaam te beheren, moet het bosbouw- en landbouwonderzoek in het land dringend opnieuw gestimuleerd worden.

Tot op vandaag, en ondanks de enorme rijkdom aan biodiversiteit en culturen, werden WEPs weinig bestudeerd in het District Tshopo, en in Congo in het algemeen. Tshopo District beschikt over een zeer groot landbouwpotentieel, maar de voedselzekerheid in de regio blijft structureel precair. Geconfronteerd met de gevolgen van voedselonzekerheid in hun dagelijkse bezigheden en zich bewust van het onbenutte potentieel aan WEPs, veronderstelden een aantal lokale NGOs dat er mogelijkheden moeten bestaan om deze lokale voedselbronnen te valoriseren voor een betere voeding en gezondheid.

De hoofddoelstelling van dit doctoraatsonderzoek was een bijdrage leveren tot de valorisatie van WEPs voor betere voedselzekerheid in Tshopo District, DRC. Daartoe werd een multidisciplinaire aanpak vooropgesteld die de domeinen van etnobotanie, marktonderzoek en voeding omvatte en hierbij WEPs in het centrum plaatste. Als lange-termijn visie, zien we de meest interessante WEPs gepromoot, gedomesticeerd en geïntegreerd op de velden voor 1) een verbeterde voeding en gezondheid; 2) een verhoogd en meer gediversifieerd inkomen voor de boeren; en 3) een ondersteund cultureel welzijn; zonder evenwel de bescherming van natuurlijke rijkdommen in het gedrang te brengen. Dit werk presenteert informatie omtrent WEP gebruiken, huidige en toekomstige commercialisatiemogelijkheden, en huidige en potentiële bijdragen van WEPs tot lokale diëten en nutriënteninnames. Verdere studie van alle WEPs die geïnventariseerd werden tijdens deze studie is bijna onmogelijk, vandaar dat dit werk ook speciale aandacht had voor het rangschikken volgens prioriteit van de verschillende soorten. De resultaten uit dit onderzoek kunnen dan gebruikt worden voor verdere studie, participatieve domesticatie en marktketenontwikkeling van de WEP die het hoogste gerangschikt werden, dit zijn de soorten met het hoogste nutritionele en socio-economische potentieel, die cultureel ook goed aanvaard worden.

Het onderzoek startte met een grondige etnobotanische studie om de lokale kennis omtrent WEPs te inventariseren bij 3 etnische groepen (Turumbu, Mbole en Bali) in 3 verschillende *Territoires* in het District Tshopo. In 3 dorpen per etnische groep werden WEPs verzameld om een referentie herbarium samen te stellen en hun eigenschappen werden besproken tijdens focus groepsdiscussies. In totaal werden 166 WEP soorten en 2 variëteiten gedocumenteerd

in 71 plantenfamilies. Hiervan werden 198 plantendelen gebruikt voor 228 verschillende specifieke voedselgebruiken. 72 soorten werden voor het eerst geciteerd als WEP in Tshopo District in vergelijking met de beschikbare literatuur. Bovendien hadden 136 van de 166 WEP soorten ook andere gebruiken zoals gebruiken in de categorie medicinaal, materiaal en kunst, culturele gebruiken, constructie, brandstoffen, lokaas, voeder of gif. Intra- en interetnische verschillen in WEP kennis werden onderzocht en dit leidde tot het resultaat dat slechts 21% van de geïnventariseerde soorten gekend waren door alle 3 de etnische groepen. Verdere inventarisatie van WEP kennis in andere etnische groepen in Tshopo District zou dus zeker nog nieuwe planten en gebruiken opleveren. Naast verschillen in culturele gewoontes en voorkeuren voor WEPs, werd ook opgemerkt dat verschillende etnische groepen geconfronteerd worden met verschillende opportuniteiten of beperkingen zoals markttoegang. Bijgevolg moeten we een onderscheid maken tussen soorten met regionaal belang en etnospecifieke soorten bij het opstellen van prioriteitenlijsten met soorten die in aanmerking komen voor verdere studie, participatieve domesticatie en/of conservatie.

Voorkeuren voor wilde vruchten, alsook wilde groenten met betrekking tot smaak, commerciele, nutritionele of culturele waarde werden besproken tijdens participatieve rankingsoefeningen bij de Turumbu, Mbole en Bali. De resultaten toonden aan dat, de drie etnische groepen samen beschouwd, *Anonidium mannii* meest geapprecieerd werd, gevolgd door *Landolphia owariensis* en *Tetracarpidium conophorum* in de wilde vruchten categorie, en *Megaphrynium macrostachyum* in de wilde groenten categorie. Aparte rankingsoefeningen voor wilde kruiden of stimulant noten werden niet uitgevoerd. Nochtans toonden de etnobotanische inventarisaties aan dat de kruiden *Piper guineense* en *Scorodophloeus zenkeri*, samen met de stimulant noten *Cola acuminata* en *Garcinia kola* in alle etnische groepen gebruikt werden voor een groot aantal verschillende doeleinden. Bovendien zijn ze sterk ingebed in de traditionele culturen, waardoor ze, volgens de auteur, toegevoegd zouden moeten worden aan de lijst van meest geapprecieerde soorten.

Vervolgens werden WEP markten in Kisangani bestudeerd met betrekking tot aantal en socio-economische karakteristieken van de verkopers, aangeboden WEP soorten, hoeveelheden, prijzen en periodiciteit in aanbod. Van de 166 WEPs gekend door de Turumbu, Mbole en Bali etnische groepen in Tshopo District, werden slechts 15 planten gedocumenteerd als aanwezig op Kisangani markten. Deze WEPs werden meestal verkocht door ‘ad hoc’ handelaren die vaak overschakelen op verschillende andere producten naargelang de beschikbaarheid. De

periode september - oktober en Marché Central zijn het belangrijkst wat betreft de handel in WEPs. Toegevoegde waarde en netto inkomens gegenereerd door de verkoop van WEPs verschillen zeer sterk, ook tussen handelaren die dezelfde soorten verkopen. Tot nu toe worden de meeste WEPs geoogst voor autoconsumptie. Bijgevolg zijn WEP markten onderontwikkeld in de regio, met uitzondering van de markt voor *Gnetum africanum* met bestemming Kinshasa waar een beginnende vorm van specialisatie werd waargenomen. Een gebrekkige transport- en marktinfrastructuur, een gebrek aan opslagplaatsen, (il)legale taxen, een tekort aan kredietfaciliteiten, onvoldoende WEPs om aan te kopen en een te lage koopkracht van de consument werden vermeld door de verkopers als de grootste belemmeringen in de handel in WEPs.

Vier types van WEP verkopers werden geïdentificeerd op basis van de verkochte plantensoorten, alsook op basis van de socio-economische karakteristieken van de handelaren, namelijk overlevings-handelaren, handelaren die diversifiëren in het aantal WEPs dat ze verkopen, handelaren die diversifiëren in aantal inkomensgenererende activiteiten en handelaren die specialiseren in de WEP handel. Deze typologie levert ons waardevolle inzichten voor verdere marktketenorganisatie en ontwikkeling, in het bijzonder omdat de verkoop van specifieke WEPs gelinkt blijkt te zijn aan specifieke socio-economische karakteristieken van de handelaren.

Er bestaan internationale, nationale en lokale markten voor *Gnetum africanum* bladeren, *Piper guineense* vruchten, en noten van *Cola acuminata* en *Garcinia kola*. De soort die de grootste vraag kent, alsook de meest dynamische handelaren is ongetwijfeld *Gnetum africanum*. Maar om een duurzame commercialisatie op lange termijn succesvol te maken, dringt de (participatieve) domesticatie en integratie van *G. africanum* in agroforestry systemen zich op. Wilde kruiden (*P. guineense, C. acuminata* en *G. kola*), aan de andere kant, worden tot dusver enkel lokaal verkocht, hoofdzakelijk in micro-hoeveelheden door extreem arme, oudere vrouwen. Het organiseren van de wilde kruiden marktketens zal dus speciale strategieën vergen die in staat moeten zijn om deze oudere vrouwen (meestal weduwen) te beschermen. Indien niet, zullen deze vrouwen niet in staat zijn om in competitie te treden met de meer dynamische handelaren die ongetwijfeld zullen aangetrokken worden door efficiëntere marktketens.

Verder blijkt uit de marktstudie dat *Landolphia owariensis* en *Tetracarpidium conophorum* als prioriteits wilde vruchten kunnen beschouwd worden voor lokale marktontwikkeling. Ze zijn beiden makkelijker te transporteren en minder bederfbaar dan de zeer grote *Anonidium mannii* vrucht, en worden door een relatief groter aantal handelaren verkocht. Hoewel *Anonidium* de hoogste score verkreeg tijdens de participatieve rankingsoefeningen in de dorpen, zullen betere transportmogelijkheden, verwerking en/of bewaringstechnieken ontwikkeld moeten worden vooraleer de *Anonidium* markt verder kan groeien. Lokale marktontwikkeling voor wilde groenten zal additionele voedingseducatie en sensibiliseringsacties vergen om de vele voordelen van een gediversifieerd dieet en wilde groenten voor een goede gezondheid over te brengen en op deze manier de vraag-zijde te stimuleren.

Om de bijdrage van WEPs tot de kwaliteit van het lokale dieet te analyseren werd de '*usual*' voedingsinname geschat met behulp van twee '*multiple-pass 24h dietary recalls*' voor 363 vrouwen in Kisangani stad en 129 vrouwen op het platteland (dorp Yaoseko) in het seizoen met grootste beschikbaarheid aan WEPs (juli-oktober). In tegenstelling tot wat verwacht werd, kwamen slechts 15 WEPs voor in het dieet en dit in slechts een beperkt aantal '*24h recalls'*. De meest noemenswaardige bijdrage kwam van de wilde safou vrucht (*Dacryodes edulis*), die in 30,1% van de *recalls* gerapporteerd werd en tot 4,8% van de totale energie-inname bijdroeg in het dorp Yaoseko en dit tijdens het safou-seizoen. De totale energie inname van de geïnterviewde vrouwen was eerder laag, met een groot percentage energie afkomstig uit vetten. Bovendien hadden 75% van de vrouwen micronutriënteninnames voor niacine, foliumzuur, vitamine B-12, ijzer, zink en calcium onder de dagelijks aanbevolen hoeveelheden. Ondanks de zeer precaire voedingszekerheid in deze regio met hoge biodiversiteit, valoriseert de stedelijke noch rurale bevolking hun kennis omtrent WEPs teneinde het dieet aan te vullen. De consumptie van WEP was te laag om adequate diëten of voedingszekerheid te bekomen. Het is dus fout om zomaar te veronderstellen dat biodiverse omgevingen automatisch leiden tot betere diëten. Dit wil, nochtans niet zeggen dat WEPs en agrobiodiversiteit in het algemeen niet méér kunnen bijdragen tot een betere voedingszekerheid.

Het is duidelijk dat in een dergelijke situatie, de promotie van WEPs alleen niet voldoende zal zijn om alle onderliggende oorzaken van voedingsonzekerheid en armoede te bestrijden, maar WEPs zouden op zijn minst een betere bijdrage kunnen leveren tot de kwaliteit van lokale

diëten dan ze op dit moment doen. Meerdere WEPs met uitstekende nutritionele kwaliteiten, zoals *Gnetum africanum* en *Treculia africana*, werden gerapporteerd in de regio, alsook andere soorten waarvoor de nutritionele samenstelling nog niet gekend is. Vooraleer de kennis omtrent deze WEPs volledig verloren gaat, moet er dringend werk gemaakt worden van de inventarisatie van lokale kennis omtrent WEPs en moet hun gebruik in het lokale dieet verder bestudeerd worden om op deze wijze het volledige potentieel aan beschikbare biodiversiteit beter te benutten en de kwaliteit van het dieet te verbeteren.

Onderzoek inzake biodiversiteit en agroforestry, vertrekkende vanuit lokale noden en indigene kennis en ondersteund door degelijke wetenschappelijke onderzoeksprincipes is noodzakelijk om innovatieve en veerkrachtige landbouwmodellen te ontwikkelen die in staat zijn om gezond voedsel te produceren op een duurzame manier en tegelijkertijd de bescherming van de biodiversiteit voor toekomstige generaties niet in het gedrang te brengen. Op deze manier kunnen we bijvoorbeeld de promotie en integratie van lokale fruitsoorten, groenten, knollen, kruiden, etc. in huistuintjes (*home gardens*) en agroforestry systemen voorstellen.
Participatieve domesticatie van lokale fruit (en medicinale) bomen en integratie van deze bomen in agroforestry systemen, samen met marktketenontwikkeling voor deze soorten, behoort tot de kernactiviteiten van ICRAF's werk in West en Centraal Afrika. Gedurende de loop van dit onderzoek werd een partnerschap met Icraf aangegaan en sedert 2009 breidde ICRAF zijn activiteiten uit in het Tshopo District. Op dit moment werken ze samen met drie lokale boerengroepen, 1 lokale NGO en de lokale universiteiten UNIKS en IFA-Yangambi.

WEPs worden vandaag slechts sporadisch verhandeld of gebruikt in Tshopo District, maar de kennis omtrent WEPs is nog steeds aanwezig en cultureel bepaald. Het moet dus mogelijk zijn om lokale socio-culturele waarden te identificeren, te omarmen en erop verder te bouwen om de consumptie en handel in WEPs te bevorderen. Vanuit onze (wetenschappelijke) zijde, moeten we dringend werk maken om meer nutritionele en gezondheidsinformatie omtrent WEPs te genereren en deze ook beschikbaar te stellen voor de lokale bevolking teneinde de bestaande lokale kennis te valideren met degelijk wetenschappelijk onderzoek. Dit is zelfs nog belangrijker in die zin dat de lokale bevolking - die decennia lang verteld werd dat alleen de conventionele gewassen goed zijn voor hun gezondheid – vragende partij is om meer informatie te verkrijgen omtrent hun planten er dus ook het meeste baat bij zou hebben. Door

de erkenning en valoristatie van hun eigen lokale kennis, kunnen lokale volkeren een duurzame manier van leven nastreven in een steeds meer moderniserende context.

Er valt ongetwijfeld nog heel wat werk te verzetten om het globale objectief van betere voedselzekerheid, een gediversifieerd en verhoogd inkomen voor de landbouwers en bescherming van het tropische regenwoud tegen overexploitatie te bereiken via participatieve domesticatie en verbeterde marktketenorganisatie. Desalniettemin hopen we met dit werk alvast een stap in de goede richting gezet te hebben door het beschikbaar maken van informatie omtrent WEP gebruiken, commercialisatie en consumptie, en door inzichten te verschaffen in de wijze waarop WEPs gevaloriseerd en geprioritiseerd kunnen worden voor verder onderzoek. Verder onderzoek is nodig om indigene kennis en preferenties omtrent WEPs te documenteren in de andere etnische groepen in de regio; om de marktketens van de prioriteitssoorten in meer detail te bestuderen en zo strategieën te ontwikkelen om deze marktketens verder te organiseren zodat de armen er meest baat bij hebben; om de nutriëntensamenstellingen van de WEPs verder te analyseren en beschikbaar te stellen; om de vele links tussen biodiversiteit, voeding, cultuur en levensstandaard verder te bestuderen en te conceptualiseren; om domesticatiemogelijkheden en duurzame oogsttechnieken te evalueren, enz.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADIDOPAS	Association pour le Développement Intégrale et Domestication des Plantes Alimentaires Sauvages de la Tshopo
AFORCO	Appui à l'organisation d'un Master en Aménagement Forestier pour le renforcement des capacités des chercheurs Congolais en vue de la relance socio-économique de la République Démocratique du Congo
AFTP4A	Increasing small-scale farmer benefits from agroforestry tree products in West and Central Africa
ANOVA	Analysis of variance
BMI	Body Mass Index
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CIA	Central Intelligence Agency
CIFOR	Centre for International Forestry Research
CINE	Centre for Indigenous peoples' Nutrition and Environment
CIUF-CUD	Conseil Interuniversitaire de la Communauté Française – Commission Universitaire pour le Dévelopemment
DHS-RDC	Demographic and Health Survey – République Démocratique du Congo
FAO	Food and Agriculture Organisation
FOMASI	Forum des Masses Silencieuses
FORAFRI	Appui à la recherche Forestière et à la valorization des connaissances scientifiques
GDP	Gross Domestic Product
GHI	Global Hunger Index
GPRSP	Growth and Poverty Reduction Strategy Paper (DSCRP, Document de Stratégies de Croissance et de Réduction de la Pauvreté)
HDI	Human Development Index
ICRAF	World Agroforestry Centre
IFA-Yangambi	Institut Facultaire d'Agronomie Yangambi
IFPRI	International Food Policy Research Institute
INERA	Institut National pour l'Etude et la Recherche Agronomique
IPGRI	International Plant Genetic Resources Institute (recently, 2006, merged with INIBAP and now called Bioversity International
IPNI	International Plant Names Index
MDG	Millennium Development Goal

NGO	Non Governmental Organization
NTFP	Non Timber Forest Product
RDA	Recommended Dietary Allowance
REAFOR	Programme de relance de la Recherche Agricole et Forestière en République Démocratique du Congo
REALU	Reducing Emissions from All Land Uses
REDD	Reducing Emissions from Deforestations and forest Degradation
REFIACO	Réseau des femmes Ingénieurs Agronomes du Congo
TLV	Traditional Leafy Vegetable
UNDP	United Nations Development Program
UNIKIS	Université de Kisangani
VlIR-UOS	Vlaamse Interuniversitaire Raad – Universitaire Ontwikkelingssamenwerking
WEP	Wild Edible Plant
WFP	World Food Program

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CHAPTER ONE

INTRODUCTION

This chapter presents a general background, followed by the context and justification of the research, the thesis' objectives and the general outline.

1.1. General background

Biodiversity, nutrition, livelihoods

In 2010, a total of 925 million people are still estimated to be undernourished, representing almost 16% of the population of developing countries (FAO 2010c). The proportion of undernourished people remains highest in sub-Saharan Africa, at about 30% (FAO 2010c). In addition, at least two billion people, mostly in developing countries, suffer from 'hidden hunger, i.e. mineral and vitamin deficiencies (Micronutrient Initiative 2009).

The world's food basket is mainly composed of 30 species, which provide 95% of the dietary energy or protein needs (FAO 1997). However, there exists thousands of species which have been cultivated or collected by humans for food at one time or another. Many of these species are 'under-utilized' and mainly only used at a local scale (Giuliani 2007; Van Damme and Termote 2008). Nonetheless, plenty of them have interesting nutritional characteristics and could be promoted for better nutrition and livelihood security (Afolayan and Jimoh 2009; Matlhare 1999; Maundu 1999). There is thus a huge potential of biodiversity to be better exploited and to contribute to healthy diets and sustainable livelihoods (Johns and Eyzaguirre 2006; Lutaladio et al. 2010).

An estimated 80% of populations in developing countries depend on biodiversity in the form of Non-Timber Forest Products (NTFP) for food, medicines, shelter, etc. (Bennett 2002). Depleting these natural resources or making them inaccessible can impoverish these people even more (Giuliani 2007). However, until now, it still remains unclear how biodiversity actually contributes to the nutrition and livelihoods of the poor. A recent review, e.g., states that very few studies were able to combine biodiversity assessment methods (exact botanical identification of species) with quantitative dietary assessment methods (Peñafiel 2011) to quantitatively study the real contributions of biodiversity. This requests for more collaboration between ethnobotanists and nutritionists to fill this methodological gap (Lutaladio 2010; Nesbitt et al. 2010).

Even though the nature of the evidence is still circumstantial, many authors argue that it is reasonable and compelling to assume that increased agricultural and forest biological diversity leads to a more varied diet, which in turn improves specific health outcomes (Bélanger and

Johns 2008; Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Lutaladio 2010; Toledo and Burlingame 2006). More and more researchers are thus convinced that biodiversity can and should be further explored and valorized to contribute to sustainable livelihoods for actual and future generations.

Enhancing the sustainable use and conservation of biodiversity has traditionally been a core element of the Food and Agriculture Organization of the United Nations' (FAO) work to fight hunger and malnutrition since the early 1960s (Toledo and Burlingame 2006). For more than fifty years, FAO has considered the planet's genetic resources to be important to agriculture, health, environment and trade. Since 1996, FAO is coordinating the Global Plan of Action as a major component of the FAO Global System on Plant Genetic Resources for Food and Agriculture (FAO 2010b, 2011).

In addition, since the late 1980s and early 1990s, in conjunction with increasing global concern about environmental issues, increased attention for rural poverty and the emergence of the concept of 'sustainable development', there is more and more support from the scientific community, NGOs and policy makers to address issues of biological conservation and poverty reduction as interrelated and not as mutually exclusive goals (Belcher et al. 2005; Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Kaimowitz and Sheil 2007; Simons and Leakey 2004). Agricultural biodiversity and its potential as a driver of economic growth, food security and natural resource conservation has gathered an increasing amount of interest since the Convention on Biological Diversity (CBD, Rio de Janeiro, June 3-14, 1992; Arnold and Ruíz-Pérez. 2001; Belcher et al. 2005). Within the program of work on agricultural biodiversity, the CBD's 7th conference of parties, has launched a crosscutting initiative on biodiversity for food and nutrition (Burlingame et al. 2007; CBD 2004; Toledo and Burlingame 2006). This initiative is led by FAO and the International Plant Genetic Resources Institute (IPGRI, currently Bioversity) and aims to: (1) promote the sustainable use of biodiversity in programs contributing to food security and human nutrition; thereby (2) raising awareness on the importance of this link for sustainable development (Burlingame et al. 2007, 2009; Toledo and Burlingame 2006). Within the context of this crosscutting initiative, recently two new indicators were developed to monitor progress in integrating local foods and traditional varieties of foods into food consumption and food composition studies (Burlingame et al. 2009), namely the *Nutrition indicator for Biodiversity: 1. Food*

composition (FAO 2008) and the *Nutrition indicator for Biodiversity: 2. Food consumption* (FAO 2010a).

The World Agroforestry Centre (ICRAF, www.worldagroforestrycentre), in collaboration with local Cameroonian famers, works on the valorization of local biodiversity through domestication and market chain development of indigenous tree species such as *Ricinodendron heudelottii*, *Dacryodes edulis* and *Irvingia gabonensis*. Participatory domestication of high potential local tree species contributes to: 1) increased nutrition security; 2) increased and diversified farmers' income; whilst 3) protecting the environment from overexploitation of local resources (Asaah et al. 2011; Leakey and Simons 1998; Leakey 1999; Leakey et al. 2003, 2004; Tchoundjeu et al. 2006, 2010), and this in a country with similar climatic and cultural characteristics as DRC. ICRAF's experiences furthermore show that domestication of indigenous tree species should be conceived together with value chain development to obtain tangible positive impacts (Leakey 1999; Leakey and Izac 1996; Leakey et al. 2003; Lombard and Leakey 2010; Tchoundjeu et al. 2006, 2010). ICRAF defines participatory domestication as a 'farmer-driven and market-led process' (Simons and Leakey 2004; Tchoundjeu et al. 2010). The incentives for domestication of indigenous trees depend on whether farmers can sell their produce in new or expanded markets and so earn some cash income for improving their livelihoods (Degrande et al. 2006; Leakey and Simons 1998; Russell and Franzel 2004; Simons and Leakey 2004; Tchoundjeu 2006).

Nutrition and biodiversity also feature directly in the Millennium Development Goals (MDGs), more specifically in Goal 1, Target 2, 'Halve the proportion of people who suffer from hunger'; and Goal 7, 'Ensure environmental sustainability' (UN 2005). Moreover Garrity (2004) states that agroforestry research and development can virtually contribute to almost all MDGs. This is so because integrating indigenous fruit trees in local agroforestry systems has a lot of potential to achieve increased income, food security and environmental services such as biodiversity conservation, thus contributing to the MDGs (Degrande et al. 2006; Garrity 2004; Simons and Leakey 2004).

Enormous work to strengthen the evidence base of current circumstances surrounding food systems and health within indigenous communities has also been the battlefield of the Centre for Indigenous Peoples' Nutrition and Environment (CINE, www.mcgill.ca/cine), a multidisciplinary research and education centre established in 1992 by Canada's indigenous

leaders and McGill University, Montreal. Its objectives include, amongst others, to document the inherent strengths of local traditional food systems; demonstrate how these local foods contribute to food security, nutrition and health; and influence local, national and international policies for environmental protection of Indigenous People's land and food sources. CINE is (inter)nationally recognized for its research and its participatory methods of working with Indigenous Peoples (Kuhnlein 2009).

More background and tangible examples on the contribution of biodiversity to nutrition and livelihood security are discussed in *chapter 2* (Biodiversity – Nutrition – Livelihoods: a brief overview).

Wild Edible Plants and traditional communities

Culture is studied by social sciences, nature by biological sciences, and health by health sciences. However, many traditional communities do not distinguish between culture, nature and health. Consequently, their cosmovision should not be forgotten at the moment of negotiating and founding the concept of development. "Life" is not just about consumption, welfare and acquisition of material goods (Correal et al. 2009). One should also take into account the many immaterial values of culture, such as the indigenous knowledge on natural environments. Traditional knowledge should be reinforced and validated for the cultural and social well-being of local populations and to guide them through the cross-cultural transition when modernization and globalization processes dramatically change the world around them (Gradé 2008, Kuhnlein 2009).

Indigenous populations' knowledge and use of Wild Edible Plants (WEP) is looked at from different angles by researchers from many scientific disciplines, such as (ethno)botanists, ethno-ecologists, agronomists, nutritionists and healthworkers, socio-economists, anthropologists, marketing specialists, development economists, biodiversity conservationists, etc.

From a nutritional point of view, WEPs play a major role in supplementing staples with much-needed micronutrients in many areas (Grivetti and Ogle 2000; Herzog et al. 1994; Maundu 1996) or can constitute a 'safety net' during periods of food shortage (de Merode et al. 2004; Keller et al. 2006; Malaisse and Parent 1985; Shackleton and Shackleton 2004; Van Damme 1998). They represent cheap but fairly good-quality nutrition for large segments of

the population in both urban and rural areas of sub-Saharan Africa (Chweya and Eyzaguirre 1999; Dansi et al. 2008).

Knowledge on WEPs in Africa has been developed and transmitted over generations during centuries of trial and error (Malaisse and Parent 1985). However, social change and acculturation processes have prevailed in Africa for some time now. Indigenous knowledge is declining and even disappearing with increasing contacts with modernization and western lifestyles (Keller et al. 2006; Lykke et al. 2002; Maundu 1997; Ogoye-Ndegwa and Aagaard-Hansen 2003). Moreover, traditional leafy vegetables are often associated with poor rural lifestyle and low status. This leads to a general decline in their use when people can afford other foods (Chweya and Eyzaguirre 1999; Clark et al., 2004; de Merode 2004; Lykke et al. 2002). Previously well-balanced diets are disturbed when traditional products are replaced by imported or newly introduced species, hereby often causing nutrient deficiencies (Herzog et al. 1994; Lykke et al. 2002; Weinberger and Swai 2006).

The loss of indigenous knowledge has also been recognized as one of the general factors affecting biological diversity (Keller et al. 2006). Replacing traditional foods by 'modern food habits' results in the loss of genetic diversity in traditional food species and a decline in cultural diversity (Bonnet and Vallès 2002; Maundu 1996). Studying indigenous knowledge on plant uses and resource management practices is thus extremely important to support biodiversity conservation programs. It is now generally recognized that the latter have more chances to succeed when they take into account the local populations' knowledge and interests (Ayantunde et al. 2008; Byg and Balslev 2001; Gemedo-Dalle et al. 2005; Hanazaki et al. 2000; Kristensen and Balslev 2003; Lykke et al. 2004; Zambrana et al. 2007).

Despite the frequently reported 'erosion of indigenous knowledge on WEPs', there are also some opportunities. WEPs are part of the intangible cultural heritage of local populations (Pieroni 2008; UNESCO 2003) and even related with their cultural identity (Dansi et al. 2008; Macía 2004; Maxia et al. 2008; Ndam et al. 2001; Pieroni et al. 2005). It would appear that cultural attachment to local culinary traditions and the appreciation of specific dishes in urban circuits may be, in some regions, sufficient to at least partially stop the erosion of traditional knowledge (Keller et al. 2006; Pardo de Santayana et al. 2005; Pieroni et al. 2005). The Cameroonian or Congolese diaspora in Europe and the United States, e.g., was shown to be

ready to pay up to resp. 13 and 50$ to obtain a kilogram of their traditional vegetable 'fumbwa' ('okok' or 'eru'; *Gnetum africanum*) (Asaha et al. 2000).

Not only the diaspora forms a ready market, but also the recent trend in the Western world to discover new food products, mainly for hedonism, convenience or as a source of nutraceuticals, offers incentives for the introduction of novel foods (Bonet and Vallès 2002; Pieroni et al. 2005; Sabbe et al. 2008 and 2009). In addition, when the processes of market development and commercialization are properly guided, sustainable harvest of WEPs and/or (participatory) domestication of these new products, may constitute an important source of income for rural smallholders (Agea et al. 2007; Tchoundjeu et al. 2006; Weinberger and Swai 2006).

Moreover, to sustain food agro-biodiversity in a meaningful way, the rights of indigenous populations to their knowledge and traditions transmitted over generations should be fully recognized (Lombard and Leakey 2010; Pieroni et al. 2005). The French concept of '*terroir*', today also known as biocultural diversity or food's inextricable links with cultural heritage, sometimes protected through so-called denomination of origin labels, may hereby be helpful (Pieroni et al. 2005).

Documenting and revalorizing indigenous knowledge on WEPs, before it is lost, is thus needed to maintain and promote nutritional health - at the local level and beyond - and to preserve genetic and cultural diversity. Clearly, increased dialogue and collaboration between ethnobotanists, agroforestry researchers, food scientists, socio-economists and marketing specialists is necessary to ensure that WEPs can be valorised and (re)adopted.

1.2. Context

Democratic Republic of Congo

Despite the country's high endowment with natural resources, 90% of the 60 million Congolese inhabitants are poor, whereas the majority of them live in rural areas (Debroux 2007). 70% of DRC's inhabitants depend on the forest for their daily livelihoods (Counsell 2006). That is why according to Ndoye and Awono (2005), valorising WEPs, and non-timber

forest products (NTFP) in general, which constitute a particular niche of the poorest, will contribute to poverty alleviation and increased nutrition security in a DRC context. The potential of NTFPs to alleviate poverty is also recognized in the country's Poverty Reduction Strategy Papers (DSCRP 2006, 2011), though the documents deplore the huge knowledge gap in this sector. According to Bamoninga (2007), NTFP-markets in DRC mainly developed during the last two decades, partly due to rapid population growth, but even more because of the political crises and armed conflicts that paralysed the economy of the country and increased the dependence of the population on forest resources. NTFP-trade in DRC is mostly part of the informal economy and no official statistics are available on production or commercialisation, nor on their contribution to the rural economy (Bamoninga 2007).

Notwithstanding the enormous biodiversity they harbour, the Congolese forests are the least known in Africa, not only in terms of their potential for industrial timber exploitation, but also in terms of socio-economic and cultural value to local populations (firewood, medicine, shelter, tools, game, caterpillars, mushrooms, honey, WEPs, dyes, cultural and spiritual values, etc.), let alone the ecosystem services for which DRC seems to have an offer, such as carbon sequestration, climate change mitigation, etc., but for which international remuneration systems such as the Clean Development Mechanism (CDM), REDD+ (Reduction of Emissions from Deforestation and reduced forest Destruction) or REALU (Reduced Emissions from all Land Uses) are not yet fully operational (DSCRP 2011; Debroux et al. 2007).

With the very scattered information available for DRC, Debroux et al. (2007) could only provide some raw approximations for the annual value of the flux of forest products at national scale for formal and informal timber production, fuelwood production, bushmeat, watershed protection, ecotourism, carbon sequestration and option/existence values (people's willingness to pay for protecting forests from which they do not derive an immediate or personal use). No estimates could be made with regard to the value of forests for other foods, medicines, materials and implements, or the cultural/political dimensions of the forests for local populations, due to a lack of reliable information. In addition, the latter authors explicitly add that the available statistics in DRC should be interpreted with a lot of precautions (Debroux et al. 2007; DSCRP 2006, 2011; Hauser et al. 2007). The last agricultural census, e.g., was held in 1980 and since then statistics are extrapolated. This worked for a few years, but not over more than 25 years and certainly not because of the

many crises the country has gone through ever since (Hauser et al. 2007). Congolese public institutions, so also the forestry and agricultural sectors, suffer since history from corruption, power abuse and badly paid and non-equipped officers. The 1996-2003 war has further aggravated this situation.

To sustain the political decisions and to find innovative ways for managing DRC's precious natural resources, there is an urgent need to revitalize forestry and agricultural research. Universities and national research institutions face many problems, such as irregular and low salaries, scientific isolation, lack of research budgets, lack of capacities, etc. If the forestry and agricultural sectors have to be the motors of DRCs rural development and economy as defined in the country's PRSPs (DSCRP 2006, 2011), local researchers have to be trained and recycled in order to be able to respond to local society problems (*Programme prioritaire de recherche forestière* 2007).

On a regional scale, a number of meetings within the scope of the FORAFRI **(***Appui à la recherche forestière et à la valorisation des connaissances scientifiques*, www.forafri.org**)** project and FAO's 'Sustainable management practices of Tropical forests in Central Africa' permitted to elaborate priority issues for Central African forestry research (Nasi and Sassen 2003). Based on these regional priorities and in collaboration with the local partners to be involved in the redynamisation of forestry research (UNIKIS, *Université de Kisangani*; and INERA, *Institut National pour l'Etude et la Recherche Agronomique*), 4 priority themes have been withheld for DRC, namely:

- public policies on sustainable development;
- establishing scientific evidence for a more sustainable exploitation of the natural production forests;
- interactions between forests and their populations, and the role of forest resources;
- plantations (including agroforestry) and rehabilitation of degraded areas

(*Programme prioritaire de recherche forestière* 2007).

Our PhD research contributes to the 3rd priority theme, i.e. improved understanding and recognition of the role of forest resources in poverty reduction. Within this theme, the '*Programme prioritaire de recherche forestière*' (2007) stipulates that research should be done in a participatory way implicating the local populations as end users and that there should be more attention to the possibility of domestication of high value species and their

integration into agroforestry systems, as well as for commercialisation issues. The African forest regions lag behind other tropical regions with regard to available knowledge on NTFPs (*Programme prioritaire de recherche forestière* 2007).

The '*Programme prioritaire de recherche agricole'*, mainly focuses on the main crops such as cassava, maize, cowpea, soya, banana and plantain, but clearly recognizes the '*fantastic*' potential of multi-strata agroforestry systems, especially 'those integrating indigenous fruit trees such as safou (*Dacryodes edulis*) or bushmango (*Irvingia gabonensis*) which have a local and regional market potential' (Hauser et al. 2007). However, for further research and development of these agroforestry systems the document refers to the 'Forestry research priority program' (Hauser et al. 2007).

It is clear that to be able to take the 'right' decisions at political levels, there is an enormous need for data 'from the field' with regard to the current contribution of NTFPs to local livelihoods, as well as to the potential of NTFPs to reduce poverty without compromising the natural resources for future generations. The value of the forest to local populations and their indigenous ways of managing forest should be fully accounted for, e.g., during the discussions on the zoning of the country with regard to land use destinations (exploitation concessions, reserves, community forests, etc.). Ideally, from bystander of the forest exploitations, local populations should become essential partners and be integrated in the management of each land use system (Debroux et al. 2007; Russell et al. 2011). Support to community dynamics and increased participation of local populations constituted one of the 5 pillars of the country's first PRSP (DSCRP 2006). In the second PRSP (DSCRP 2011), this subject remained very important and became a transversal theme over the 4 pillars (1: governance building and peace; 2: diversification of the economy, accelerating growth and promotion of employment; 3: increasing access to basic social services and human capital building; 4: environmental protection and climate change mitigation).

Tshopo District

Although very little reliable information is available, it does not need complicated statistics to confirm that food security in Tshopo District remains very precarious. A survey conducted in 1995-1996 (before the 1996 - 2003 conflicts) showed that the mean energy content of the diet in the Oriental Province was 1758.24 kcal/inhabitant/day, far below the 2100 or 2300 kcal recommended by resp. WFP (World Food Program) or FAO (PNUD/UNOPS 1998). Based

on the WFP's 'diet and diversity' indicator, Tshopo District counted 11.5% of severe food-insecure households in 2008 (CFVS 2008), whereas according to the DHS-RDC (2008), 17.3% of women in the Oriental Province had a Body Mass Index (BMI) lower than 18.5 (underweight), whereas 1.1% had a BMI higher than 30 (obese). Over the whole country, these figures were resp. 15.9 % and 20.6 % with BMI lower than 18.5, and 3.9 % and 1.1 % with BMI higher than 30 for resp. urban and rural women (DHS-RDC 2008).

This situation is in sharp contrast with the enormous agricultural potential of DRC (Rossi et al. 2006). Only 10% of the country's arable land is presently being used, whereas 97% of these lands have an agricultural season of at least 8 months (DSCRP 2006). In addition, the country, being the 5th most biodiverse country in the world (Counsell 2006) hosting 10,000 plant species of which 10% are endemic (Debroux et al. 2007), harbours an enormous wealth of (un)known useful species.

1.3. Problem statement

Faced with the consequences of food insecurity in their daily activities and aware of the underutilized potential of WEPs, some local NGO's have put forward that opportunities should exist to valorize local wild foods for better nutrition and health. The locally-based NGO FOMASI (*Forum des Masses Silencieuses*), e.g., which is working to empower women groups through gardening projects, nutritional education, processing of local products, etc. was already experimenting with '*tangawusi*', a local beverage based on ginger also containing, amongst others, fruits of the wild *Piper guineense* L. liana, *Aframomum* spp. fruits and cola nuts (*Cola acuminata*). Through their representative, Ms Sophie Ndeke, they contacted Prof. D'heda Djailo of UNIKIS to know more about the value and potential of some local, wild edibles.

Until now, notwithstanding its richness in biodiversity and cultures, WEPs have been little studied in Tshopo District, c.q. DRC (Termote et al. 2010, 2011). A few fragmented studies providing general lists of wild edible plants from in and around Kisangani were found in international literature (Bokdam and Droogers 1975; Bola and Szafranski 1991; Liengola 2001; Mosango and Isosi 1998; Mosango and Szafranski 1985; Nyakabwa et al. 1990;

Kawukpa and Angoyo 1994), generally with different methodological approaches, no herbarium references and no distinction between knowledge of different ethnic groups. Nevertheless, these preliminary inventories were enough to put forward that there exists quite some indigenous knowledge on WEPs in the region. Moreover, the dilapidated state of the roads and recent periods of war and civil strife in Tshopo District (and DRC in general) did not favour many exchanges with other cultures. This brought us to the additional hypothesis that rural communities, especially those in the remote areas of the District, still actively use their traditional plant knowledge.

Apart from the 7 above-cited ethnobotanical inventories around Kisangani, we only found two unpublished student works (Bagula 1977; Bhua 1991), and a preliminary report (Liengola 1999) on WEP markets. Yet, these studies do not mention prices nor quantities sold. Biloso and Lejoly (2006) investigated NTFP-markets in Kinshasa, and Ndoye and Awono (2005) NTPF-markets in the provinces 'Equateur' and 'Bandundu'. We also found some project documents, such as the one elaborated by Bamoninga (2007) giving a brief overview of NTFP use and contribution to food security in DRC; Mbumba (2008), making a brief inventory of NTFP traders in Kinshasa; and Manirakiza et al. (2009), studying the market chain of *Gnetum* spp. in Kinshasa. We could not find any information about WEP consumption and the contribution of WEPs to local diets, nor on food consumption and macro- and micronutrient contributions of diets in general.

The above-mentioned inventories and other sources, furthermore, revealed us that the region harbours many interesting species, with fair potential to increase nutrition security and/or to alleviate poverty through commercialization. Seeds from the indigenous *Treculia africana* Decne. tree, e.g., are known to have a higher biological protein value than soya beans (Bijttebier 1992; Edet et al. 1985; Lawal & Bassir 1986). During the 1996-2003 period of civil strife and war, flour made from the seeds of *T. africana* was used as substitute for soya in nutrition rehabilitation centers in Kisangani (Kisanganivzw: www.kisangani.be). Unfortunately, the high work load to transform the seeds into a flour (extracting seeds from the fruit, drying, roasting and dehulling before pounding) is cited as the main reason why they are not used more often. *Gnetum africanum* Welw. ('fumbwa') is another species with high nutritional value (important source of protein, contains all essential amino-acids and many minerals; Eyo et al. 1983; Isong et al. 1999) growing in the Kisangani rainforest. Although

very popular in Cameroon, and Bandundu and Bas-Congo provinces in DRC, this leafy vegetable does not belong to the culinary habits of the original population of Kisangani and surroundings. Nevertheless, huge quantities are harvested around Kisangani and transported by airplanes to serve customers in Kinshasa markets (Bwama 2007). If no action is undertaken, this wild vegetable will soon be threatened by extinction and the local populations living from this trade will lose their income source.

The above described observations sustained the idea that 'WEPs, freely available in nature, should be more researched and promoted to sustain livelihoods, nutrition security and health of the local populations in Tshopo District and DRC, in general'. Consequently, a WEP project proposal was elaborated together with FOMASI (see above) and some other interested grass roots organizations. The WEP project's research questions were defined as:

- What are the WEPs known and used by the different ethnic groups in Tshopo District?
- How are these plant used? And which plants are most appreciated?
- What is the nutritional value of the WEPs known and used? What is the actual and potential contribution of WEPs to local diets?
- What is the actual and future commercial potential of WEPs in the District?
- How can WEPs be better valorized and what are the priority species for promotion, future research, (participatory) domestication and market chain organization?

The present doctoral study was performed within this broader WEP research project executed in Tshopo District, DRC, between 2004 and 2010 by Ghent University (UGent) in collaboration with the University of Kisangani (UNIKIS) and funded by the Flemish Interuniversity Council – University Development Cooperation (VlIR-UOS; ZEIN2004_3000; MPRDC2007_25).

During the course of our investigations, we also established a partnership with ICRAF Cameroon through the project '*Increasing small-scale farmer benefits from agroforestry tree products in West and Central Africa*' (AFTP4A, 2009-2012) funded by the Belgian Directorate General for Development Cooperation and since 2009, ICRAF has extended its activities in Tshopo District. At present, the AFTP4A project is working on participatory domestication and market chain organization for *Gnetum africanum*, *Cola acuminata*, *Anonidium mannii*, *Piper guineense* and *Dacryodes edulis* together with three local farmer

groups (ADIDOPAS, REFIACO and Tujenge)[1], the local NGO FOMASI and the local universities UNIKIS and IFA-Yangambi. In this way, local investigators can benefit from the wide range of ICRAF's experiences with participatory domestication and value chain organization. On the other hand, our WEP project revealed new interesting species to enlarge ICRAF's experience with domestication and Tshopo District constitutes for ICRAF a new research environment with particular post-conflict field conditions.

1.4. Project and thesis objectives

The WEP project's long term vision is to see the most interesting WEPs being promoted, commercialized, eventually domesticated and integrated into farmers' fields, for the benefit of the poor. The global aim is to 1) improve food security, 2) diversify and increase farmers' incomes, and 3) protect the rainforest from overexploitation through participatory domestication and improved market chain organization of WEPs.

Initially, funding of the MPRDC2007_25 project was for two years, so we had to formulate a limited number of short term objectives that could be reached within that timeframe. According to Franzel et al. (1996), Leakey and Simons (1998), Pauku et al. (2010), Simons (1996) and Simons and Leakey (2004), priority setting is the first, very important step, of any participatory domestication process.
Consequently, the specific objectives of the WEP project were formulated as follows, to:

- inventory all WEPs known and document how they are used by the indigenous populations in Tshopo District (14 major ethnic groups were identified in the District to that end);
- study the economic, nutritional and socio-cultural importance of WEPs through socio-economic household interviews within the 14 major ethnic groups, market surveys and food consumption evaluation;

[1] ADIDOPAS: '*Association pour le développement Intégrale et domestication des plantes alimentaires sauvages de la Tshopo*'; in the village Yaoseko: 34 km east of Kisangani on the road to Yangambi; ethnicity: Turumbu
REFIACO: '*Réseau des femmes Ingénieurs Agronomes du Congo*'; in Mangobo municipality/Kisangani
Tujenge: Swahili for '*Construisons l'environnement*'; 14 km east of Kisangani on the road to Yangambi; multi-ethnic village SEP Congo

- assess the nutritional value of the WEPs through (bio-)chemical analyses; and
- elaborate a list with priority species which come into scope for further study and participatory domestication.

The species with highest nutritional and socio-economic potential, and cultural acceptance, can then form the object of further study, participatory domestication and value chain development. The latter activities are since 2009 being executed by ICRAF (see higher).

Within the framework of the above described WEP project, the global objective of this doctoral work was to contribute to the valorization of WEPs for better nutrition and livelihood security in Tshopo District. We eventually defined the specific objectives of the present PhD thesis as to:

- inventory and document WEPs known and used by the Turumbu, Mbole and Bali indigenous ethnic groups living in Tshopo District (*chapters 4* and *5*);
- document preferences for wild vegetables and wild fruits by the Turumbu, Mbole and Bali men and women through participatory ranking exercises (*chapters 4* and *5*);
- analyze WEP markets in Kisangani with regard to number and socio-economic characteristics of sellers, WEP species and quantities offered, prices and periodicity (*chapter 6*);
- evaluate the importance of WEPs in local diets and nutrition security of women in Kisangani and Yaoseko, a rural Turumbu village (*chapter 7*).

Finally, we can mention that the work is not only moving on within the ICRAF AFTP4A-project, but many new (international) partners and research projects became interested in Kisangani ever since. Most of these projects are working around biodiversity (Congo Biodiversity Centre and Congo boat expedition[2], VLIR-IUS[3]), (agro-)forestry (REAFOR[4],

[2] Congo Biodiversity Initiative has 3 main components: *Boyekoli Ebale Congo 2010* (or study of the Congo River), capacity building and Biodiversity surveillance centre, and is executed by a consortium of UNIKIS, Royal Belgian Institute of Natural Sciences (KBIN), Royal Museum of Central Africa (KMMA-MRAC) and National Botanic Garden of Belgium, www.congobiodiv.org/en/mission; accessed September 2011

[3] VLIR-IUS: Belgian Interuniversity Development Cooperation, http://iuc.vliruos.be/index.php; accessed September 2011

[4] REAFOR: *Programme de relance de la recherche agricole et forestière en République Démocratique du Congo*, led by FAO, partners are the Center for International Forestry Research (CIFOR), the International Institute of

REFORCO[5], AFORCO[6]) and/or agriculture (REAFOR, VLIR-IUS), some of which also work with participatory research methods (*Programme prioritaire de recherche forestière* 2007). This opens a lot of opportunities for our results to be picked up and further exploited, especially because most of our project collaborators continue to be involved in the above-mentioned research projects. From the beginning of our investigations, we could work in strong collaboration with the local researchers at UNIKIS and IFA-Yangambi. The latter learned about participatory research methodologies and interview techniques, while in turn teaching us to better understand and recognize local biodiversity, to interpret local plant uses, and so much more.

Some challenges

Some particularities of the research setting in post-conflict DRC and Tshopo District are noteworthy here, because they help to understand the work conditions (and limitations) of this PhD study.

There was not only a huge knowledge gap on WEPs in Tshopo District, but also a lack of side information to frame the research. To give a few examples: almost nothing is known about the ethnic groups we worked with (Turumbu, Bambole and Babali), except for some old references, mostly written up by colonial administrators or missionaries as footnotes. When we tried, at the start of the project, to define the principal ethnic groups in Tshopo District, we planned to work within 13 ethnic groups. As the field work was going on, we were obliged to add a 14th ethnic group to our list. Subsequently, the biodiversity in the region around Yangambi (where the INERA research station is located) has been quite well-studied, but no detailed vegetation data were found for the other areas around Kisangani (Opala, Bafwasende, Ubundu, Lubutu, etc.); they urgently need further exploration and collection (Bamps in Kendrick 1989).

Tropical Agriculture (IITA), the National Institute for Agronomic Study and Research (INERA) and the University of Kisangani (UNIKIS) www.reafor.cd; accessed September 2011

[5] REFORCO: No website available yet (per Sept. 2011), but this project is mainly a succession of the REAFOR project

[6] AFORCO: *Appui à l'organisation d'un Master en Aménagement forestier pour le renforcement des capacités des chercheurs congolais en vue de la relance socio-économique de la République Démocratique du Congo***,** CIUF-CUD PIC (*Projet Interuniversitaire ciblé*) project, http://www.cud.be/content/view/867/353/lang,/ accessed September 2011

Other challenges faced were the difficulties with logistics, inexisting roads, insecurity and illegal barriers ('*tracasseries*'). When we arrived in Kisangani for the first time in 2006 to prepare the MPRDC2007_25 VlIR-project proposal, the city was recovering from the 1996-2003 period of civil strife and war. There were almost no cars, a few motorbikes from NGO or university projects and a lot of taxi bicycles ('*toleka*'); still this was the 3rd city of the country. The city, under alternating governance of Rwanda and Uganda, had been totally cut off from the capital Kinshasa during many years and universities became very isolated with almost no possibilities for cooperation or exchange. The first collaborative project (ZEIN2004_3000) was started by our colleague ir. Wouter Vanhove, travelling from Kampala (Uganda) to Kisangani with a Russian Antonof, the only way to get there at that time. Field conditions at that time were very hard, with many illegal barriers, insecurity and totally dilapidated roads, not permitting to reach most parts of Tshopo District. However, gradually the region became more secure and accessible, and the cooperation between UGent and UNIKIS was rather successful. These promising evolutions permitted us to continue and to conceive the WEP project as described above. Anno 2010, we could reach our study villages without having to stop for illegal barriers and nowadays one should watch out for cars and motorcycles when crossing the streets in Kisangani.

1.5. Thesis outline

The thesis starts with the present 'general introduction' chapter, while *chapter 2* explores some of the multiple links between biodiversity, nutrition and livelihoods, which are of interest to our research. The chapter ends with an overall strategic plan of this doctoral thesis, explaining how this multidisciplinary research linking biodiversity with nutrition and livelihoods was conceived in accordance with our specific objectives. *Chapter 3* consists of a brief presentation of the Democratic Republic of Congo in general and the study area, Tshopo District in particular. *Chapters 4* to *7* present the results of our field research in the form of papers published in or submitted to internationally peer-reviewed scientific journals. Each paper can stand on its own, in other words, each chapter can be read and understood independently and is related to one or two of the above described objectives. *Chapter 4* discusses the process and results of documenting WEP knowledge within the Turumbu ethnic group together with their preferences for wild fruits and wild vegetables. *Chapter 5* does the

same for 3 ethnic groups, Turumbu, Mbole and Bali, but with an emphasis on comparison of traditional knowledge between the three ethnic groups. *Chapter 6* presents the results of our Kisangani markets investigations, and *chapter 7* discusses the contribution of wild edible plants to dietary adequacy and nutrition security of women in Kisangani and Yaoseko, a rural Turumbu village. The final *chapter (8),* then, provides a general conclusion, where the most important findings of the thesis are summarized and discussed. Moreover, implications of this doctoral research and recommendations for further research are set forth in this chapter.

CHAPTER TWO

BIODIVERSITY - NUTRITION - LIVELIHOODS: an overview

This chapter explores some of the multiple links between biodiversity, nutrition and livelihoods, which are of interest to our research. Thereafter follows a brief note on participatory research. The chapter ends with the rationale behind this thesis, explaining how all different research performed in this thesis strategically fits together.

2.1. Introduction

Agricultural biodiversity provides a lot of tangible and intangible goods and services to human mankind (figure 2.1).

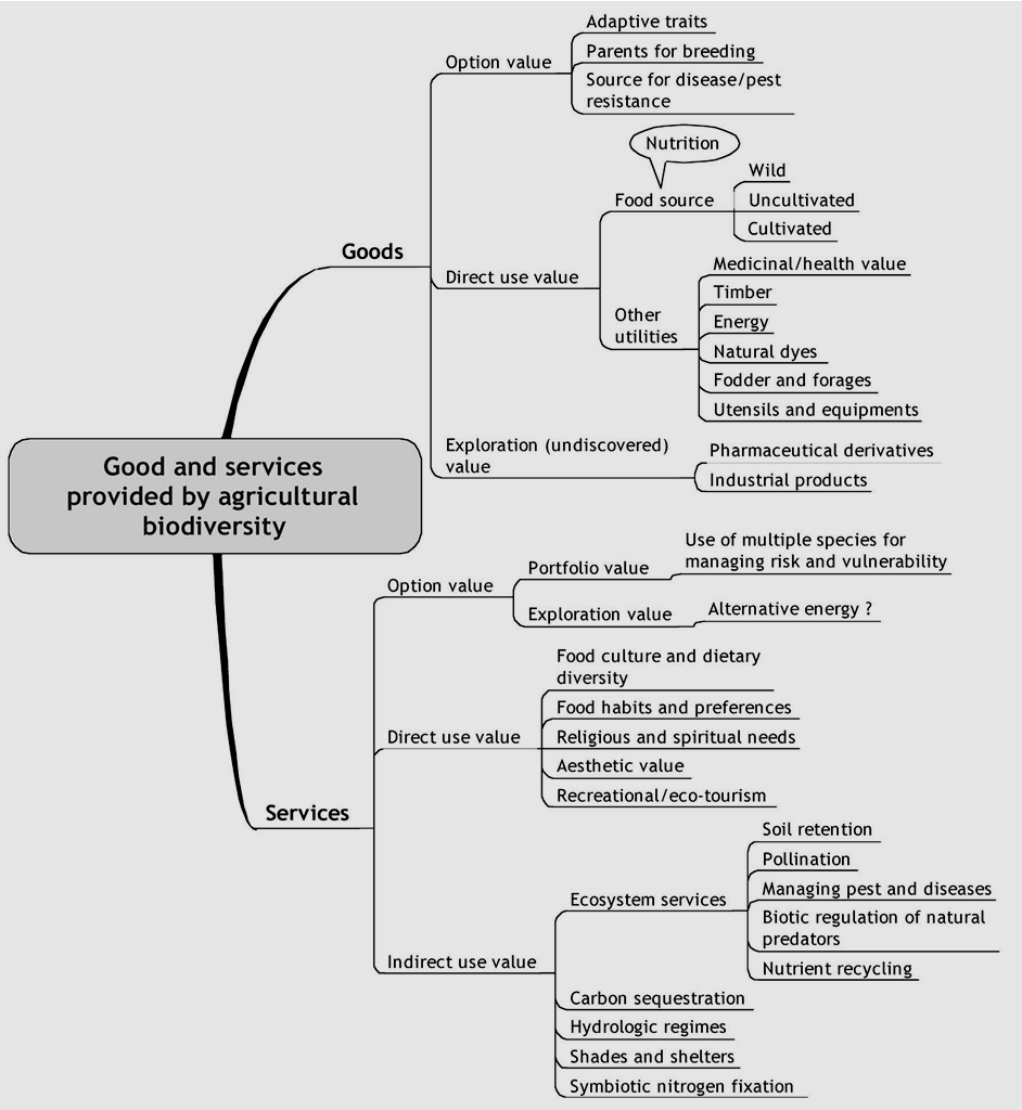

Figure 2.1: Agricultural biodiversity provides goods and services with: (1) option value, (2) direct use value, and (3) exploration value (Sthapit et al. 2008).

The conservation of biodiversity is of utmost importance for agriculture in general and world food supply more specifically. However, existing biodiversity is still underutilized to increase food production. About 30,000 of the more than 250,000 plant species that have been scientifically described are edible, whereas only about 7,000 have been cultivated or collected by humans for food at one time or another (FAO 1997). Several thousands of species could thus be considered to have potential to contribute to food security, but the value of many of

them still remains underestimated. Data on national food energy supplies aggregated at global level show that only about 30 species provide 95% of the dietary energy or protein needs of the world (FAO 1997). Compiling information at national levels, about 103 (Prescott-Allen and Prescott-Allen 1990) to 120 (FAO 1997) plant species are found to 'feed the world.'

Until now, Africa has been the source of only a few food crops with 'universal' importance (coffee (*Coffea* spp.), sorghum (*Sorghum bicolor* (L.) Moench), oil palm (*Elaeis guineensis* Jacq.) and upland rice (*Oriza glaberrima* Steud.)), besides some crops with local or regional importance such as yam (*Dioscorea* spp.), cowpea (*Vigna unguiculata* (L.) Walp.), African eggplants (*Solanum aethiopicum* L. and *S. macrocarpon* L.) or date palm (*Phoenix dactylifera* L.). There exist, however, a number of other useful species that are only known and used by local communities (Van Damme and Termote 2008). These 'underutilized' species need further research to be characterized, nutritionally evaluated and promoted, whereas their possible domestication should be explored in order to expand our food baskets (Johns and Eyzaguirre 2006). Moreover, these species are well adapted to particular agro-ecological niches and marginal areas, and are cultivated and/or utilized using indigenous knowledge (Giuliani 2007).

Since most of the world's impoverished populations live in countries harbouring the largest amounts of biodiversity, biodiversity conservation and poverty cannot be addressed independently from each other (Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Sunderlin 2005; Toledo and Burlingame 2006). Depleting the natural resources on which poor people rely or making them inaccessible can impoverish these people even more (Giuliani 2007; Kaimowitz and Sheil 2007).

Adding value to biodiversity, by linking it up to the market and to health, increases farmers' likelihood of conserving and enhancing diversity ('conservation through use' principle, Chweya and Eyzaguirre 1999). Though, raising farmers' awareness about the potential of biodiversity is hereby essential (Johns and Sthapit 2004). Sustainable management and use of traditional species can trigger incentives to conserve, not only intra- and interspecies biodiversity, but also the landscapes in which they grow. Indeed, useful species do not only grow in primary forests, but also as 'weeds' in agricultural lands, in homegardens, near roads and around homesteads, etc. (Van den Eynden 2004).

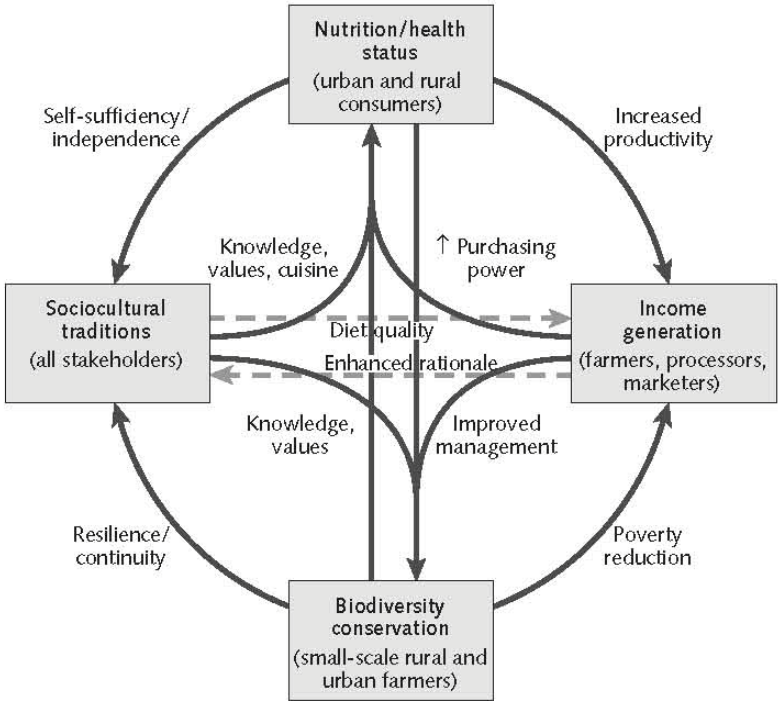

Figure 2.2: Population-level synergies linking biodiversity conservation and human nutrition in developing countries. Positive feedback loops ensure that benefits are widely enjoyed and offer several entry points for a sustainable strategy to use agricultural biodiversity to improve livelihoods (Frison et al. 2006; Johns and Sthapit 2004).

Although the impact of biodiversity on nutrition and income generation is difficult to separate, we will continue this chapter with an introduction on some links between 1) biodiversity and nutrition; and 2) biodiversity and income generation; which are of interest to this work. Of course, in a real life situation, biodiversity, nutrition and income generation together with prevailing socio-cultural traditions, are multi-linked and influence nutritional outcomes and other livelihood indicators in a very complex way (see figure 2.2). Therefore any project promoting the use of indigenous genetic resources should combine adequate measures to increase both sustainable production and consumption of local foods; it makes no sense to try to promote their consumption without ensuring adequate supply. Furthermore, increasing their production and availability without increasing market demand will create overabundant offers and thus act as a disincentive to further production. Success of promotion programs, therefore, will depend on how these factors can be timely combined and synchronized (Chweya and Eyzaguirre 1999).

2.2. Biodiversity and nutrition

FAO (2009) stated that 'nutrition and biodiversity converge to a common path leading to food security and sustainable development' and that 'wild species and intraspecies biodiversity have key roles in global nutrition security'. In that sense, Toledo and Burlingame (2006) presented a so-called biodiversity and nutrition rationale (see table 2.1).

Table 2.1: Biodiversity and nutrition rationale (Toledo and Burlingame 2006)

- Wild species and intraspecies biodiversity have key roles in global food security
- Different varieties have statistically different nutrient contents
- Acquiring nutrient data on existing biodiversity needs to be a prerequisite for decision making in GMO work
- Nutrient content needs to be among criteria in cultivar promotion
- Nutrient data for wild foods and cultivars need to be systematically generated, centrally compiled and widely disseminated
- Biodiversity questions and/or prompts need to be included in food consumption surveys
- Acquiring nutrient data and intake data for varieties is essential in order to understand the impact of biodiversity on food security

Undoubtedly, there is a huge potential of biodiversity to be better exploited and to contribute to nutrition security. A growing body of peer-reviewed data generated in developing countries addresses the health properties of indigenous foods (Johns and Eyzaguirre 2006; Lutaladio et al. 2010). Different authors stressed the outstanding nutritional qualities of traditional leafy vegetables (TLV). Matlhare et al. (1999), for example, found high protein, vitamin, calcium, magnesium and iron contents for TLVs in Botswana which have huge potential to complement the low contents of these elements in local maize-based diets. In Kenya, Maundu et al. (1999) also found that TLVs are good sources of micronutrients. In South Africa, Afolayan and Jimoh (2009) reported 4 wild leafy vegetables (*Chenopodium album* L., *Sonchus asper* (L.) Hill, *Solanum nigrum* L. and *Urtica urens* L.) as good sources of protein, crude fibre, calcium, iron, manganese as well as phenolics. Diouf et al. (1999) and Afolayan and Jimoh (2009) even found that the nutritional value of African TLV was higher than that of cultivated, Western-type vegetables like spinach, lettuce and cabbage. Herzog et al. (1994) analyzed the nutritional content of 11 wild fruits in Ivory Coast and concluded that they complement local diets with vitamins and minerals, provide rare nutrients and are important sources of variation to local diets.

In addition to their nutritional qualities, wild foods can also provide pharmacologically active substances, which cultivated species may have lost during domestication processes (Leonti et al. 2006; Toledo and Burligname 2006). *Solanum nigrum* L., e.g., is an important component of the traditional diet of the Luo people of Western Kenya. At the same time, this indigenous vegetable is also recognized by the Luo to protect against gastro-intestinal disturbances caused by the protozoan parasite *Giardia lamblia* (Johns et al. 1995). Moreover, spices and sauce condiments as indispensable components of African diets, not only contribute to the daily intakes of iron, zinc and calcium, but have also repeatedly been reported to contain antioxidant and insulin-modulating properties (Frison et al. 2006; Srinivasan 2005). In addition, Srinivasan (2005) reports anti-inflammatory, antimutagenic and anticarcinogenic potentials of traditional spices.

Unfortunately, considerable local knowledge on traditional food species is being lost at increasing rates due to social change and acculturation processes (Malaisse and Parent 1985; Kuhnlein et al. 2009). Many reasons for the decline in use of indigenous food species have been put forward, amongst which the most frequently mentioned are: declining availability of wild foods due to overharvesting and land clearing for agriculture; difficulties in access to land and land tenure; local populations' perceptions about wild foods as being 'food for the poor'; loss of traditional knowledge; high work load to collect, process and prepare traditional foods; integration in market economies and globalization (Kuhnlein et al. 2009; Bharucha & Pretty 2010). Consequently, in many indigenous communities, traditional food products are more and more being replaced by imported or newly introduced foods (refined and processed foods, fats, sugars) giving rise to nutrition transitions (Weinberger and Swai 2006). Once well-balanced diets are disturbed whereby deficiencies in nutrients (Herzog et al. 1994; Lykke et al. 2002; Weinberger and Swai 2006) and diet-related non-communicable diseases such as obesity, type 2 diabetes and cardio-vascular diseases may emerge (Kuhnlein et al. 2009). On the other hand, undernutrition and micronutrient deficiencies continue to be a public health challenge in Sub-Saharan Africa (Weinberger and Swai 2006), undermining health, psychological well-being, work capacity and economic development (Arimond et al. 2010; Kennedy et al. 2010; Torheim et al. 2010).

If previously nutrition interventions in developing countries were mainly oriented to single-nutrient supplementation, nowadays, the roles of micronutrients in health and well-being, and synergies in the physiological functions of nutrients are increasingly recognized (Frison et al.

2006; Remans et al. 2011). In addition, micronutrient deficiencies rarely occur in isolation (Burchi et al. 2011). Nutrition interventions should thus focus on improving overall diet quality; which calls for promoting dietary diversification and food-based nutritional interventions (Frison et al. 2006). The World Declaration and Plan of Action for Nutrition adopted at the 1992 International Conference on Nutrition recommended the promotion of dietary diversity and the use of locally available nutrient-rich indigenous and traditional foods as a vital strategy to fight against food insecurity, malnutrition, and disease (ICN 1992).

Some successful dietary diversification interventions focusing on vitamin A deficiency, and to a lesser extent, iron deficiency, have been reported in recent years. In an extremely resource-poor area in Mozambique, Low and colleagues (2007) assessed the effectiveness of introducing orange-fleshed sweet potatoes (rich in β-carotene) in an integrated agriculture and nutrition intervention. Children of intervention households were more likely to eat orange-fleshed sweet potatoes than control children and their vitamin A intakes were much higher (median retinol activity equivalents 426 vs 56 μg, $P<0.001$). Likewise, in Tanzania a combined program of home gardening and nutrition education resulted in a 66% increase in the production of β-carotene-rich fruits and vegetables, and a commensurate increase in daily consumption of these fruits and vegetables by the children in the intervention households (Kidala et al. 2000).

Although the above-described interventions are food-based, they are all designed to address the single nutrient problem of vitamin A deficiency. In addition, attempts at promoting dietary diversification, particularly with the active involvement of women, that have been found effective in controlled pilot-study settings, have rarely been scaled up to community levels. Frison et al. (2006) cite the lack of political commitment as being partly responsible for the underutilization of locally available food resources, together with the lack of direct scientific evidence for the effectiveness of dietary diversification strategies to make a convincing case in support of large-scale implementation programs. One of the root causes of the poor results that are often reported with food-based interventions is lack of knowledge about available indigenous and traditional foods (Burlingame 2000; Frison et al. 2006; Johns and Eyzaguirre 2006) and the complexity of the environment in which this kind of projects are conducted. Many confounding factors such as the circumstances under which people participate in these interventions, their health and sanitation environment, cultural practices,

etc., interfere with the implementation and outcomes of programs which aim at promoting agrobiodiversity for better nutrition and health (Masset et al. 2012).

A lot of further research is thus needed to provide the necessary evidence of the contribution of dietary diversity as well as the real and potential contribution of agricultural and wild biodiversity to adequate diets (Frison et al. 2006; Johns and Eyzaguirre 2006; Johns and Sthapit 2004). Methodological approaches have to be refined and conceptualized, and indicators of diversity have to be developed. There is, e.g., still discussion about the best tools for evaluating diversity in diets and nutritional outcomes (food variety score versus dietary diversity score) and the ideal assessment tools (food frequency questionnaires versus 24h recalls) (Frison et al. 2006; Kennedy et al. 2010; Ruel 2003; Savy et al. 2005, 2007; Torheim et al. 2004). Moreover, a recent review states that very few studies were able to combine biodiversity assessment methods (exact botanical identification of species) with quantitative dietary assessment methods (Peñafiel 2011). This requests for more collaboration between ethnobotanists and nutritionists to fill this methodological gap (Lutaladio 2010; Nesbitt et al. 2010) and to create innovative dietary assessment methods able to capture the role of wild foods and local varieties of species (Bélanger and Johns 2008; Toledo and Burlingame 2006; Lutaladio et al. 2010). Bélanger and Johns (2008) state that population-based studies combining clinical data and measures of access and consumption of biological diversity are key to demonstrate the important relationships between biodiversity, dietary diversity, and health outcomes and thus to construct a stronger evidence base than currently exists.

A recent study from Remans et al. (2011) assessed the nutritional diversity of cropping systems in African villages, introducing a novel nutritional functional diversity metric calculated using data on farm species' composition and species' nutritional composition. Although there is room for improvement, the strength of the study lies in the development of a system approach and the steps it takes towards integrating agriculture, nutrition and ecology studies (Remans et al. 2011). The study particularly analysed the link between nutritional diversity of the farming system and nutrition outcomes at the village level. Though, the authors suggest that a more appropriate scale to link nutritional functional diversity metrics to food consumption and nutrition indicators would be the '*foodshed*', defined as the geographic area that supplies a population centre with food. Their metric was only based upon the on-

farm species' composition and did not take into account the nutritional diversity of foods bought from the markets.

In addition, it does not need to be emphasized that more food composition data on wild foods and local/wild varieties of cultivated foods should urgently be generated (Burlingame et al. 2009; Johns and Eyzaguirre 2006; Lutaladio et al. 2010). Food composition data will be extremely helpful to further explore synergies between biodiversity and nutrition (Burlingame et al. 2009; Toledo and Burlingame 2006).

Eventually, even though the nature of the evidence is still circumstantial, the assumption that increased agricultural and forest biological diversity leads to a more varied diet, which in turn improves specific health outcomes, is reasonable and compelling (Bélanger and Johns 2008; Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Lutaladio 2010; Toledo and Burlingame 2006). More and more researchers are convinced that dietary diversification offers the best option for long-term sustainability of food systems in communities (Bélanger and Johns 2008; Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Frison et al. 2006; Kuhnlein 2009). This is especially true when traditional knowledge and socio-cultural values linked with traditional foods are present and can be reinforced to (re-)obtain healthier diets (Kuhnlein 2009). Local food systems should form the basis for integrated interventions addressing conservation together with nutrition and health objectives (Bélanger and Johns 2008, Burchi et al. 2011; Johns and Sthapit 2004). International and national policies that build on biodiversity and cultural strengths inherent in traditional food systems optimize chances for vulnerable populations to adapt to changing conditions in a sustainable manner (Johns and Sthapit 2004). Food-based dietary guidelines, e.g., which emphasize the use of locally available foods, food variety, traditional cuisines; and culturally sensitive methodologies to address both undernutrition and the nutritional transition, need to be developed (Johns and Sthapit 2004). Promotion of traditional foods begins with the identification and documentation of local sources and varieties as well as perceptions regarding use, palatability, accessibility, and reasons for low or high popularity. Subsequent interventions to increase consumption may involve nutrition education and transmissions of knowledge (Bélanger and Johns 2008).

According to Johns et al. (2000) and others, the important roles played by plant sterols, omega-3 fatty acids, and other dietary components in reducing a certain number of diseases have been established largely through the initial study of traditional diets that are associated

with longevity and good health (Johns and Eyzaguirre 2006; Johns and Sthapit 2004). Ironically, in the developing world, people prefer to consume fashionable, 'modern' foods and gradually abandon traditional diets that are considered to be a sign of backwardness and poverty, while in industrial societies people increasingly look for traditional ingredients and dishes such as those of East Asia and the Mediterranean as embodiments of good nutrition for health (Frison et al. 2006).

2.3. Biodiversity and income generation

During the last 10-20 years, interest in the role of Non Timber Forest Products (NTFPs) as promoters of rural development and for poverty alleviation on the one hand and conservation of natural resources on the other hand, has been growing (Arnold and Ruiz-Pérez 2001; Belcher et al. 2005; Bista and Webb 2006; Kusters et al. 2006; Sunderlin et al. 2005). But, whether the trade in Wild Edible Plants (WEPs), and NTFPs in general, is rather a poverty trap or an opportunity to fill the poverty gap is a debate that continues to divide opinions (Lescuyer 2010; Newton et al. 2006; Ruiz-Pérez et al. 2004; Sunderlin et al. 2005).

Some authors argue that NTFP harvest and trade constitute a 'safety net' for poor households allowing them to acquire some income or to provide for their otherwise unfulfilled needs, without, however, allowing them to 'lift' out of poverty (Naheulhual et al. 2008; Neumann and Hirsch 2000; Ruiz-Pérez et al. 2004). According to the latter authors, they should rather concentrate on other, more stable, income-generating activities to fight poverty. Lescuyer (2010) even states that promoting NTFP trade leads to forest-based economies that continue to remain in permanent poverty. By contrast, other authors describe examples of successful NTFP trade, where some well-chosen NTFPs have been able to generate decent incomes (Hoare 2007; Mahapatra et al. 2005; Ruiz-Pérez et al. 2004).

Ruiz-Pérez et al. (2004), trying to explain these divergent findings, compared 61 NTFP commercialisation cases from Africa, Asia and Latin America, and differentiated 3 categories of NTFP-trading households. Households using/trading a large range, but small amounts of NTFPs are poor, unspecialized and highly depend on different NTFPs for their survival (Belcher et al. 2005; Bista and Webb 2006; Ruiz-Pérez et al. 2004; Shackleton et al. 2002;

Sundriyal and Sundriyal 2004). They often live in isolated areas. A second group comprises households that are better integrated into the cash economy and are thus able to diversify their income sources. They are less dependent on NTFP trade, although NTFPs provide a welcome supplement at times when other sources of income are low (Belcher et al. 2005; Kusters et al. 2006; Ruiz-Pérez et al. 2004). A third category of households are those that specialize in the trade of one or two NTFPs (Ruiz-Pérez et al. 2004; Shackleton 2004). The latter households in particular are able to obtain decent incomes from NTFP commercialisation (Belcher 2005; Kusters et al. 2006). This is possible, if large and stable regional or even international markets exist and are easily accessible. Hoare (2007) concludes that NTFPs do play an important role in the life of many people, increasing both livelihood and economic security. Therefore NTFPs should be central to any strategy for sustainable rural development, but the expectations of economic benefits should not be raised too high, as NTFPs are only part of a system with many alternative livelihood options.

Whether NTFP commercialisation is sustainable in the long term not only depends on the market environment, but also on the sustainability of harvest practices and resource availability. Local communities all over the world have harvested NTFPs for centuries and their use for subsistence has not really put a high burden on the natural resource base, except in special situations such as civil wars, etc. (Arnold and Pérez 2001; Sundriyal and Sundriyal 2004). However, when NTPF markets are developing and demand is growing, many local communities experience diminishing resource availability due to overexploitation and unsustainable harvest practices to obtain immediate financial gains (Delvaux et al. 2010; Sundriyal and Sundriyal 2004). According to the typology of Ruiz-Pérez et al. (2004), cases where NTFPs have been domesticated and integrated into agroforestry systems, are more sustainable. If NTFPs are thus to be useful in efforts to reduce poverty, (participatory) domestication and integration into agroforestry systems seems a better option to comply with growing market demand, and to minimize overexploitation and biodiversity loss (Belcher et al. 2005; Bista and Webb 2006; Hoare 2007; Ruiz-Pérez et al. 2004; Sundriyal and Sundriyal 2002; Tchoundjeu et al. 2006).

Although the benefits from NTFP commercialisation go far beyond the impact on rural communities, little research has been done on the contribution of NTFPs to urban livelihoods. NTFP trade offers many job opportunities to assemblers, transporters, other intermediaries and retailers in the growing African cities. Stoian (2005) and Jensen (2009) strongly advise to

study more thoroughly the entire local supply chains of NTFPs and its stakeholders as well as the rural-urban linkages. Information on NTFP availability, prices and market channels is essential for a correct valuation of forests and forest products, and to assess the role and potential of NTFPs at local, regional and national levels (Hegde et al. 1996; Sundriyal and Sundriyal 2004). However, until now, local markets have been poorly acknowledged and often remain under-researched (Shackleton et al. 2008).

Gradually, more and more insights are gained into the multiple roles of NTFPs. However, a suitable theoretical/analytical framework is still lacking (Belcher et al. 2005). Some attempts to conceptualize have been made, but much has still to be done, and more formal and coordinated studies to further analyse the link between biodiversity and income generation should be organised and conducted (Giuliani 2007). According to Marshall et al. (2003), it is difficult to generalize factors of success in NTFP-trade, since social and economic situations and NTFP products highly differ from case to case. Hence, highly detailed, site-specific studies are the way forward. NTFP activities can neither be researched nor promoted in isolation from the livelihood dynamics that are affected by them or without addressing the broader regional socio-economic development context ('societywide view'). (Ruiz-Pérez 2004; Shackleton et al. 2008; Sunderlin et al. 2005). New initiatives to promote NTFPs should first recognize the products with the highest potential of making an economic contribution under given market conditions ('priority setting') (Franzel 1996; Leakey and Simons 1998; Nahuelhual 2008). Secondly, they should identify those people who can really improve their living beyond the subsistence level through the collection and trade of NTFPs (Nahuelhual 2008).

2.4. Participatory research

It is more and more recognized that local and indigenous communities provide tremendous efforts in the conservation and sustainable management of the biodiversity that feeds the world (Russell et al. 2011; Toledo and Burlingame 2006). Our research deals with local populations and aims to valorize the indigenous knowledge on Wild Edible Plants (WEPs), so, inherently, research methodologies have to be, at least partly, participatory. Participatory approaches require the combination of natural and social sciences with local experience-based knowledge (Friss-Hansen and Sthapit 2000). According to Degrande (2005), 'people's participation' is one of the critical components of success in agricultural development and a wide range of organizations have attempted to involve people in at least some aspects of planning and implementation of projects.

It has been argued that participatory approaches ensure greater efficiency and effectiveness of investments and also contribute to the empowerment of participants (Friss-Hansen and Sthapit 2000). However, many authors cite different levels of participation (Degrande 2005; Friss-Hansen and Sthapit 2000; Pretty 1996; White 1996). According to Friss-Hansen and Sthapit (2000), the lowest level is *nominal participation*, where the farmer simply lends/rents land and labour to researchers. The second level is *consultative participation*, where farmers' opinions and knowledge are explored. The third level is *action-oriented participation*, where farmers are directly involved in implementing part of the research activities. The fourth level is *decision-making/design participation* in which farmers take part in deciding on the objectives of the research plan, the design of the experiments and their implementation. These participation levels are not strictly tied, they can change during the course of a project or between different participants (White 1996).

Thus, beyond the scope of exploring the potentials of indigenous knowledge, participation can also be seen as an end in itself. Participation is thought to empower poor people by enhancing local management capacity, and increasing confidence in their own worth and abilities as individuals but also as a community (Friis-Hansen and Sthapit 2000).

The primary participatory objective of this thesis was to elicit local knowledge on WEPs through participatory techniques (mainly focus group discussions, interviews and ranking

exercises) in order to document and valorize this knowledge in Tshopo District. Other participatory techniques used, but for which the results are not presented in this document were village mappings, venn diagrams, village history lines, agricultural calendars and gender analysis (adapted from Rennie & Singh 1996).

The work of Gradé (2008) shows that documentation and promotion of indigenous knowledge through all available indigenous, endogenous and exogenous networks helps to preserve it from disappearing. Through the recognition and valorization of their own knowledge, local populations are better prepared to cope with acculturation processes and may make better prepared choices between two worlds (traditional or modern). This also enables a smoother transition into the next cultural identity era in which local populations can reach a sustainable, independent way of living in conjunction with the modern context (Gradé 2008).

In addition, as has been explained in *chapter 1*, our research was a first step to come to participatory domestication of the most interesting WEPs in the region, and can thus be situated in the appraisal and diagnostic part of the flow diagram of ICRAF's participatory farmer-centered agroforestry research and extension approach (figure 2.3). The latter approach reaches far higher levels of participation than the preliminary research we conducted. Ideally, indigenous communities engage in community-based scientific research to guide the course along which they can continue to meet their subsistence, economic, and social aspirations (Johns and Sthapit 2004).

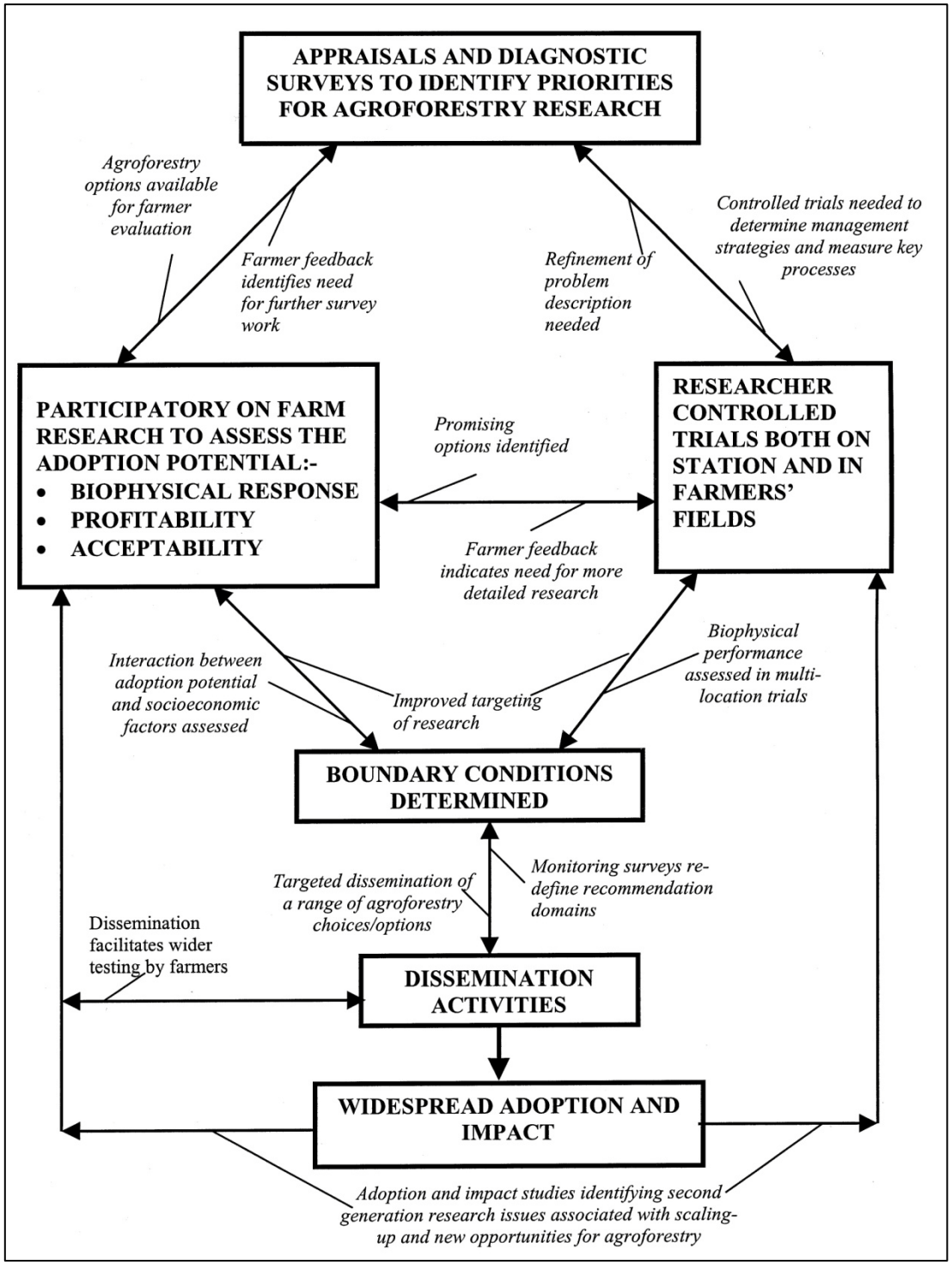

Figure 2.3: Flow diagram of decisions and activities in farmer-centered agroforestry research and extension (Franzel et al. 2001)

2.5. Rationale behind the thesis

Now that we have some background on the multiple links between biodiversity, nutrition and livelihoods, we will explain how the different sub-studies in this work are interlinked. Our research was centered on WEPs as one, but certainly not the only, component of the area's 'edible' biodiversity. Other components that were not studied here, are e.g. wild edible animals, caterpillars, termites and mushrooms.

At the start of the WEP project, we defined what we considered to be *Wild Edible Plants* in the framework of this study. This definition was used throughout the whole thesis.

> Heywood (1999) defines **non-cultivated** plants as: '*plants that grow spontaneously in self-maintaining populations in natural or semi-natural ecosystems and can exist independently of direct human action*'. In accordance with him, we consider as '**wild**' all plants that are gathered (not cultivated), even if some of them grow on cultivated rather than on uncultivated or forest land.
>
> We further defined wild **edible** plants as: '*plants of which a part is consumed as vegetable, fruit, tuber, spice, tea substitute, stimulant/strengthener, etc., and not exclusively to treat a (self-)diagnosed illness nor for narcotic or hallucinogenic purposes*' (Termote et al. 2010a).

Hereunder, we describe the strategic plan of this thesis. Per specific objective we indicate the main methodology used and explain how the objectives are linked together.

Specific objective 1: *inventory and document WEPs known and used by the Turumbu, Mbole and Bali indigenous ethnic groups living in Tshopo District*

Because a thorough inventory of WEPs had never been done before in our study area (Tshopo District), it was obvious that, before we could start evaluating the importance of WEPs in nutrition and livelihoods, we had to perform an ethnobotanical inventory documenting the existing indigenous knowledge on WEPs in the region. Several authors state that WEPs are part of the intangible cultural heritage of local populations (Pieroni 2008; UNESCO 2003) and even related with their cultural identity (Dansi et al. 2008; Macía 2004; Maxia et al. 2008; Ndam et al. 2001; Pieroni et al. 2005). Hence, our first exercise consisted of an inventory of the major ethnic groups living in the District and the selection of the research sites per ethnic

group. As a result, fourteen major indigenous groups were listed: Turumbu, Bambole, Babali, Balengola, Basoko, Bangando, Babua, Lokele, Topoke, Bamanga, Bakumu, Bango, Bangelema and Bambesa. We subsequently chose three villages per group as research sites. The present doctoral thesis will characterise and discuss WEP knowledge of the Turumbu, Mbole and Bali. Data obtained for the other groups are currently being analysed in the broader WEP project. Tshopo District is situated in the Guineo-Congolian regional center of endemism with mixed moist semi-evergreen forests (White 1983). However, until now, we haven't found further detailed information about possible vegetation differences in the different regions of the District. The regions around Opala (Mbole) and Bafwasende (Bali) are in urgent need for further exploration and collection (Bamps in Kendrick 1989).

As there were almost no basic ethnobotanical data available, we were initially interested in an inventory of all WEPs known per village/ethnic group, rather than in a more in-depth, individual informants' knowledge inventory. Hence, we decided to organize participatory focus group discussions in each study site to document all wild plants that participants told us they know as being used as food. Subsequently, per village all WEPs discussed during these focus group discussions were collected with key informants during 'walks-in-the-wood' (Cotton 1996) to constitute a reference herbarium. The process and results of documenting WEPs in Tshopo District was illustrated for the case of the Turumbu in *chapter 4*, while *chapter 5* presents the results for all 3 ethnic groups together, and discusses similarities and differences in WEP knowledge between the 3 groups. Comparison of ethnobotanical knowledge between communities and ethnicities has been done before by several authors for different reasons (e.g. Arenas and Scarpa 2007; Dansi et al. 2008; Ichakawa 1993; Koura et al. 2011; Macía 2004; Sheil and Salim 2012). As stated by Dansi et al. (2008), Maxia et al. (2008) and Sheil and Salim (2012), the (dis-)similarities in WEP knowledge between ethnical groups originate form a mix of biological and cultural factors and historical linkages which can mostly not be studied separately from each other. Nonetheless, it remains important to know if differences in WEP knowledge between ethnical groups in Tshopo District exist and if so, to identify WEPs with regional importance for the whole district and others with only ethno-specific importance (Dansi et al. 2008). The main purpose of our study was to contribute to the valorisation of WEPs, hence we should be able to take into account biocultural differences and similarities when promoting WEP consumption and trade in the region.

Specific objective 2: ***document preferences for wild vegetables and wild fruits by the Turumbu, Mbole and Bali men and women through participatory ranking exercises***

Once we had an overview of the WEPs used in each village, our next objective was to obtain an idea about which plants were most preferred by the local populations themselves. This information is useful c.q. needed if one wants to set priorities for WEP species which should be further researched, or domesticated participatorily and for value chain development. In this context, it is very important to start from the needs and wishes of the local populations (Franzel 1996). Participatory preferences ranking exercises (adapted from Cotton's 'direct matrix ranking', 1996) were used to document local preferences in taste, and economic, nutritional and socio-cultural values of wild fruits and wild vegetables. At this stage, we did not perform preference ranking exercises for spices nor other food types.

Specific objective 3: ***analyze WEP markets in Kisangani with regard to number and socio-economic characteristics of sellers, WEP species and quantities offered, prices and periodicity***

A next step in our research was to assess the socio-economic value of the WEPs inventoried during ethnobotanical investigations. We therefore performed socio-economic household interviews in the study villages (not described in this thesis) and studied WEP markets in Kisangani (*chapter 6*). Because markets are the main places for the exchange of goods, the hypothesis was that studying WEP markets should provide us with valuable information on WEP trade and the socio-economic value of WEPs. To analyze WEP markets in Kisangani, we targeted the main market (*Marché Central*), the 2 supplying markets (*IAT* and *Djubudjubu*), 2 of the 9 municipal markets (*Tshopo 11ième avenue* and *Kabondo Foyer*) and the main road selling point *Libanga*. In order to cover a whole calendar year, all WEP traders present in the target markets during four one-month sessions between September 2007 and July 2008 were interviewed about their socio-economic household characteristics and the process of buying and selling WEPs, recalling the year preceding the interview. WEP species were easily identified, using the WEP lists from *chapters 4* and *5*. This sub-study should provide valuable information for priority setting of species which come into scope for value chain development and subsequent participatory domestication. In addition, the detailed information on trader socio-economic characteristics can further be used and refined to elaborate pro-poor strategies for value chain development of the priority species. Better-organized value chains should ultimately lead to higher and more diversified incomes for WEP gatherers and traders.

Specific objective 4: evaluate the importance of WEPs in local diets and guaranteeing nutrition security of women in Kisangani and Yaoseko, a rural Turumbu village

WEPs can be widely used for auto-consumption, without however being traded to generate incomes (Delang 2006). To assess local diets and the real contributions of WEPs herein, we estimated the usual dietary intake from 2 multiple-pass 24h recalls for 363 urban (Kisangani) and 129 (rural) women (*chapter 7*). In the study of local diets, we decided to work with women because women are responsible for cooking and are the decision-makers when it comes to nutritional choices in the households in DRC. Men often do not know into detail all the ingredients used to prepare the dishes. Yaoseko (a Turumbu village) was selected because this was the village where we had registered the highest number of WEPs during ethnobotanical inventories.

Further investigations regarding the nutrient composition of WEPs (not presented in this work) would allow to integrate WEPs into well-targeted food-based dietary guidelines for the region. 'Awareness' of the multiple benefits of WEPs for better nutrition security should be created through community based nutritional education, role plays, WEP fairs or recipe exchanges. Nutritional education in the city may stimulate demand for local foods, thereby reinforcing local production-consumption links and providing the necessary market incentives for farmers to cultivate/gather local foods (Johns & Eyzaguirre 2006). Any project promoting the use of indigenous genetic resources should simultaneously work on the supply (sustainable production and marketing) and demand side (consumption).

The final aim of this thesis is to contribute to the valorization of WEPs in Tshopo District for better livelihoods and nutrition. By performing these different sub-studies, we hope to provide valuable insights into the knowledge, trade and use (consumption) of WEPs which should help to 1) prioritize species for further study and participatory domestication; 2) develop pro-poor strategies for WEP value chain development; and 3) elaborate strategies for better valuation of WEPs into local diets and nutrition. As stated above, it makes no sense to promote WEP consumption without ensuring adequate supply. Furthermore, increasing WEP production and availability without increasing market demand will create overabundant offers and thus act as a disincentive to further production. Therefore these factors should be timely combined and synchronized (Chweya and Eyzaguirre 1999).

CHAPTER THREE

STUDY AREA: TSHOPO DISTRICT IN THE DEMOCRATIC REPUBLIC OF CONGO

This chapter gives a brief overview of DRC and Tshopo District, our study area. The chapter ends with a presentation of the few data available on the ethnic groups we worked with (Turumbu, Mbole and Bali).

3.1. Democratic Republic of Congo (DRC)

A brief history

As a former Belgian colony, the Republic of the Congo gained its independence on June 30, 1960 with Patrice Lumumba (MNC, *Mouvement National Congolais)* as prime minister and Joseph Kasavubu (Abaco, *Alliance des Bakongo*) as president. Congo's early years were marked by political and social instability, until colonel Joseph Mobutu seized power and declared himself president after the November 1965 coup. In 1967, Mobutu founded the MPR (*Mouvement Populaire de la Révolution*) as unified political party and changed the constitutional law in order to concentrate all the power in hands of the head of state. Mobutu retained his position for 32 years (CIA 2011; Poppe 2010; Van Reybrouck 2010).

In the early seventies, Mobutu launched his authenticity campaign and changed the name of the country and its main river in Zaïre[1] and that of the capital in Kinshasa. All city names became Zaïrized, whereas his name became henceforth Mobutu Sese Seko. He nationalized the whole economy and allocated all enterprises to his partisans, who did not care about 'good' management, only about immediate profits. This was disastrous for the Congolese economy, which became more and more a cleptocracy. The economy steadily slowed down until a zero-point. The Structural Adjustment Programs of the IMF in the eighties (to reimburse the enormous debts which had mainly served to enrich the rulers) further pulled down the livelihoods of the millions of poor Congolese inhabitants. The physical infrastructure disaggregated; education and health services declined to a ghostly apparition of what they once were; political institutions became implausible and the economy further collapsed (Berwouts 2001).

The beginning of the nineties was characterized by some feigned manoeuvres of Mobutu to install a democracy, but he grasped every opportunity to promote chaos and violence. On May 11, 1990, Mobutu's elite troops caused a bloodbath at the Lubumbashi University campus. Officially 39 students were killed, but according to most sources more than 100 students died. This slaughter was the direct motive for Belgian development cooperation with the country to be stopped. In September 1990, after new price increases, the national army orchestrated a wave of pillages (plunders) over the whole country. In January 1993, a second

[1] In reality, Zaïre is not an African word, but a Portuguese alteration of 'nsadi' which means river in the Kikongo language (Berwouts 2001).

looting occurred in the country, again under orchestration of the national army (Poppe 2010; Van Reybrouck 2010).

When finally Mobutu lost his last esteem, in 1994 the country was afflicted by a humanitarian crisis that had started with Rwandan refugees who had fled into Eastern Zaïre. To some extent, the enormous relief operation financed and led by the international community in Eastern DRC, again strengthened Mobutu's position, but not for long (Berwouts 2001).

The presence of the refugees in Eastern DRC also constituted the motive to start off a rebellion backed by Rwanda and Uganda, and headed by Laurent Désiré Kabila (AFDL, *Alliance des Forces Démocratiques pour la Libération*). After a seven month rebellion, Laurent Kabila became President on Mai 29, 1997. He renamed the country the Democratic Republic Congo (DRC), but in August 1998 his regime was itself challenged by a second insurrection from the east, and again backed by Rwanda and Uganda. Troops from Angola, Chad, Namibia, Sudan, and Zimbabwe intervened to support Kabila's regime and because of the number of countries involved, some called this conflict the first African world war. Laurent Kabila was eventually assassinated in January 2001 and his son, Joseph Kabila, subsequently named head of state (CIA 2011).

By the end of 2002, the new president was successful in negotiating the withdrawal of Rwandan forces occupying eastern Congo. The Pretoria Accord was signed by all remaining warring parties to end the fighting and establish a government of national unity. A transitional government was set up in July 2003. Joseph Kabila as president and four vice-presidents represented the former government, former rebel groups, the political opposition, and civil society. The transitional government held a successful constitutional referendum and elections for the presidency, National Assembly, and provincial legislatures in 2006. The National Assembly was installed in September 2006 and Kabila inaugurated president in December 2006. By November 28, 2011, Kabila was reelected president for a second term (CIA 2011).

Nowadays, some rebels are still active in the east of the country undermining the peace agreement signed by the DRC, Rwanda and Uganda, and the rebel group *Congrès national pour la défense du peuple* (CNDP). The humanitarian situation in the east remains uncertain because of fighting between the DRC army (FADRC) and rebels of the *Front démocratique de libération du Rwanda* (FDLR) (AfDB/OECD/UNDP/UNECA 2010). If the original

motives for the conflicts and civil strife were the presence of Rwandan refugees, occupying parties quickly learned that they could easily gain money through controlling the many natural resources present in the Congolese soil (coltan, gold, diamond, cobalt, copper, zinc, etc.). Some say that ironically, the enormous richness of the country is the main reason for its misery and its population to remain poor.

Geographical situation

DRC is the second biggest country on the African continent (2,344,858 km²). It is located north and south of the equator in Central Africa. Neighbouring countries are the Republic of Congo, the Central African Republic and South-Soudan in the north; Uganda, Rwanda, Burundi and Tanzania in the east; and Zambia and Angola in the south (Figure 3.1; AfDB/OECD 2008). DRC also has 37 km of coast-line in the west. Currently, the country consists of 10 provinces together with the capital province Kinshasa (11 in total), but this will become 26 after further decentralization (25 and the capital province Kinshasa).

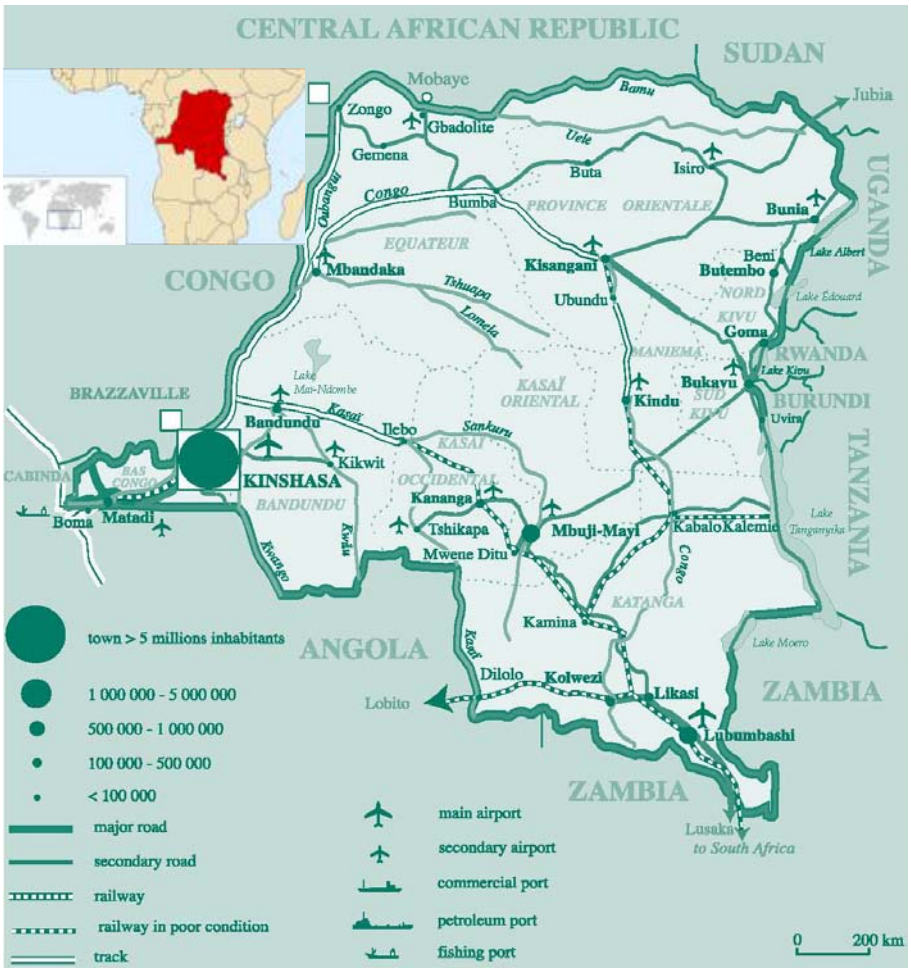

Figure 3.1: Map of the Democratic Republic of Congo (AfDB/OECD 2008)

Population data

According to CIA (2011), total population was estimated at 71,712,867 inhabitants in July 2011. In 2010, 35% of the population lived in urban areas. About 44.4% is younger than 15 years, 53% is between 15-64 years whereas only 2.6% are 65 years or older. Life expectancy at birth is 55.33 years according to CIA (2011) and 48 years according to the Human Development Report (UNDP 2010). Infant and under-five mortality rates decreased from resp. 126 and 199 per 1,000 live births in 2008 (UNDP 2010) to resp. 97 and 158 per 1,000 live births in 2010 (MICS-RDC 2011). Annual population growth rate is currently estimated at 2.614% and literacy rate at 67.2% (CIA 2011). The official administrative language is French. Lingala, Kiswahili, Tshiluba and Kikongo are recognized as national languages. Over 200 ethnic groups live in the country of which the majority is Bantu. The 4 largest tribes, Kongo, Luba, Mongo (all Bantu) and Mangbetu-Azande (Hamitic), make up about 45% of the population (CIA 2011).

Climate and vegetation

DRC has three well-defined relief features. The Congo River Basin encompasses an immense depression, drained by the Congo river and its affluents, and has an average altitude of 300-500 m. Northeast and south of the Congo River Basin are plateaus with a mean altitude of around 600 m. To the east, the East African Rift shaped the Albertine Rift Valley Lakes (Tanganyika, Kivu, Edouard and Albert) and mountains which form Congo's oriental border. The snow-covered peaks of the Rwenzori Mountains (Mountains of the Moon), stretching along Congo's border with Uganda, reach their highest point at 5119 m with the Margherita Peak (third highest peak on the African continent) (www.congonline.org; Kendrick 1989; Robert 1946).

Because of its geographical vastness, DRC possesses a range of climates, which are generally characterized by high mean annual temperatures. On the equator, mean temperatures of 25.5°C show very small annual variation and only exceptionally descend below 20°C; in the areas more distant from the equator, nights can be cooler. In the northeast, east and southeast, the plain and mountain regions, altitude considerably influences climate conditions (www.congonline.org; Robert 1946).

Rainfall is more variable than temperature in DRC. Highest rainfalls (annual means of more than 2000 mm) are observed in the central basin and at the basis of the Oriental mountains next to lake Kivu. From there, rainfall decreases following north-south directions. Only a few regions have mean annual rainfalls below 900 mm. Going from the equator in northern or southern directions, one can observe more and more distinct dry seasons. In the northern part of the country (above the equator), the rainy seasons last from April to June and from September to October, the dry seasons from November to March (long dry season) and from July to August (short dry season). The rhythm of the seasons becomes opposite in the southern part of the country (beneath the equator) (www.congonline.org; Robert 1946).

Following Köppen's classification, the equatorial and tropical warm and humid climates are classified as type A. Climates Af and Am are characterized by the absence of a clearly marked dry season; climates Aw and As have a distinct dry season in resp. in Winter and Summer. If the mean temperature of the coldest month drops below 18°C, then Köppen classifies the climate as subtropical C. In DRC, we find two C climates, namely Cf (with no marked dry season) and Cw (with dry season in Winter). Finally, in the highest mountainous regions, we find some climates with mean annual temperatures of the hottest month not exceeding 10°C (type ETH) or 0°C (type EFH).

According to the UNESCO/AETFAT/UNSO vegetation map of Africa, the Congolese rainforests in the Congo basin (*cuvette*), belong to the Guineo-Congolian regional center of endemism. In the northeast, the Ubangi-Uele plateaus on the border with the Central African Republic are within the transition zone between the Guineo-Congolian and Sudanian phytochoria. South of the *cuvette*, Congo extends through a transition zone into the Zambezian center of endemism of High Africa (Kendrick 1989, White 1983).

In the central basin, the vegetation consists of mixed, moist semi-evergreen forests (White 1983). The western parts of the basin, inundated on a consecutive basis, consist of a more swampy vegetation. Leaving the equator behind, the vegetation becomes more and more open and on the plateaus we find tree savannas. In the east, above the 1200 m height line, we find a tropical mountainous forest (www.congonline.org).

Given in part its size and location in the heart of tropical Africa, DRC exhibits high levels of biodiversity at both, the ecosystem and species level. The country is estimated to be the 5th most biodiverse country in the world (Counsell 2006). While not all of the broad taxonomic flora groups of DRC have been described, current knowledge shows a minimum of 10,531 flora species in DRC (including 8,867 spermaphyte species) of which 1,337 are endemic (Eba'a Atyi and Bayol 2008). At fauna level, DRC counts at least 4,758 known wildlife species, namely 456 land invertebrates, 1,782 aquatic invertebrates, 1000 fresh water fish, 1099 birds (22 endemic species) and 421 mammals (15 endemic species) (Anonymous 2009; Eba'a Atyi and Bayol 2008 ; Wolfire et al. 1998). About 21 mammal species figure on the list of endangered mammals in DRC, among which, white rhinoceros (*Ceratotherium simum*), mountain or eastern gorilla (*Gorilla gorilla berengei*), western lowland gorilla (*Gorilla gorilla graueri*), bonobo (*Pan paniscus*), chimpanzee (*Pan troglodytes*), leopard (*Panthera pardus*) and African elephant (*Loxodonta africana*) (Eba'a Atyi and Bayol 2008). Species such as bonobo (*Pan paniscus*), Congo peacock (*Afropavo congensis*) or okapi (*Okapia johnstoni*) are endemic to DRC (Bashige and Debonnet 2004).

The protected areas cover 10 million ha or 8.5% of DRC's total surface. They encompass 7 national parks, 3 biosphere reserves and several wildlife reserves and hunting areas (Carr-Dirick et al. 2007). DRC's forest code of August 2002 states that the objective is to protect 15% of its national territory (Debroux et al. 2007).

DRC's forests

In total, DRC possesses 145 million ha of forest; this is 62 % of its territory and 58% of the Congo basin forests. DRC encompasses hereby the second biggest tropical forest massif in the world (Bamoninga 2007). Until now, DRC's forests are quite well preserved. Between 1984 and 1998, annual deforestation rate was around 0.4%, which is moderate in comparison to other tropical regions (Laporte and Justice 2001). However, this is an estimation and hides regional differences. Especially around Kinshasa in Bas-Congo and in the East ,deforestation rates are higher (Laporte and Justice 2001). Except for some illegal timber exportations to Rwanda and Uganda during the war, insecurity and inaccessibility (totally dilapidated roads) protected the forest from what would have been destructed if there had been no war (Debroux et al. 2007). In fact, until 2004, agriculture and collection of firewood for cooking were the main forest destruction activities. Nowadays, peace is gradually being restored and roads rebuilt, so forests become again accessible to industrial timber companies. It is feared that

personal interests and market forces will dominate and that the Congolese institutions are too weak to turn the renewed interest in timber exploitation into benefits for the local people and the country. They lack capacities and means to control the operations in the field in a weak socio-political context (DSCRP 2011; Trefon 2007a).

However, with the aid from international partners (UNDP, FAO, etc.) and in accordance with the World Bank's forest strategy, a 'Priority Agenda' was elaborated and some encouraging measures have been taken since 2002, such as the adoption of a new forest code (29 August 2002), a moratorium on the allocation of new concessions, the return to the public domain of 25.5 million hectares of noncompliant concessions, the legal revision of all remaining concessions with an independent observer, etc. (Debroux et al. 2007; Trefon 2007b). Although these reforms are supported by the highest political levels, they constitute only some initial steps. The continued engagement of all stakeholders during the whole process of reforms will be crucial to preserve the Congolese forests to the benefit of its indigenous people and the entire mankind. A fair-minded mix of encouragements and critics from the international community is likely to have a qualifying impact on the ongoing efforts of DRC to reform the forestry sector (Debroux et al. 2007).

Economy and development

The economy of DRC - a nation endowed with enormous amounts of natural resources - is slowly recovering from decades of decline. Systemic corruption since independence and the 1996-2003 conflict dramatically reduced national production and government revenue, increased external debt, and resulted in the deaths of more than 5 million people from violence, famine, and disease. Since 2002, the former transitional government re-launched relations with international financial institutions and international donors, and President Kabila began to implement reforms (CIA 2011).

Progress is slow and much of the economic activity still occurs in the informal sector, which is not reflected in gross domestic product (GDP) data. According to Debroux et al. (2007), informal activities account for 80 % of the economy. An uncertain legal framework, corruption, and a lack of transparency in government policy are long lasting problems for the country's economy (CIA 2011). DRC signed a Poverty Reduction and Growth Facility

agreement with IMF in 2009, and received $12 billion in multilateral and bilateral debt relief in 2010 (CIA 2011).

DRC moved up four places in the World Bank's *Doing Business* report, reaching the 175th place out of 183 countries in 2010, mainly because of reforms involving starting businesses, granting building permits and registering property (DSCRP 2011).
Meanwhile, the country is at the stage of joining the free-trade area of the Common Market for Eastern and Southern Africa (COMESA) and has completed a survey of how it might profit from joining another, i.e. the Southern African Development Community (SADC) (AfDB/OECD/UNDP/UNECA 2010).

The global recession has cut DRC's economic growth in 2009 to 2.8%, less than half its 2008 level, but real GDP growth in 2010 returned to 6.1% (AfDB/OECD/UNDP/UNECA 2010), or even 7.2% according to CIA (2011). Major contributors to overall growth were mining (11.8%), construction (10.1%), and wholesale and retail trade (6.3%). Over the next two years, the economy is expected to grow at an annual rate of 6.5% (AfDB/OECD/UNDP/UNECA 2010). The 2010 GDP in Purchasing Power Parity (PPP) amounted to $23.12 billion (CIA 2011). GDP per capita was estimated at $300 for 2010 (CIA 2011). This 'offers' DRC, together with Burundi, the last place in the world ranking of 228 countries with regard to GDP per capita. In addition, DRC has a highly unequal income distribution or Gini coefficient of 0.44 according to UNDP (2010) or 0.314 according to DHS-RDC (2008). According to CIA (2011), the agricultural sector contributed in 2010 48.4% of GDP, industry 22.7%, whereas the services sector contributed 29% of GDP.

The main export commodities of the country are diamonds, gold, copper, cobalt, wood products, crude oil and coffee. The main imported commodities are food, mining machinery and other industrial hardware, transport equipment and fuels (CIA 2011).

Although agriculture contributes 48.8% to GDP, the sector is marginalized in government spending and gets only 0.64% of the total budget, far below the 10% spending target of African countries as a whole (AfDB/OECD/UNDP/UNECA 2010). Coffee, sugar, palm oil, rubber, tea, cotton, cocoa, quinine, cassava, bananas, plantains, peanuts, root crops, corn, fruits and wood products are the main agricultural commodities produced in DRC (CIA 2011).

DRC has about 152,500 km of roads (only 2,794 km is paved) with nine main routes linking provincial capitals. On top of it, it has 15,000 km of navigable waterways and 4,007 km of railways. The whole transport network is in very poor condition due to lack of maintenance and investment in recent decades. The electricity grid shows a wide gap between supply and demand despite the country's huge generating potential of 100,000 MW. An aid agreement with China and resumption of relationships with foreign donors should re-energize the transport and energy sub-sectors (AfDB/OECD/UNDP/UNECA 2010; CIA 2011).

Nowadays, 54% of DRC's population (20% in urban and 72% in rural areas) has no access to improved drinking water sources (CIA 2011; MICS-RDC 2010; UNDP 2010) and 67% (CIA 2011) over 77% (UNDP 2010) to 86% (MICS-RDC 2010) has no access to improved sanitation facilities. With a Human Development Index (HDI) of 0.286 DRC occupies the last place on a total of 187 countries (UNDP 2011). The HDI provides a composite measure of three basic dimensions of human development: living a long and healthy life (measured by life expectancy at birth), being educated (since the 2010 report measured by mean years of schooling and expected years of schooling) and having a decent standard of living (since 2010 measured by gross national income per capita).

The percentage of population with an income under the 1.25 $/day poverty line or under the national poverty line, is resp. 59.2 and 71.3% (UNDP 2010). UNDP's multidimensional poverty index (a measure of serious deprivations in the dimensions of health, education and living standards that combines the number of deprived and the intensity of their deprivation) shows that 73.2% of the population lives in multidimensional poverty, 16.1% are at risk of multidimensional poverty and 85.5% of the population experiences at least 1 deprivation in living standards (UNDP 2010). During the 2004-2006 period, 75% of the population was considered undernourished with a mean food energy shortfall of 25% (UNDP 2010). Even at present, with a score of 39 (in the extremely alarming zone) on IFPRI's Global Hunger Index 2011, DRC ranks 81st and last (IFPRI 2011). The percentage underweight children-under-five decreased from 31.1% in 2001 (UNICEF 2002) over 25.1% in 2007 (DHS-RDC 2008) to 24% in 2010 (MICS-RDC 2010), but stays above the 16.8% target to be on the right way to reach the MDGs (DSCRP 2011). In 2010, 24% of the children under-five were underweight (insufficient weight for age), 43% were stunted (insufficient height for age) and 9% were wasted (insufficient weight for height) (MICS-RDC 2010). HIV prevalence is estimated at 3.25% (DSCRP 2011).

To conclude, the country is having a hard time meeting the MDGs of reducing extreme poverty and hunger, reaching gender equality and in its fight against HIV/AIDS, malaria and other diseases. Some progress has been made in health and education, but only a few MDGs will be reached (AfDB/OECD/UNDP/UNECA 2010). In December 2008, DRC elaborated a national plan to realize the MDGs entitled '*Document de plaidoyer pour la mobilization des resources en faveur des OMD*'. This document revealed that it is almost impossible to reach the MDGs by 2015 and sets its goal to reach them by 2020 with a strong commitment to reach them in 2015 if the socio-economic context allows it (DSCRP 2011). Poor quality or almost non-existence of statistical data impede efforts to assess and monitor MDGs and their indicators. Strengthening national data gathering and analysis is a major problem for the social and human development sector as for all others (AfDB/OECD/UNDP/UNECA 2010; DSCRP 2011).

3.2. Tshopo District

The Oriental Province in northeastern DRC consists of 4 districts, namely Ituri, Bas-Uélé, Haut-Uélé and Tshopo. The capital of the Oriental Province, Kisangani (0°31'NB, 25°11'E, 428m), is situated in the middle of Tshopo District (figure 3.2).

Tshopo District is further subdivided into 7 territories (i.e., Bafwasende, Banalia, Basoko, Isangi, Opala, Ubundu and Yahuma; figure 3.2), whereas Kisangani is administratively divided in six municipalities (Makiso, Tshopo, Mangobo, Kabondo, Kisangani and Lubunga).

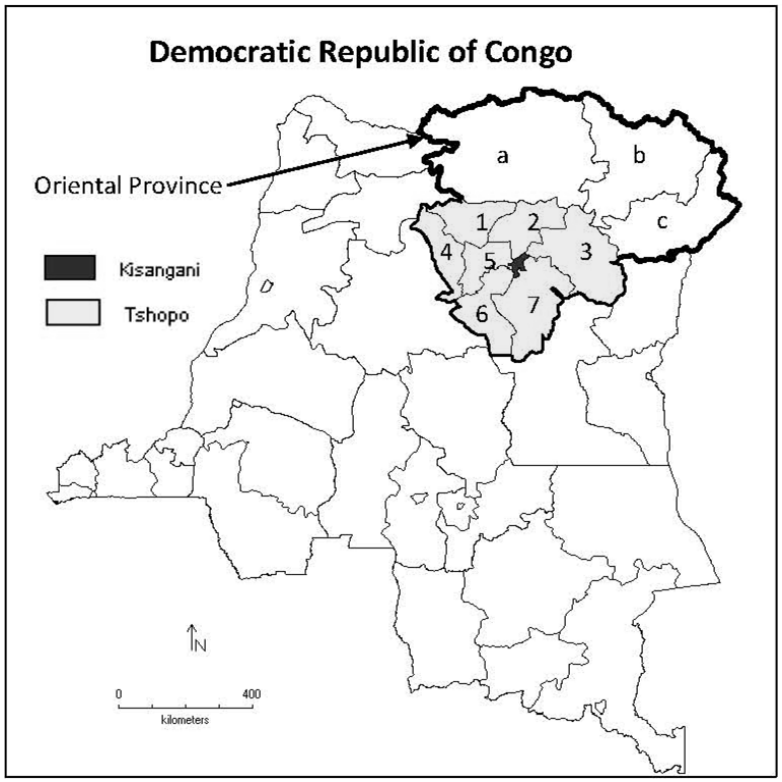

Figure 3.2: Map of the Democratic Republic of Congo with indication of study area (made in Diva-GIS 7.4). The Oriental Province consists of 4 districts: Tshopo (grey), Bas-Uélé (a), Haut-Uélé (b) and Ituri (c); Tshopo District consists of 7 territories: Basoko (1), Banalia (2), Bafwasende (3), Yahuma (4), Isangi (5), Opala (6), Ubundu (7).

The hot and humid climate in Tshopo District is classified as Af in Köppen's typology (Bultot 1950 in Ntamulyango 1975). Annual rainfall amounts to 1800 mm (PNUD/UNOPS 1998) and is well-distributed over the whole year. A small dry period in January-February and in June-July, and a more rainy period from September till November and from March till April can be observed (Libendele 1976). The mean temperature of 23.5°C shows very small intra-annual variations (PNUD/UNOPS 1998).

The very northeast of Bafwasende Territory, belonging to the Uele plain, lies in the transition zone (Am) between the Af and Aw climates. The latter climate differs from the Af climate because of its clearly pronounced dry season (PNUD/UNOPS 1998).
Soils originate from old aeolian depositions and belong mostly to the class of ferrasoils with a high degree of alteration and very few minerals available in the clay fraction (Van Wambeke 1954).

Tshopo District is situated in the Guineo-Congolian regional center of endemism with mixed moist semi-evergreen forests (White 1983). The Yangambi biosphere reserve, covering more than half of the Turumbu area, is dominated by secondary forests mainly consisting of *Pycnanthus angolensis* (Welw.) Warb. and *Fagara macrophylla* Engl.; mixed semi-deciduous secondary rain forests; primary rain forests with *Gilbertiodendron dewevrei* (De Wild.) J.Léonard; climax forests with *Brachystegia laurentii* (De Wild.) Louis ex Hoyle; and marshland forests (UNESCO 2008). No detailed vegetation data were found for the other areas around Kisangani (Opala, Bafwasende, Ubundu, Lubutu, etc.); they are in urgent need of further exploration and collection (Bamps in Kendrick 1989).

The original populations of Kisangani were Wagenia and Kumu. Today, Kisangani city is composed of a broad mix of ethnic groups coming from over the whole country. According to the *Ministère du plan* (2005), the population of Kisangani and Tshopo District was estimated at 895,880 inhabitants and 1,367,306 inhabitants respectively in 2004, but different statistical sources (Institut National de Statistique (INS), annual territory reports, health service reports, etc.) provide very divergent data. The last population census was organized in 1984 (CFSVA 2008).

Within the scope of the Wild Edible Plant project in Tshopo District, we identified 14 major indigenous ethnic groups in the district, namely Basoko, Bangando, Bambesa, Lokele, Topoke, Turumbu, Bambole, Baboa, Bamanga, Bangalema, Bakumu, Babali and Balengola. Although the WEP project inventoried indigenous knowledge in all 14 ethnic groups, fieldwork for the present PhD thesis was concentrated on the Turumbu, Bambole and Babali communities as well as in the city of Kisangani.

The Turumbu

The Isangi territory comprises 13 '*collectivités*,' operational units at the basis of the hierarchical administration system. The Turumbu live in the '*collectivité Turumbu*', in the north bordered by the Banalia Territory and Aruwimi river, in the east by the Lindi river, in the south by the Congo river and in the west by Basoko Territory (figure 3.3).

Data on surface area or population numbers of the '*collectivité*' are contradictory: 4600 km² with 40,421 inhabitants on July 1, 2004 according to the National Institute of Statistics (*Ministère du Plan* 2005) or 3674 km² with 61,905 inhabitants in 2007 according to the Isangi Territory Report (2008).

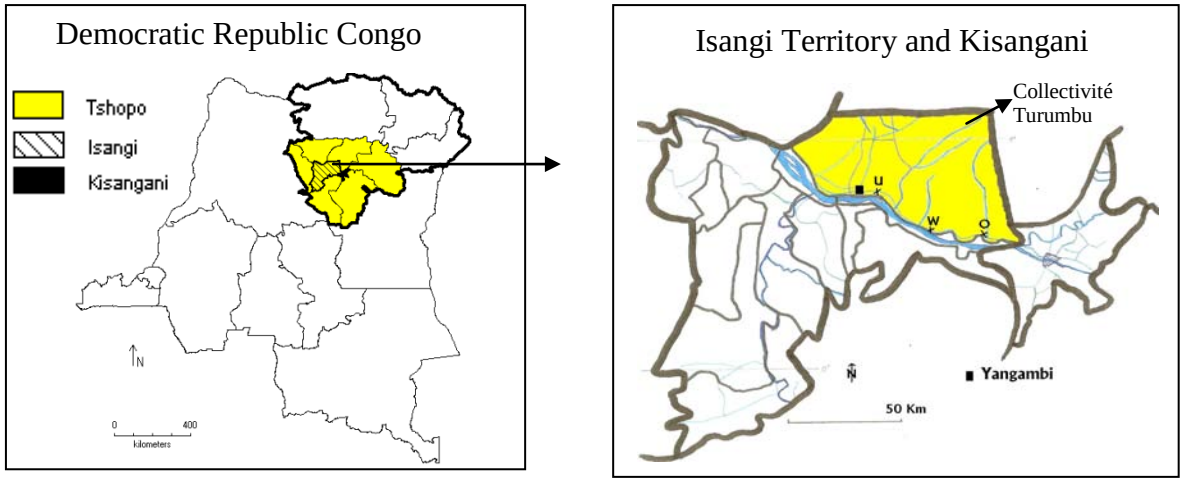

Figure 3.3: Geographical location of the Turumbu ethnic group. The Turumbu live in the '*collectivité Turumbu*', one of the 13 '*collectivités*' of the Isangi Territory. The study villages Yalungu (U), Yasekwe (W) and Yaoseko (O) are indicated on the map.
Source: DIVA-GIS (DRC) and adapted from De Saint Moulin & Kalombo Tshibanda, 2005 (Isangi)

The original name of the ethnic group 'Olombo' signifies 'human being' in several local languages. It was the colonial administration who adopted the name 'Turumbu'. They must have asked the name of the tribe to a stranger (probably one of the river bank inhabitants who despised forest people), who added a pejorative prefix 'to-' to the name. Due to some difficulties to distinguish between u and o, and between l and r in the regional languages 'Tolombo' must have been written as 'Turumbu' (Carrington 1947).

The Turumbu and their culture have hardly been studied. Van der Kerken (1944) classified them into the larger Bantou group of Topoke-Lokele-Turumbu-Basoko. The history and origin of this Bantou group, however, remains very unclear. According to Henry (1979), they migrated centuries ago from the northern savannas into the equatorial forest where they had to

adapt to the hot and humid climate. Before colonial times, they lived scattered in the forest between the Aruwimi and the Congo River and lived form hunting, gathering and shifting cultivation.

Under influence of the colonial administration, they settled along the roads on the right bank of the Congo River from Yangambi up to the Lindi river and between Yangambi and Ngazi (Henry 1979). An alley cropping experimental agricultural system was introduced in 1944 by the Belgian colonialists and the region was called '*paysannat Turumbu'* (Besombi 1947). Agricultural production significantly increased and the Turumbu were the primary beneficiaries of agricultural research at the INERA Yangambi station and Faculty of Agronomy (IFA-Yangambi, currently active in Kisangani). Today, hardly anything is left from this productive period due to difficulties in the agricultural extension and commercialization system (Mbaya and Streiffeler 1986; Miasuekama Nkusu 1974; Russell 2011); the recent wars (1996 – 2003) destroyed much of the remaining socio-economic tissues (*Ministère du Plan* 2005). Current interest of young people for artisanal diamond exploitation represents an extra burden on agricultural productivity because they neglect their fields to work in the artisanal quarries (Kienia'h Bikitwa 1999).

Nevertheless, agriculture remains the principal activity, whereas hunting, fishing, gathering and cattle-breeding are of secondary importance. The Turumbu also specialized in handicrafts such as vans, baskets, mortars and canoes. Traditionally houses are constructed with clay and leaves, with different dimensions and irregular dispositions (Lititiyo 1977). Only 8% of houses are constructed in lasting materials (bricks and corrugated iron) (Kienia'h Bikitwa 1999).

Since the colonial period, the Turumbu practice a mixed cropping system with as major crops rice, maize, cassava and plantain bananas (Ntamulyango 1975; own observations). To diversify food sources, also pineapple, gourd, eggplant, chili peppers, sugarcane, sweet potato or yams are sometimes introduced in small quantities in the fields with variable importance. Rice used to be the main cash crop, but its importance has decreased a lot, mainly due to commercialization problems.

The Mbole

The Mbole live in Opala Territory (figure 3.4), in the north bordered by Isangi Territorry, in the east by Ubundu Territory, in the south by the Oriental Kasaï Province and in the west by the Equator Province. Opala Territory consists of 11 '*collectivités*'. According to the National Institute of Statistics the Opala Territory counted 186,549 inhabitants on July 1, 2004 for a surface area of 26,665 km² (*Ministère du Plan* 2005). The Opala Territory Report (2008) mentions 218,966 inhabitants in 2007.

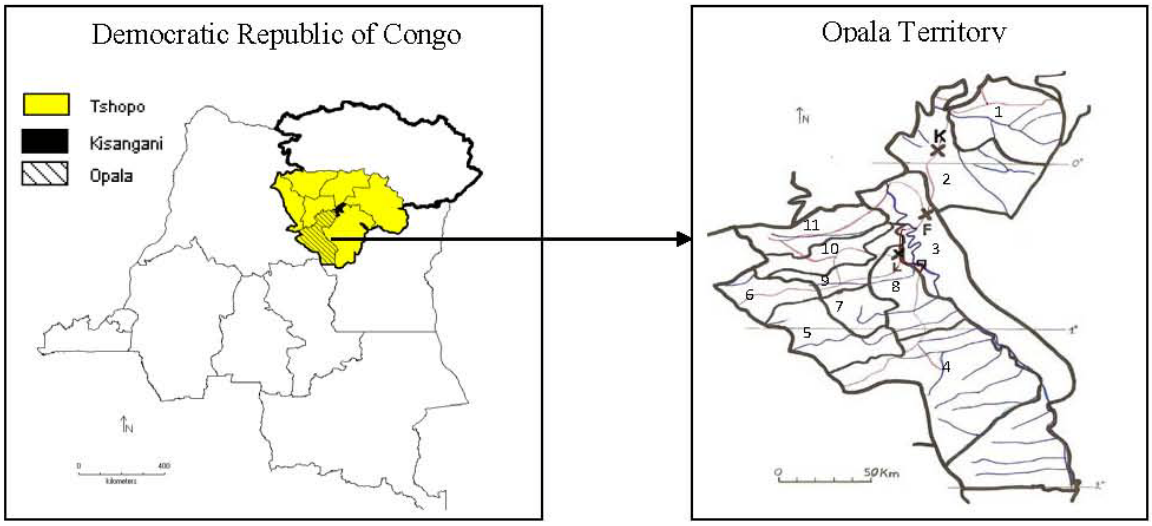

Figure 3.4: Geographical location of the Mbole ethnic group. The Mbole live in the Opala Territory, which consists of 11 '*collectivités*' (1: Lobaie, 2: Tooli, 3: Balinga-Lindja, 4: Yawende-Lolo, 5: Yeyango, 6: Iye, 7: Yomale, 8: Yalingo, 9: Yapandu, 10: Mongo and 11: Kembe). Yaleko Village (K) is situated in the '*collectivité*' Tooli, Olife (F) in the '*collectivité*' Balinga-Lindja and Lefundelo (L) in the '*collectivité*' Yalingo. Source: DIVA-GIS (DRC) and adapted from De Saint Moulin & Kalombo Tshibanda, 2005 (Opala)

According to Van Der Kerken (1944), the Mbole belong to the larger group of the Mongo Bantous, who occupy a big part of the Congo Basin. The Mbole constitute one tribe but can be divided into 2 groups based on some dialectic differences. The Mbole Ima occupy the Lobaye and Tooli '*collectivités*', whereas the Mbole Ngoya occupy the 9 other ones (Opala Territory Report 2004). Their principal activity is agriculture complemented by hunting, fishing, gathering and livestock raising.

Their whole socio-cultural live is dominated by the *Lilwa* (also *Lilwakoy*) institution (Kalala Nkudi 1979). All adult males are member of the *Lilwa* through an enthronization ceremony, where they learn the norms, values and laws of their culture. During this enthronization ceremony, the importance to maintain the secrets of the *Lilwa*, as well as the severeness of the

penalties inflicted on traitors are stressed. The *Lilwa* also comprises ritual therapists (*kanga*), blacksmiths (*tuli*), sculptors, singers, ritual assistants (*opinga*), principal officiates (*onanga a lilwa*), the *ikoni koy,* charged with the execution by hanging of the ritual victims and the *Yeni,* the most highly esteemed ritual dignitaries of the *Lilwa (*Kalala Nkudi 1979). The *Lilwa* exercises its control over all activities of the Mbole through the *Lilwa* tribunal.

According to Kalala Nkudi (1979), all studies on the Mbole society should be interpreted against a thorough knowledge of the *Lilwa*, but apart from his exploratory work, little is known about this secret society. The rigidity and attachment to their cultural traditions in combination with their geographically isolated position and a neglect of the region with relation to the construction of education infrastructure caused, according to Bongeli Yeikelo (1975), a delay in the development of the Mbole in comparison to their neighbouring ethnic groups.

The Bali

Bafwasende Territory comprises 6 '*collectivités*'. The Bali, occupy 4 of them, namely Bafwandaka, Bakundumu, Bekeni Kondolole and Bemili (figure 3.5). The Bali ethnic group is in the north bordered by the Bas Uele and Haut Uele Districts, in the east by the Ituri District, in the south by the Barumbi-Opienge '*collectivité*' of Bafwasende Territory, and in the west by Kisangani and the Ubundu and Banalia Territories of Tshopo District. Data on surface area and populations are very contradictory. According to the National Institute of Statistics, the 4 Bali '*collectivités*' counted 62,511 inhabitants on July 1, 2004 on a surface area of 22,496 km² (*Ministère du Plan* 2005). The Bafwasende Territory Report (2008) mentions 161,851 inhabitants in 2007 on a surface area of 26,952 km².

On the basis of their language, being a dialect of the Bobua language, Van Der Kerken (1944) attaches the Bali to the larger Bantou group of the Bobati-Bobenge-Boyew-Bodongola-Bobua-Mangbele with eastern origins. Their principal activity is agriculture complemented by hunting, fishing, gathering and livestock raising. The Bali were formerly also known for their excellent blacksmiths (Van Geluwe 1960). Although no information could be found in literature to confirm, personal observation learned that, nowadays, the Bali are highly involved in diamond digging (still more than the Turumbu), hereby neglecting agricultural production.

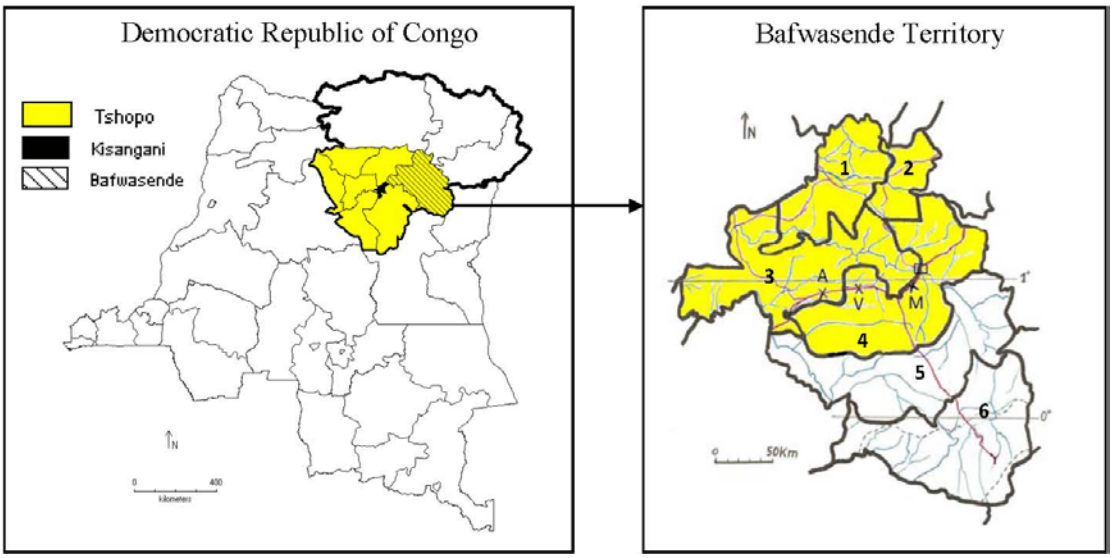

Figure 3.5: Geographical location of the Bali ethnic group. The Babali live in the Bafwasende Territory, which consists of 6 '*collectivités*' (1: Bemili, 2: Bafwandaka, 3: Bekeni-Kondolole, 4: Bakundumu, 5: Barumbi-Opienge, 6: Bakumu d'Angumu). '*collectivité*' 1, 2, 3 and 4 are populated by Babali; '*collectivité* 5 and 6 by Barumbi and Bakumu. Bafwabula (A) is located in the 'Collectivité' Bekeni-Kondolole, Bavoy (V) and Bafwambalu (M) in the '*collectivité*' Bakundumu. Source: DIVA-GIS (DRC) and adapted from De Saint Moulin & Kalombo Tshibanda, 2005 (Bafwasende)

The political structure of the Bali consists of the family *sensu strictu (agbadili)*, the extended family *(logo)*, the village (*unzi*), the clan (*kuzi*) and the tribe (*Deeli*). The village council is composed of the different heads of the *logos* (*metundji*) and leaded by the *metundji nkuru* (Bouccin 1935; Van Geluwe 1960).

The Bali do not practice circumcision, but have the *mambela* as enthronization rite. During *mambela*, the boys are incised with circles or forks - according to the clan or family they belong too - on the breast and they are taught to be strong Bali adult men with respect for culture and traditions.

The colonial administration prohibited the *mambela* in 1933-1934 because of the suspected relationship with the *aniota* or leopard men, a secret society causing death and terror in the region (Saerens 1947; 1947b). Since then, the Bali adopted a set of medico-religious rituals (*lingula*) from the Bakumu. They strongly believe in witchcraft, amulets (*bohogu*) and fortunetellers (*mombi engula*). The cause of sickness or death is always imputed to the bad eye or bad will of another person's soul (*muhuma*) (Saerens 1947a and 1947b). The *mombi engula* is charged to discover who threw the bad fate and to indicate the traditional healer (*unzokolo*) who may treat the patient (Van Geluwe 1960).

CHAPTER FOUR

INDIGENOUS KNOWLEDGE ON WILD EDIBLE PLANTS IN TSHOPO DISTRICT: THE CASE OF THE TURUMBU

Figure 4.1: Above left: man transporting safou (*Dacryodes edulis*, purple) and tito (*Tetracarpidium conophorum*, green); above right: woman coming from the field, bringing melelu (*Talinum triangulare*) for today's meal; below: woman having harvested liyo fruits (*Landolphia owariensis*)

Abstract

Documenting and revalorizing the rapidly disappearing indigenous knowledge on wild edible plants is essential to promote health and preserve biocultural diversity. Focus group discussions were organized in 3 Turumbu villages to document wild foods known, their availability, preparation methods and uses. Preferences in taste and commercial, nutritional and cultural value were discussed during participatory ranking exercises. The Turumbu know at least 85 species within 70 genera and 44 families. Fruits of *Anonidium manni* and *Landolphia owariensis*, and (unfolded) leaves of *Megaphrynium macrostachyum* and *Talinum triangulare* are most appreciated. Inventories and preference rankings should be complemented with nutritional analyses and market studies to set priorities for further participatory domestication.

Céline Termote, Patrick Van Damme, Benoît Dhed'a Djailo
Eating from the wild: Turumbu indigenous knowledge on noncultivated edible plants, Tshopo District, DRC. Ecology of Food and Nutrition, 2010, 49(3): 173-207 (Impact Factor: 0.577).

4.1. Introduction

Until recently, only a few fragmented studies concerning WEPs had been conducted in and around Kisangani resulting in some incomplete lists with WEPs of the region (Bola and Szafranski 1991; Mosango and Isosi 1998; Mosango and Szafranski 1985; Kawukpa and Angoyo 1994). To our knowledge, no ethnobotanical studies were ever carried out in the hinterlands of Kisangani (Tshopo District), in the indigenous territories of the different ethnic groups living in the area, except for some preliminary studies on the Lokele and Turumbu (Liengola 2001), Wagenia (Bokdam and Droogers 1975) and Kumu (Nyakabwa et al. 1990). Faced with this knowledge gap, we decided that the first objective of our WEP project had to be a thorough documentation of WEP knowledge in the District. Our first exercise consisted of an inventory of the major ethnic groups living in the District and the selection of the research sites per ethnic group. As a result, fourteen major indigenous groups were listed (Turumbu, Bambole, Babali, Balengola, Basoko, Bangando, Babua, Lokele, Topoke, Bamanga, Bakumu, Bango, Bangelema and Bambesa) and three villages per group chosen as research sites. By way of example, this chapter discusses the process and results of documenting WEP knowledge within the Turumbu ethnic group. Additionally, the author of this thesis also conducted field work within the Bambole and Babali ethnic groups. Data for all 3 ethnic groups together and comparisons between the groups are further presented in *chapter 5*. The local project collaborators continue analyzing data for the other 11 ethnic groups.

The objectives of this initial study were to 1) inventory WEPs known by the Turumbu, one of the major ethnic groups in the district; and 2) document local preferences in taste and economic, nutritional and socio-cultural values of the WEPs.

Scientific and vernacular names, plant parts used, modes of preparation, specific uses, seasonality patterns in collection and use, and commercialisation possibilities of the different WEPs are presented here, together with participatory ranking exercises' results.

4.2. Material and methods

For a description of the study area and the Turumbu ethnical group we refer to *chapter 3*.
What we considered as *wild edible plant*, was defined in *chapter 2, section 2.5*.

Data collection
All research protocols were developed, approved by and implemented in collaboration with the University of Kisangani.

Given the lack of reliable information on number and exact location of the different Turumbu villages, we opted for a non-probabilistic reasoned sample of 3 research villages (De Pelsmacker and Van Kenhove 2006), with selection directed by:
1) accessibility (villages in the region are mostly situated along the main road);
2) consisting of 1 tribe (no co-habitation of different tribes in the same village because this might mutually influence knowledge and use of WEPs);
3) at least 30 households living in the village; and
4) full consent and collaboration of the village chief (and participants) after clear presentation of the research objectives and protocols.

Ethnobotanical research was carried out in Yaoseko (August 2007, 00°35'03"N, 024°56'14"E, 34 km east of Kisangani, group 'Yawenda', 184 households), Yasekwe (September 2007, 00°37'16"N, 024°37'16"E, 61 km east of Kisangani, group 'Yawenda', 115 households) and Yalungu (July 2006 and September 2007, 0°46'22"N, 024°32'59"E, 92 km east of Kisangani, group 'Yelongo', 120 households) (figure 3.3).

An exploratory qualitative research approach was used to document all WEPs known at village level and to gain insight in their uses, preparation methods, seasonality patterns and commercialization. According to Rennie and Singh (1996), focus group discussions are claimed to generate results of less apparent precision, but greater evidential value, than more common quantitative survey techniques. The decision to opt for participatory focus group discussions stems from the fact that in an initial phase, with almost no basic ethnobotanical data available, we were interested in an inventory of all WEPs known per village/ethnic group, rather than in more in-depth individual informants' knowledge.

Focus groups were organized in each village and lasted for 5 to 7 days (according to number of WEPs known and as a function of the participants' other activities). Each focus group was composed of key informants knowledgeable in plant uses, chosen in collaboration with the village headman (Cotton 1996). Other villagers expressing their interest to join the focus group, whether or not only during part of the exercise, were not excluded. Following Alexiades (1996), the latter were even encouraged to participate, because group discussions also serve as social occasions to facilitate transmission of cultural knowledge across generations. The focus group in Yaoseko counted 6 male and 1 female permanently present key informants; they totaled 6/2 and 8/2 key informants in Yasekwe and Yalungu, respectively. Women were encouraged, but not forced to participate. They mostly had multiple other obligations which did not allow them to participate during all discussions.

During the first session in each village, we asked participants to enumerate all 'wild' plants they know that could be used as food ('free-listing', Cotton 1996). Plant names were recorded in their native '*Turumbu*' language, and per village a list of WEPs was compiled. To constitute a reference herbarium collection, in each village, all species mentioned on the list were collected during field trips with the key informants ('walks-in-the-wood', *sensu* Alexiades 1996).

During subsequent focus group sessions, participants discussed uses, preparation methods, seasonality patterns, commercialization and any possible inconvenience for each species on the list of WEPs of their village. Discussions were conducted in Lingala (the regional language commonly known by the Turumbu) with the help of a local research assistant from UNIKIS for Lingala – French translations and guided by a 'topic list' prepared in advance by the researcher (Cotton 1996). Answers were recorded after reaching group consensus.

At the end, in each village, two new groups were formed (men and women apart) for participatory ranking exercises. Men groups were composed of 5, 4 and 7 participants, whereas women groups consisted of 7, 4 and 9 participants for Yaoseko, Yasekwe and Yalungu, respectively. Before starting the ranking as such, each group had to weigh four characteristics of WEPs: taste, economic value, socio-cultural value and nutritional value, to obtain the relative importance of these characteristics to each other. The four characteristics were derived from literature (Agea et al. 2007; Dansi et al. 2008). Taste and nutritional quality deal with their intrinsic value as food, cash value with income generation, whereas

socio-cultural value is concerned with the possibility of valorizing the species in multiple ways (multi-purpose species). Weighing was done by distributing 50 palm kernels over the four characteristics, in such a way that the more important a characteristic was according to the group members, the more kernels it was given. Thereafter, researchers asked the group to cite the 10 most important wild fruits (we let groups themselves decide upon what they considered as fruit (*mbuma*)). These fruits were subsequently ranked once for each characteristic (adapted from Cotton's (1996) 'direct matrix ranking'). Ranking was done by distributing 50 palm kernels over the 10 fruits. In this way, for example, fruits with a better taste received more kernels than less tastier fruits. This procedure allowed illiterate villagers to take part in the exercise, which was also repeated with 10 wild vegetables (*ndunda*). At this stage, we did not perform preference ranking exercises for spices or other food types.

Data analysis

Species used as WEP

Herbarium specimens were identified with the aid of the '*Flore d'Afrique Centrale (Congo-Kinshasa, Rwanda and Burundi)*' (Bamps 2000 -) and deposited at the National Botanic Garden of Belgium, Meise (acronym BR). Duplicates of the latter were deposited at the herbarium of the host institution (Faculty of Sciences, University of Kisangani, DRC). Species names were verified on the IPNI (International Plant Names Index) website (www.ipni.org) and allocated to botanical families according to the APGII-system (Angiosperm Phylogeny Website; http://www.mobot.org/MOBOT/research/APweb/).

In what follows, when we refer to vernacular Turumbu names of WEPs, the term '*folk species*' will be used. When referred to a scientific name, we will use the term '*species*'. According to Berlin (1973) and Holman (2002), a one-to-one correspondence (1 folk species = 1 scientific species) may not always be assumed:

1) two or more folk species can refer to a single scientific species = **over-differentiation** (Berlin 1973); whereas

2) one vernacular name (or folk species) may cover several scientific species, usually species which are morphologically very similar **= under-differentiation** (Berlin 1973).

In addition, Bokdam and Droogers (1975) found, in the region of Kisangani, that some plants have different vernacular names for different plant parts used (e.g., the fruit may have another name than the whole tree or liana). This can lead to an overestimation of the number of WEPs

known and used if data are not carefully cross-checked and/or complemented with collection of species for reference herbaria.

Non-food uses of WEPs

The number of WEPs having uses in categories other than food was counted. The different use categories were adapted from Cook (1996) to meet field realities of the research area. Secondly, the total number of use citations (one specific use cited for one specific species in one village = one use citation), food uses included, were calculated for each plant species (with: total number of use citations = number of use citations in Yalungu + number of use citations in Yasekwe + number of use citations in Yaoseko). For example, if a plant species is used as vegetable in Yalungu, but also to treat malaria and to chase bad spirits, it has 3 use citations in Yalungu; if the same species is used as vegetable and to treat malaria in Yasekwe, it has 2 use citations in Yasekwe; and if in Yaoseko it is only used as vegetable, it has 1 use citation in Yaoseko. This species obtains thus in total (3+2+1=) 6 use citations.

Because non-food uses were not the primary target of the study, these should be considered as preliminary. Only when a WEP figured on the list of WEPs in the respective villages, we asked about other, non-food uses of the species.

Participatory rankings

The number of kernels a WEP received for a given characteristic was multiplied by the relative importance of the characteristic (i.e., the number of kernels the characteristic had obtained during weighing). These results, obtained per WEP for each of the four characteristics, were summed to find the global weighted ranking result of each folk species (adapted from Cotton's 'direct matrix ranking', 1996).

To obtain an aggregated result for the 6 (= 3 villages x 2 groups (men and women)) fruit ranking exercises, the number of times a species appeared in the top three for a given characteristic was counted as well as the number of times a species appeared in the top three of the global weighted ranking. The same procedure was followed for the 6 vegetable rankings.

4.3. Results

Species used

Table 4.1 presents the plant species known as food in the Turumbu villages studied. 81 folk species were identified as 85 scientific species, distributed over 70 genera and 44 families. Some folk species refer to several scientific species. The Malvaceae family, for example, comprises 5 *Cola* species, but locally these occur as 2 folk species (*'Losakanu'* is the Turumbu name for *Cola bruneelii*, *C. congolana*, *C. marsupium* and *C. urceolata;* '*angbongbolia'* for *C. acuminata*). The Apocynaceae family contains most WEPs (7 (folk) species), followed by Malvaceae (6 species, 3 folk species), Dioscoreaceae (5 (folk) species) and Araceae, Euphorbiaceae and Fabaceae (each with 4 (folk) species) (table 4.1).

The number of plants known in all 3 villages, in paired villages and in each simple village is shown in figure 4.2. Of all plants inventoried, 53% are known in the 3 villages. Similarities between paired villages vary from 56% to 73%.

Table 4.1: Wild Edible Plants (WEP) known by the Turumbu, Isangi Territory, DRC

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
Achariaceae	*Caloncoba subtomentosa* Gilg	lisende (o)	196	fruit	raw	fruit	NSP 2x/year°		*3*	X
Amaranthaceae	*Amaranthus dubius* Mart. ex Thell.	ngbelengbele (o) lonenge (w,o)	249, 302	leaves	cooked	leafy vegetable	permanent		6	
	Celosia trigyna L.	iphowuphowu (w,o)	218	leaves	cooked	leafy vegetable	permanent	x	2	X
	Celosia leptostachya Benth.	iphowuphowu (w,o)	1006	leaves	cooked	leafy vegetable	permanent	x	2	
Anacardiaceae	*Antrocaryon nannanii* De Wild.	bokongo, kongo (u,w,o)	993	seeds	raw	- nut - condiment	July - Oct.		(4)	X
Annonaceae	*Anonidium mannii* (Oliv.) Engl. & Diels	anguto (u,w,o)	198, 270, 316	fruit	raw	fruit	July – Oct.	xxx	(12)	X
Apocynaceae	*Clitandra cymulosa* Benth.	inono (u,w,o)	263, 337	fruit	raw	fruit	July – Oct.	xxx	(12)	
	Dictyophleba lucida (K.Schum.) Pierre	iyoyoliki (u) liyoliyoliki (w) iyayawoliki (o)	122, 235, 997	fruit	raw	fruit	July – Oct.	x	(3)	
	Landolphia foretiana (Pierre ex Jum.) Pichon	lingbotoma (o)	197	fruit	raw	fruit	July – Oct.		*3*	
	Landolphia owariensis P.Beauv.	lilolo (u) liyo (w,o)	336, 984 228, 272	fruit	raw	fruit	July – Oct.	xxx	(12)	X
	Landolphia villosa J.G.M.Pers.	libii (u) lilombo (w) inono (w)	293, 991	fruit	raw	fruit	July – Oct.	xx	5	
	Landolphia sp1	ngilaseka (u,w)	327	fruit	raw	fruit	July – Oct.	x	5	
	Saba comorensis (Bojer ex A.DC.) Pichon	lilombo (u,o) libii (w)	240 303	fruit	raw	fruit	July – Oct.	xx	(5)	
Araceae	*Anchomanes giganteus* Engl.	likondoyaolimo (o)	222	young sprouts	cooked	vegetable	permanent		*1*	
	Colocasia esculenta (L.) Schott	maniango (o)		tubers	cooked	starch	permanent	x	*1*	
	Xanthosoma sagittifolium (L.) Schott	yopho (o)		- tubers - leaves	cooked cooked	starch leafy vegetable	permanent	x	*2*	

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
Arecaceae	*Laccosperma secundiflorum* (P.Beauv.) Kuntze	(boloke bo) likawu (u,o)	229, 319	leaf button	cooked	vegetable	permanent		5	X
	Raphia sese De Wild.	ikolo, fande (u)	312	- fruit - tree sap	cooked raw	fruit beverage (palm wine)	permanent		*6*	
Asteraceae	*Crassocephalum crepidioides* (Benth.) S.Moore	limbiti (u,w,o)	20, 332	leaves	cooked	leafy vegetable	permanent	x	(4)	
Burseraceae	*Canarium schweinfurthii* Engl.	bobele, ibele (u,w,o)	232	fruit	cooked	fruit	July – Oct.	xx	(9)	X
	Dacryodes osika (Guillaumin) H.J.Lam.	ibele sawu, isawusawu (u,w,o)	239	fruit	- cooked - roasted	fruit fruit	July – Oct.	xx	(5)	
Clusiaceae	*Mammea africana* Sabine	boliti (o)	244	fruit	raw	fruit	July – Oct.		*2*	X
Costaceae	*Costus lucanusianus* J.Braun & K.Schum.	bokako (bobaye) (u,w,o)	13, 224, 266, 309	- stem - flower	raw raw	fruit fruit	permanent July – Oct.		(12)	X
Dennsteadtiaceae (pteridophyta)	*Pteridium aquilinum* (L.) Kuhn	lilele (o)	205	immature fronds	cooked	condiment	permanent		*4*	
Dichapetalaceae	*Dichapetalum mombuttense* Engl.	ekpalanganga (u,o) lisungulingba/lisunguliteti (w,o)	11, 17, 311 211, 267	fruit	raw	fruit	permanent		(5)	X
Dioscoreaceae	*Dioscorea alata* L.	lengu (o) ilumbelumbe (w)	243	tubers	cooked	starch	permanent	xx	2	
	Dioscorea baya De Wild.	ikuse (u,w,o)	989, 1000	tubers	cooked	starch	permanent	xx	(3)	
	Dioscorea dumetorum (Kunth) Pax	elenge (u) yayii (w,o)	119 290	tubers	cooked	starch	permanent	xxx	(3)	
	Dioscorea liebrechtsiana De Wild. & T.Durand	bosondi (u,w,o)	330, 996, 1004	tubers	cooked	starch	permanent	xxx	(3)	
	Dioscorea minutiflora Engl.	ikeke (u,w,o)	18, 121, 216, 277, 310, 987, 999	tubers	cooked	starch	permanent	xx	(3)	
Euphorbiaceae	*Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg.	liondje (u,w,o)	16, 23, 213, 297	dry leaves	cooked	decoction (tea subst.)	permanent		(9)	

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
	Erythrococca atrovirens (Pax) Prain var. *flaccida* (Pax) Radcl.-Sm.	likile (w,o)	241	leaves	cooked	leafy vegetable	permanent		5	
	Euphorbia hirta L.	ngotoindika (o)	226	flower	raw	fruit	permanent		*3*	
	Tetracarpidium conophorum (Müll.Arg.) Hutch. & Dalziel	botito, tito (u,w,o)	262, 338	seeds	- cooked - roasted	nut nut	July – Oct.	xxx	(4)	X
Fabaceae (Caesalpinioideae)	*Gilbertiodendron dewevrei* (De Wild.) J.Léonard	mbolu, lofete (u,w,o)	118, 245, 269, 317	seeds	cooked	starch	July – Oct.		(15)	
	Scorodophleus zenkeri Harms	bofili (u,w,o)	259, 283, 315	- young leaves	cooked	- leafy vegetable - condiment	permanent	xxx	(10)	X
				- bark	cooked	condiment	permanent			
Fabaceae (Papilionoideae)	*Desmodium setigerum* (E.Mey.) Benth. ex Harv.	ikpesaamuku (o)	217	roots	raw	fruit	permanent		*2*	
	Dewevrea bilabiata Micheli	lofembembo (u,o)	201,319	young leaves	cooked	condiment	permanent		2	X
Gnetaceae	*Gnetum africanum* Welw.	fumbwa (u,w,o)	247	leaves	cooked	leafy vegetable	permanent	xxx	(5)	
Huaceae	*Hua gabonii* Pierre ex De Wild.	lofiongi (u,w) longowu (w,o)	248, 276, 318	- young leaves	cooked	- leafy vegetable - condiment	permanent	xx	(9)	X
				- bark - fruits	cooked cooked	condiment condiment				
Irvingiaceae	*Irvingia smithii* Hook.f.	bosombo (w,o)	255, 301	- seed - fruit	raw raw	nut fruit	June – Oct.		5	
Malvaceae	*Cola acuminata* (P. Beauv.) Schott. & Endl.	angbongbo(lia) (u,w,o)	261, 265, 326	seeds	raw	nut	July – Oct.	xxx	(10)	X
	Cola bruneelii De Wild.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	24, 123, 236, 306	- fruit - leaves	raw cooked	fruit leafy vegetable	permanent permanent		(10)	X
	Cola congolana De Wild. & T.Durand	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	4, 289	fruit	raw	fruit	permanent		(8)	
	Cola marsupium K.Schum.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	204	fruit	raw	fruit	permanent		(8)	
	Cola urceolata K.Schum	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	124, 194	fruit	raw	fruit	permanent		(8)	

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
	Hibiscus acetosella Welw. ex Hiern	damudamu (u)	335	leaves	cooked	decoction (tea subst.)	permanent		*3*	
Marantaceae	*Megaphrynium macrostachyum* (Benth.) Milne-Redh.	(bolokebo)likongo, beye (u,w,o)	275, 323	leaf buds	cooked	vegetable	permanent	xx	(12)	X
	Trachyphrynium braunianum (K. Schum.) Baker	ikokombeshalia, bolikabwalima (w) ikokombeibaye (o)	281 223	seeds	raw	fruit	permanent		4	
Melastomataceae	*Tristemma mauritianum* J.F.Gmel.	lituma lilokonda (u,w,o)	1, 214, 286	fruit	raw	fruit	permanent		(6)	X
Menispermaceae	*Chasmanthera welwitschii* Troupin	ndénde (u) tongatobolondi (w)	331	fruit	raw	fruit	June – Sept.		2	X
	Penianthus longifolius Miers	lokumbo (o)	200	fruit	raw	fruit	permanent		*3*	
Moraceae	*Musanga cecropioides* R.Br. ex Tedlie	bokombo (o)	221	young sprouts	cooked	vegetable	permanent		*3*	
	Treculia africana Decne. ssp. *africana* var. *africana*	bombimbo, limbimbo (u,w,o)	203, 296, 325	seeds	roasted	- nut - condiment	permanent		(3)	X
Pandaceae	*Panda oleosa* Pierre	bakale (u,w,o)	2, 199, 285	seeds	- raw - roasted	nut - nut - condiment	permanent[†]	xx	(5)	X
Passifloraceae	*Passiflora foetida* L.	maveve (u,w,o)	225, 292, 314	fruit	raw	fruit	permanent		(4)	X
Pentadiplandraceae	*Pentadiplandra brazzeana* Baill.	etekele, amelalokulu (u,w,o)	210, 282, 307	fruit	raw	fruit	permanent	xxx[‡]	(15)	X
Phyllantaceae	*Hymenocardia ulmoides* Oliv.	bokelele(w,o)	227, 280	young leaves	cooked	decoction (tea subst.)	permanent		8	
Phytolaccaceae	*Hilleria latifolia* (Lam.) H.Walter	lokobo (u,w,o)	14, 256, 300, 333	leaves	cooked	leafy vegetable	permanent		(6)	X
	Phytolacca dodecandra L'Hér.	lisingo (u,w,o)	322	leaves	cooked	leafy vegetable	permanent		(4)	X
Piperaceae	*Peperomia pellucida* (L.) Kunth	lombaye lolitoko (u)	120	leaves	cooked	leafy vegetable	permanent		*1*	

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
	Piper guineense Schumach. & Thonn.	iketu (u,w,o)	19, 233, 273, 321	- leaves	cooked	decoction (tea subst.)	permanent	xxx	(12)	X
				- liana	cooked	decoction (tea subst.)	permanent			
				- fruits	raw	condiment	July – Jan.			
Polygalaceae	*Carpolobia alba* G.Don	lokembia (w,o)	288	roots	- raw - roasted	strenghtener strenghtener	permanent	xx	2	X
Portulacaceae	*Talinum triangulare* (Jacq.) Willd.	melelu (u) sese (w,o)	8, 313 219	leaves	cooked	leafy vegetable	permanent	x	(5)	X
Rubiaceae	*Sabicea johnstonii* K.Schum. ex Wernham	damudamu (o)	230	fruit	raw	fruit	permanent		*2*	
	Sherbournia bignoniiflora (Welw.) Hua	losabola (u,w,o)	212, 264, 305	- fruit - leaves	raw cooked	fruit decoction (tea subst.)	permanent permanent		(7)	X
Rutaceae	*Zanthoxylum macrophyllum* Nutt. var *preussii* Engl.	bolongo (o)	258	bark	cooked	decoction (tea subst.)	permanent		*5*	
Sapindaceae	*Chytranthus macrobotrys* (Gilg) Exell & Mendonça	botokolo, tokolo (u,w,o)	246, 329	seeds	cooked	nut	July – Oct.	x	(3)	
	Pancovia laurentii (De Wild.) Gilg ex De Wild.	botende, ntende (u,w,o)	260, 1002	fruit	raw	fruit	July – Oct.	x	(5)	
Sapotaceae	*Chrysophyllum lacourtianum* De Wild.	bolinda, lilinda (u,w,o)	207, 291, 334	fruit	raw	fruit	July – Oct.	xxx	(6)	X
	Synsepalum brevipes (Baker) T.D.Penn.	bokokolo, ikokolo (w,o)	254	fruit	raw	fruit	June – Aug.	xx	3	X
	Synsepalum stipulatum (Radlk.) Engl.	bonga, tonga (u,w,o)	9, 21,251, 287, 324	fruit	raw	fruit	April - July	xxx	(4)	X
Scrophulariaceae	*Bacopa* sp.	ingawungawu (w)	295, 995	leaves	cooked	decoction (tea subst.)	permanent		*1*	
Smilacaceae	*Smilax anceps* Willd.	likako (u,w,o)	252, 294, 988, 1005	tubers	cooked	starch	permanent	xx	(4)	
Solanaceae	*Capsicum frutescens* L.	mbase ikukunde (w,o)	220, 274	fruit	raw	condiment	permanent	xx	7	X

Botanical family	Scientific name	Vernacular name[1]	Herbarium reference (PAS)[2]	Plant part(s) used as food[3]	Raw or cooked[3]	Specific use[3]	Availability	Trade[4]	Total number of use citations [5]	Liengola 2001
	Solanum distichum Schumach. & Thonn.[#]	ikalu (w,o)	206, 278, 992	fruit	cooked	decoction (tea subst.)	permanent		2	
	Solanum aethiopicum L. "gilo group"	losuke (w,o)	994	fruit	cooked	- vegetable - condiment	permanent permanent	x	5	X
Tiliaceae	*Desplatsia dewevrei* (De Wild. & T.Durand) Burret	bokomba, likamba (u) lisuli (w,o)	257, 271	seeds	raw	nut	permanent		(8)	X
Urticaceae	*Myrianthus arboreus* P.Beauv.	bongunguna (u) bohuma (w,o)	304 209, 298	fruit	raw	fruit	July – Oct.	xx	(6)	X
	Myrianthus preussii Engl.	bohuma bolukund (w) bohuma petit (o)	990 238	fruit	raw	fruit	June – Sept.		1	
	Urera thonneri De Wild. & T.Durand	likile (u)	22, 985	leaves	cooked	leafy vegetable	permanent		*1*	
Verbenaceae	*Vitex congolensis* De Wild. & T.Durand	ebite (o)	242	leaves	cooked	decoction (tea subst.)	permanent		*3*	
Vitaceae	*Cissus dinklagei* Gilg & M.Brandt	wese (o)	202	stem sap	raw	beverage (water subst.)	permanent		*1*	
	Cyphostemma adenocaule (Steud. ex A.Rich.) Desc. ex Wild & R.B.Drumm.	bombeye (o)	215	whole plant	cooked	decoction (tea subst.)	permanent		*3*	
Zingiberaceae	*Aframomum laurentii* (De Wild. & T.Durand) K.Schum.	bongongoo, soso (u,w,o)	5, 234, 268, 308	fruit	raw	fruit	permanent	x	(7)	X

[1] (u), (w), (o) vernacular name(s) under which the plant species is known and used in Yalungu, Yasekwe and Yaoseko, respectively. All vernacular names have their corresponding plurals by changing the prefixes, e.g. 'ikeke' becomes 'tokeke', 'liyo' becomes 'ayo', etc.

[2] Vouchers are stored following the reference format: PAS followed by the respective numbers; PAS 1 – 25, PAS 118 – 124, PAS 304 – 338 and PAS 984 – 985 have been collected by the author in Yalungu; PAS 264 – 303 and PAS 986 – 996 have been collected by the author in Yasekwe; PAS 194 – 263 and PAS 997 – 1007 have been collected by the author in Yaoseko

[3] When more than 1 plant part is used per plant species, these are separated with dashes, idem for more than one preparation method per plant part used and more than one specific use per preparation method.

[4] x = species traded in 1 village, xx = species traded in 2 villages, xxx = species traded in the 3 villages

[5] *numbers in brackets*: total number of use citations recorded in all 3 villages; *numbers underlined*: total number of use citations recorded in the 2 villages where the species has at least one food use; *numbers in italic*: total number of uses cited in the only village where the species has at least one food use. The numbers between brackets can only be compared to other numbers between brackets. Idem for the numbers underlined and those in italic.

° Period not known by the focus group members, but appears two times a year

† Fruits mature between June and Oct., they rot the whole year round on the ground and can be gathered at any time of the year. The more the fruit flesh is rotten, the easier the access to the kernel.

‡ It are not the edible fruits of *Pentadiplandra brazzeana* that are commercialized, but the roots for medicinal purposes.

[#] The non-prickly, semi-domesticated *Solanum distichum* may well be treated as a cultivar group of the prickly wild progenitor *Solanum anguivi* Lam. (Lester and Seck 2004).

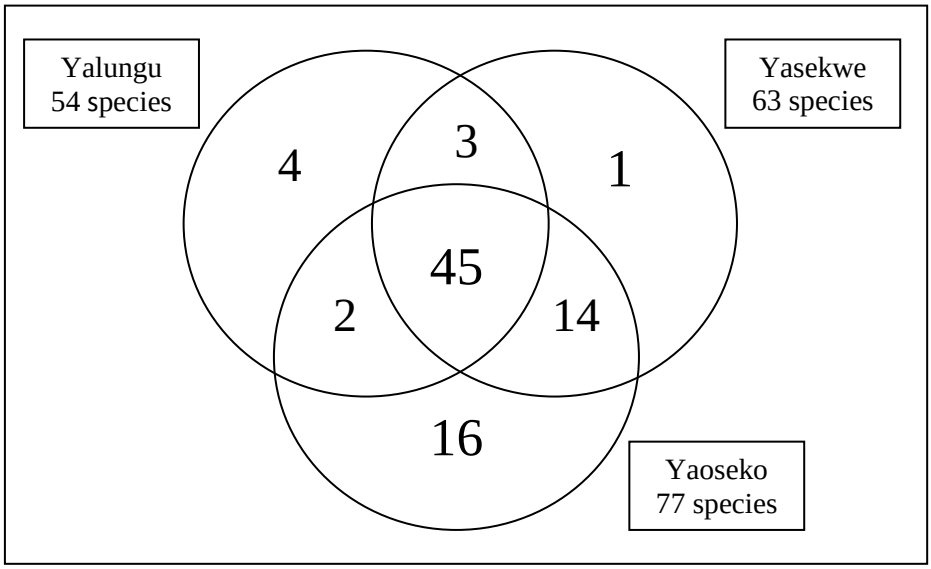

Figure 4.2: Number of WEP species known in all three Turumbu villages surveyed (inner circle), and in only two or one village (outer circle segments); behind each village name, the total number of species identified in this village is given.

Plant parts used

Table 4.2 shows that most WEPs are used for their fruits (38), followed by leaves (23), seeds (10) and tubers (8). Some WEPs have several plant parts used for food, e.g. fruits of *Cola bruneelii* are eaten raw, whereas leaves are prepared as leafy vegetables.

Specific food uses

The 96 plant parts mentioned can be employed raw or prepared as 106 different specific food uses (table 4.3), with fruit uses being most important, followed by leafy vegetable uses. The categories of specific food uses presented in table 4.1 and 4.2 were based on the level 3 descriptors for foods called *food types* by Cook (1996). Other categories such as tea substitutes, water substitutes, palm wines and strengthener/stimulants, which fell under the '*other food type'* category in Cook (1996) were added to the food descriptors list to better comply with folk perceptions and field realities.

Preparation methods

Leafy vegetables are prepared in 3 different ways. The traditional method consists of wrapping them in leaves of species from the Marantaceae family and to put this package above boiling cassava in the cooking pot until ready (steaming). Another, similar method is to wrap the vegetables in Marantaceous leaves and put the package close to the fire until done. According to one's own specific taste, salt or chili pepper can be added before consumption.

However, the most frequent practice consists of chopping and boiling the vegetables, discarding (or not) the boiling water, adding palm oil, fish or meat, salt, chili pepper or other condiments and let the whole mixture simmer.

Table 4.2: WEP parts used by the Turumbu, Isangi Territory, DRC

Plant parts used	Number of species
fruits	38
leaves	23
seeds	10
tubers	8
stem & stem sap	4
bark	3
leaf buds	2
young sprouts	2
flowers	2
roots	2
immature fronds	1
whole plant	1
TOTAL	**96**

Table 4.3: Specific uses of WEPs known by the Turumbu, Isangi Territory, DRC

Specific use	Number of species
fruit	39
leafy vegetables	15
condiment	13
tea substitute	11
nut	10
starch	9
other vegetables	5
strenghtener	2
water substitute	1
palm wine	1
TOTAL	**106**

Seeds of *Antrocaryon nannanii*, *Treculia africana* and *Panda oleosa* are eaten as a snack (nut) or pounded into a paste to season dishes. Seeds of *A. nannanii* are consumed raw; those of *P. oleosa* can be eaten raw or roasted, but need to be roasted before processing them into a paste. Seeds of *T. africana* are always roasted. The hard shell is removed prior to consumption or preparation into a condiment paste.

Seeds of *Tetracarpidium conophorum* (conophor nut) are boiled (rarely roasted) to reduce bitterness. When water is drunk within one hour after consumption, one experiences a very bitter sensation in the mouth. Some people claim that the raw nuts are poisonous.

Fruits of *Dacryodes osika* and *Canarium schweinfurthii* are dropped in hot, non-boiling water for ten minutes, in a similar way as their 'cultivated' counterpart 'safou,' *Dacryodes edulis.*

Figure 4.3: Wild edible nuts: *Tetracarpidium conophorum* (above); *Panda oleosa* (middle); *Treculia africana* (below)

Young leaves, bark or fruits of *Scorodophleus zenkeri* and *Hua gaboni* are used as a substitute for onion and/or garlic to season the dishes. Both species, called 'tropical garlic trees', are highly appreciated by the Turumbu. Leaves of *S. zenkeri* are also prepared as a leafy vegetable.

Roots of *Carpolobia alba* are chewed either raw or roasted for the purpose of restoring strength, for example, during intensive labour.

Seeds of *Gilbertiodendron dewevrei* are used as a hunger food, if no other staple foods are available anymore. Seeds are boiled, peeled and grated into a flour to prepare a paste wrapped in Marantaceous leaves like '*chikwangue*' (made of cassava). According to the information gathered, their last use dates back to the Simba rebellion in 1964. With the 1960 war of

independence and the following civil wars in Congo, people fled and subsisted on whatever they found in the forest as they were unable to access cultivated foods.

Dioscorea tubers are a good source of dietary starch, but care should be taken before consuming them. Some *Dioscorea* spp. are extremely poisonous and species are morphologically very similar. Informants warned that tuber toxicity sometimes depends on development stage. In Yalungu, for instance, informants mentioned the following for 'elenge' (*D. dumetorum*): '*When leaves start to dry, the tuber is edible; when leaves are totally dry and start to fall, the tuber is a poison and you will die*'.

Seasonality

Most fruits are available from July till October, while tubers and (leafy) vegetables are available the whole year round (table 4.1).

Trade

Although sometimes rather occasionally, almost half of the WEPs known by the Turumbu (47%) can be sold locally within the village or to passing travellers (table 4.1). During a preliminary market survey (September – October 2007), 14 of these species were recorded on the markets of Kisangani (Everaert 2008).

Non-food uses of WEPs

Besides being known as food, 64 of the 85 WEPs have one or more other uses: 44 plants have medicinal values; 22 species have uses in the category technology, materials and arts; 19 species have cultural values; 9 species are used as fuels, 8 species for house construction, 5 species as bait, 4 species as fodder, whereas 3 species are used as poison (table 4.4).

The total number of use citations per plant species (food uses included) is shown in the penultimate column of table 4.1. *Gilbertiodendron dewevrei* and *Pentadiplandra brazzeana* show the highest number of use citations (15), followed by *Anonidium mannii*, *Clitandra cymulosa*, *Landolphia owariensis*, *Costus lucanosianus*, *Megaphrynium macrostachyum* and *Piper guineense*, each with 12 use citations.

Table 4.4: Non-food uses of the WEPs known by the Turumbu, Isangi Territory, DRC

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
Achariaceae	*Caloncoba subtomentosa* Gilg	lisende (o)	construction fodder	branches: building poles (o) host tree for edible caterpillars (o)
Amaranthaceae	*Amaranthus dubius* Mart. ex Thell.	ngbelengbele (o) lonenge (w,o)	cultural fodder	leaves: chasing bad spirits/witches (o,w), ancestral benediction (o) pig feed (o)
Anacardiaceae	*Antrocaryon nannanii* De Wild.	bokongo, kongo (u,w,o)	fuels	firewood (w)
Annonaceae	*Anonidium mannii* (Oliv.) Engl. & Diels	anguto (u,w,o)	medicinal cultural	bark: snake bite (o,u), eye injuries (o), foot wounds (o,u), post-partum pain and bleeding (w,u), lumbago (u) bark: ancestral judgement of guilt (u)
Apocynaceae	*Clitandra cymulosa* Benth.	inono (u,w,o)	medicinal tech & mat bait	latex: intestinal worms (o) latex: making balls (o,w,u), ngong handles (o), repair flat tyres (o,w,u) fruit: bait for apes (u)
	Landolphia foretiana (Pierre ex Jum.) Pichon	lingbotoma (o)	tech & mat	latex: making balls (o), repair flat tyres (o)
	Landolphia owariensis P.Beauv.	lilolo (u) liyo (w,o)	tech & mat bait	latex: making balls (o,w,u), ngong handles (o,w), repair flat tyres (o,w,u) fruit: bait for apes (u)
	Landolphia villosa J.G.M.Pers.	libii (u) lilombo (w) Inono (w)	tech & mat bait	latex: making balls (u), repair flat tyres (u) fruit: bait for apes (u)
	Landolphia sp1	ngilaseka (u,w)	tech & mat bait	latex: making balls (w), repair flat tyres (w) fruit: bait for apes (u)
	Saba comorensis (Bojer ex A.DC.) Pichon	lilombo (u,o) libii (w)	medicinal	roots: gonorrhoea (o) fruit juice: haemorrhoids (o)
Arecaceae	*Laccosperma secundiflorum* (P.Beauv.) Kuntze	(boloke bo) likawu (u,o)	medicinal tech & mat construction	leaves: snake bite (o) liana: mats (o,u), beds (u), fish fykes (o) leaves: roof thatching (u)
	Raphia sese De Wild.	ikolo, fande (u)	tech & mat construction fodder	leaf veins: brooms (u) palm leaves: local/temporary beds in forest (u) palm leaves: roof thatching (u) host tree for edible larvae (u)
Asteraceae	*Crassocephalum crepidioides* (Benth.) S.Moore	limbiti (u,w,o)	cultural	*'bolenge'* reduce female domination (love charm) (u)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
Burseraceae	*Canarium schweinfurthii* Engl.	bobele, ibele (u,w,o)	medicinal tech & mat cultural fuels	bark: back ache (o) varnish (w) resin: smoke to chase bad spirits (u) resin: candles (o,w,u)
	Dacryodes osika (Guillaumin) H.J.Lam.	ibele sawu, isawusawu (u,w,o)	fuels	firewood (w,u)
Clusiaceae	*Mammea africana* Sabine	boliti (o)	cultural	stimulate children to start to walk (o)
Costaceae	*Costus lucanusianus* J.Braun & K.Schum.	bokako (bobaye) (u,w,o)	medicinal tech & mat cultural	stem sap: measles (o,w), injuries (w), syrup to add to other medicinal products (u) young plant: antidote (o) leaf sap: amoeba (o) bark: ropes for transporting firewood (w) eating young leaves: problem solving (o)
Dennsteadtiaceae (pteridophyta)	*Pteridium aquilinum* (L.) Kuhn	lilele (o)	medicinal tech & mat	young leaves: eye injuries (o) young buds: remove thorns in feet (o) whole plant: conservation of fish (o)
Dichapetalaceae	*Dichapetalum mombuttense* Engl.	ekpalanganga (u,o) lisungulingba/lisunguliteti (w,o)	medicinal tech & mat	fruit juice: back ache (u) branches: traps (w)
Euphorbiaceae	*Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg.	liondje (u,w,o)	medicinal cultural bait	young leaves: dental caries (o) leaves: anaemia (u) leaves: wound healing after circumcision (u) fruits: bait/poison for fish (w,u) and birds (u)
	Erythrococca atrovirens (Pax) Prain var. *flaccida* (Pax) Radcl.-Sm.	likile (w,o)	medicinal	leaves: bruises (o), eye injuries (w) bark: eye injuries (w)
	Euphorbia hirta L.	ngotoindika (o)	medicinal	whole plant: amoeba (o), intestinal worms (o)
	Tetracarpidium conophorum (Müll.Arg.) Hutch. & Dalziel	botito, tito (u,w,o)	cultural	children put nut peel on forehead to play/for beauty (u)
Fabaceae (Caesalpinioideae)	*Gilbertiodendron dewevrei* (De Wild.) J.Léonard	mbolu, lofete (u,w,o)	medicinal tech & mat cultural fuels construction	bark: back ache (u) bark: 'sombotiti' local (temporary) mortar (w, o) trunk: mortar (o) seeds: children's toy (u) bark: for good health and smooth skin of newborn (o) firewood (w) wood: boards (w,o,u) leaves: roof thatching (o,u)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
	Scorodophleus zenkeri Harms	bofili (u,w,o)	medicinal poison	bark: hernia (u), filariasis (u), ascaris (= roundworm infection) (u) fish poison (o)
Fabaceae (Papilionoideae)	*Desmodium setigerum* (E.Mey.) Benth. ex Harv.	ikpesaamuku (o)	cultural	root: luck charm for winning e.g. foot match (o)
Gnetaceae	*Gnetum africanum* Welw.	fumbwa (u,w,o)	medicinal	leaves: cholera (o) leaves/liana: diarrhoea (o)
Huaceae	*Hua gabonii* Pierre ex De Wild.	lofiongi (u,w) longowu (w,o)	medicinal cultural poison	fruit juice: amoeba (o) leaves: cataract (u) leaves: stimulating dogs for good hunting (u) fruit/bark: fish poison (o)
Irvingiaceae	*Irvingia smithii* Hook.f.	bosombo (w,o)	medicinal	root: strenghtener (o) bark: back ache (o), intestinal worms (w)
Malvaceae	*Cola acuminata* (P. Beauv.) Schott. & Endl.	angbongbo(lia) (u,w,o)	medicinal cultural	seeds: male potency (o,u), hernia (o) seeds: luck charm (o,w,u); solving problems (u)
	Cola bruneelii De Wild.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	medicinal tech & mat	roots: joint problems, rheumatism (o,u) leaves: stimulating maternal milk production (o) branch: children's toy (gun) (o)
	Cola congolana De Wild. & T.Durand	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	medicinal tech & mat	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o) branch: children's toy (gun) (o)
	Cola marsupium K.Schum.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	medicinal tech & mat	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o) branch: children's toy (gun) (o)
	Cola urceolata K.Schum	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o)	medicinal tech & mat	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o) branch: children's toy (gun) (o)
	Hibiscus acetosella Welw. ex Hiern	damudamu (u)	medicinal cultural	leaves: anaemia (u) leaves: red decoction water serves as symbol of Christ's blood in church (u)
Marantaceae	*Megaphrynium macrostachyum* (Benth.) Milne-Redh.	(bolokebo)likongo, beye (u,w,o)	tech & mat construction	leaves: packing material, plates (o,w,u) stems: mats, beds (o,w,u) leaves: roof tatching (o,w,u)
	Trachyphrynium braunianum (K. Schum.) Baker	ikokombeshalia, bolikabwalima (w), ikokombeibaye (o)	tech & mat cultural	leaves: packing bait (o) stems: good luck for fishermen (w)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
Melastomataceae	*Tristemma mauritianum* J.F.Gmel.	lituma lilokonda (u,w, o)	medicinal cultural	leaves: intestinal worms (o) fruit: avoiding snake bites (o, u)
Menispermaceae	*Penianthus longifolius* Miers	lokumbo (o)	medicinal tech & mat	root: back ache (o), male potency leaves: shooter on bows to direct arrows (o)
Moraceae	*Musanga cecropioides* R.Br. ex Tedlie	bokombo (o)	tech & mat	trunk: beds (o), canoes (o)
Pandaceae	*Panda oleosa* Pierre	bakale (u,w,o)	medicinal	fruit: eye injury (o) bark: buboes (= inflammation of lymph nodes due to an STI (sexually transmitted infection) or bubonic plague) (u)
Passifloraceae	*Passiflora foetida* L.	maveve (u,w,o)	medicinal	measles (o)
Pentadiplandraceae	*Pentadiplandra brazzeana* Baill.	etekele, amelalokulu (u,w,o)	medicinal poison	root: back ache, lumbago (o,w,u) malaria (o), shingles (o), warm abscess (o), gonorrhea (u), dental caries (u), measles (u), scabies of dogs (u) bark: fish poison (o,u)
Phyllantaceae	*Hymenocardia ulmoides* Oliv.	bokelele(w,o)	medicinal fuels construction	bark: snake bite (o) leaf decoction: stimulating maternal milk production (o) firewood (w), charcoal (w) branch: piles houses/fences (o,w)
Phytolaccaceae	*Hilleria latifolia* (Lam.) H.Walter	lokobo (u,w,o)	medicinal	leaves: asthma (o), swellings (o), felon (whitlow) (u)
	Phytolacca dodecandra L'Hér.	lisingo (u,w,o)	medicinal	stem: dental caries (u)
Piperaceae	*Piper guineense* Schumach. & Thonn.	iketu (u,w,o)	medicinal	leave decoction: back ache (o,w), cough (o) roots: general pain (w) fruits: cough (w) liana/fruits: back and thorax ache (u)
Polygalaceae	*Carpolobia alba* G.Don	lokembia (w,o)	medicinal	roots: male potency (o)
Portulacaceae	*Talinum triangulare* (Jacq.) Willd.	melelu (u) sese (w,o)	medicinal fodder	leaves: thorns in feet (o) pig feed (u)
Rubiaceae	*Sabicea johnstonii* K.Schum. ex Wernham	damudamu (o)	medicinal	fruit: anaemia (o)
	Sherbournia bignoniiflora (Welw.) Hua	losabola (u,w,o)	medicinal cultural	leaves: gastritis (u) roots: cough (u) leaves: reduce female domination (love charm) (o)
Rutaceae	*Zanthoxylum macrophyllum* Nutt. var *preussii* Engl.	bolongo (o)	medicinal	bark decoction: back ache (o), malaria (o), cough (o), general weakness (o)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
Sapindaceae	*Pancovia laurentii* (De Wild.) Gilg ex De Wild.	botende, ntende (u,w,o)	tech & mat fuels	latex: making balls for children (o) firewood (w)
Sapotaceae	*Chrysophyllum lacourtianum* De Wild.	bolinda, lilinda (u,w,o)	medicinal fuels construction	bark: stimulating maternal milk production (u) firewood (w) trunk: house piles (w)
	Synsepalum brevipes (Baker) T.D.Penn.	bokokolo, ikokolo (w,o)	medicinal	bark: back ache (o)
	Synsepalum stipulatum (Radlk.) Engl.	bonga, tonga (u,w,o)	fuels	firewood (w)
Smilacaceae	*Smilax anceps* Willd.	likako (u,w,o)	cultural	liana around house protects against nightmares (o)
Solanaceae	*Capsicum frutescens* L.	mbase ikukunde (w,o)	medicinal	leaves: abscess (o), felon (whitlow) (o), otitis (o) fruit: constipation (o), post-partum pain (w)
	Solanum aethiopicum L. "gilo group"	losuke (w,o)	medicinal	fruit: anti-poison (o) roots: to close fontanel of newborns (o)
Tiliaceae	*Desplatsia dewevrei* (De Wild. & T.Durand) Burret	bokomba, likamba (u) lisuli (w,o)	tech & mat cultural	bark: basketry (u) fruit: protect fishermen (w), drive away hippopotamus (u), chasing mosquitoes (o), permits pregnant women to enter tomato fields (o)
Urticaceae	*Myrianthus arboreus* P.Beauv.	bongunguna (u) bohuma (w,o)	medicinal cultural fuels	leaves: antidote (o) bark: anti-domination product (o) firewood (w)
Verbenaceae	*Vitex congolensis* De Wild. & T.Durand	ebite (o)	medicinal construction	leaves: tuberculosis (o) building poles, fence posts (o)
Vitaceae	*Cyphostemma adenocaule* (Steud. ex A.Rich.) Desc. ex Wild & R.B.Drumm.	bombeye (o)	medicinal	leaves: head ache (o) roots: abscess (o)
Zingiberaceae	*Aframomum laurentii* (De Wild. & T.Durand) K.Schum	bongongoo, soso (u,w,o)	medicinal	fruit: filariasis (o), syrup to add to other medicinal products (u) fruit pulp: general pain (w)

[1] (u), (w), (o) vernacular name(s) under which the plant species is known and used in Yalungu, Yasekwe and Yaoseko, respectively
[2] (u), (w), (o) other use registrated in Yalungu, Yasekwe and Yaoseko, respectively

Participatory ranking

The aggregated results of the ranking exercises are shown in tables 4.5 and 4.6. Only species which appeared more than once in the top three for at least one characteristic are included in the tables.

In the fruit category, *Anonidium manni* scores best on each characteristic and ranks first in the weighted global ranking. *Landolphia owariensis* ranks second in the weighted global ranking and scores best (together with *A. mannii*) on taste and economic value. In the vegetables category, *Talinum triangulare* scores best on taste and nutritional value, *Megaphrynium macrostachyum* on economic and nutritional value, and *Hua gaboni* on socio-cultural value. In the global weighted ranking, *M. macrostachyum* preceeds *T. triangulare*.

Surprisingly, the ranking exercises with men and women in the same village do not show great differences. Differences seem much higher between villages, although this could not be tested statistically.

Besides their food uses, 'preferred' species have also many other properties and can thus be seen as 'multi-purpose' species (table 4.4).

Table 4.5: Aggregated results of the 6 participatory ranking exercises for fruits performed by men and women apart in Yalungu, Yasekwe and Yaoseko, Isangi Territory, DRC

Fruits	Taste	Economic Value	Socio-cultural value	Nutritional value	Global weighted ranking
Aframomum laurentii	0	1	2	0	0
Anonidium mannii	**4**	**5**	**4**	**6**	**6**
Chrysophyllum lacourtianum	0	3	1	4	2
Landolphia owariensis	**4**	**5**	0	3	4
Pentadiplandra brazzeana	3	1	2	0	1
Synsepalum stipulatum	3	1	1	0	0
Tetracarpidium conophorum	2	2	0	3	2

Note: Numbers represent number of times a plant species appeared in the top three for the different characteristics (taste, economic value, socio-cultural value or nutritional value) and in the global weighted ranking; maximum = 6 (in top three of all ranking exercises performed by men and women in Yalungu, Yasekwe and Yaoseko), minimum = 0 (not in top three of any ranking exercise); in bold = highest score obtained per categorie and for the global weighted ranking

Figure 4.4: *Anonidium mannii* (anguto) tree and fruits; above right: children selling pieces of the fruit along the roadside

Table 4.6: Aggregated results of the 6 participatory ranking exercises for vegetables performed by men and women apart in Yalungu, Yasekwe and Yaoseko, Isangi Territory, DRC

Vegetables	Taste	Economic Value	Socio-cultural value	Nutritional value	Global weighted ranking
Celosia spp.	3	1	0	4	2
Crassocephalum crepidioides	0	0	2	1	0
Gnetum africanum	0	2	1	0	2
Hilleria latifolia	0	0	2	0	0
Hua gaboni	5	4	**5**	1	2
Megaphrynium macrostachyum	4	**6**	2	**6**	**6**
Scorodophloeus zenkeri	1	4	4	1	1
Talinum triangulare	**6**	2	0	**6**	**4**

Note: Numbers represent number of times a plant species appeared in the top three for the different characteristics (taste, economic value, socio-cultural value or nutritional value) and in the global weighted ranking; maximum = 6 (in top three of all ranking exercises performed by men and women in Yalungu, Yasekwe and Yaoseko), minimum = 0 (not in top three of any ranking exercise); in bold = highest score obtained per categorie and for the global weighted ranking

Figure 4.5: Wild vegetables highly appreciated by the Turumbu, *Megahrynium macrostachyum* (above) and *Talinum triangulare* (below)

4.4. Discussion

Turumbu WEP knowledge

Compared to the inventory results of Bokdam and Droogers (1975), Bola and Szafranski (1991), Liengola (2001), Mosango and Isosi (1998), Mosango and Szafranski (1985), Nyakabwa et al. (1990) and Kawukpa and Angoyo (1994), 18 species were cited for the first time as WEP in the region: *Celosia leptostachya*, *Dictyophleba lucida*, *Landolphia villosa*, *Raphia sese*, *Crassocephalum crepidioides*, *Dioscorea alata*, *D. liebrechtsiana*, *Alchornea cordifolia*, *Desmodium setigerum*, *Cola congolana*, *Penianthus longifolius*, *Musanga cecropioides*, *Zanthoxylum macrophyllum*, *Pancovia laurentii*, *Bacopa* sp., *Smilax anceps*, *Vitex congolensis* and *Cissus dinklagei*.

The only author (Liengola 2001) who did ethnobotanical research within the '*Collectivité Turumbu*', interviewed 31 individual informants and registered 58 WEPs. The present study confirmed the food use of 37 of these species (table 4.1), whereas 14 species[1] were not found in our study. For 7 species[2], identical vernacular names correspond to different scientific species names in our study. Whether this is due to identification differences or under-differentiation of the local plant classification system, could not be checked because herbarium references are lacking in Liengola (2001).

With respect to indigenous knowledge on plant uses, Turumbu agriculturalists can be considered as quite interesting. They know far more WEPs (85) than Ngandu (69) or Boyela (50) agriculturalists (both Bantou groups of the Equator Province, DRC; Takeda 1990; Takeda and Sato 1993), and slightly less than the Mbuti (84) or Efe (92) hunter-gatherers (both Pygmies of the Ituri forest, DRC; Terashima and Ichakawa 2003). This is surprising, because Pygmies were the first inhabitants of the Congo basin forest. Based on their closer relationship and longer experience with the forest, one would expect them to know and use a lot more WEPs than the Turumbu, who are Bantous who immigrated into the area only some hundreds of years ago and generally rely more on agriculture for their livelihood. Adding the 14 species Liengola (2001) found to our own 85 WEPs, the Turumbu even seem to know more WEPs than either Mbuti and Efe Pygmies. In addition, the Turumbu exhibit a more uniform pattern of wild plants known for food than the Pygmies. Terashima and Ichakawa (2003) in their comparative study of 2 Mbuti and 2 Efe communities found similarity values that were always lower than 52% (percentage of species known in both localities compared). Similarity values in our study vary from 56% to 73% (figure 4.2).

[1] *Dialium polyanthum* Harms, *Lagenaria siceraria* (Molina) Standl., *Buchnerodendron speciosum* Gürke, *Mostuea hirsuta* (T.Anderson ex Benth. & Hook.f.) Baill. ex Baker, *Thaumatococcus daniellii* (Benn.) Benth. & Hook.f., *Psidium guineense* Sw., *Blighia welwitschii* (Hiern) Radlk., *Synsepalum bequaertii* De Wild., *Aframomum angustifolium* (Sonn.) K.Schum., *Garcinia kola* Heckel, *Homalium africanum* (Hook.f.) Benth., *Pentaclethra macrophylla* Benth., *Heisteria parvifolia* Sm., *Aframomum melegueta* K.Schum.

[2] *Crassocephalum sarcobasis* (DC.) S.Moore, *Pancovia harmsiana* Gilg, *Cola selengana* R.Germ., *Urera trinervis* (Hochst.) Friis & Immelman, *Amaranthus viridis* L., *Ancylobotrys amoena* Hua and *Landolphia jumellei* (Pierre ex Jum.) Pichon

Continuum cultivated - non-cultivated plant species

Focus group discussions revealed that while some people gather certain *Dioscorea* tubers in the forest, others cultivate the same species in their fields. In accordance with Casas et al. (1996) and Thomas and Van Damme (2011), we discovered that distinguishing between cultivated and non-cultivated species is sometimes confusing since the same plant species may be collected in the wild and grown in gardens. As we are interested in wild foods from the local populations' point of view, we also decided to include *Colocasia esculenta* and *Xanthosoma sagittifolia* in our list of wild food plants. Originally introduced as food crops from Asia and tropical America, they became naturalized and omnipresent in wild stands (Safo Kantanka 2004). Similarly, the fruits of *Capsicum frutescens* and *Solanum aethiopicum* are collected both from wild and cultivated stands. Including these species in the list is justified since this does not challenge the above-defined concept of being 'wild'.

On the other hand, *Dacryodes edulis* (safou), a tree native to Central Africa, does not occur on our WEP list, because it was unanimously considered as cultivated by focus group participants in all 3 villages studied. According to Asaah (ICRAF scientist in Cameroon, personal communication), '*farmers are collecting seeds of their best safou trees to sow them in their farms or homesteads. Furthermore, this action in itself can be considered as the onset of domestication'*.

According to Van den Eynden (2004) and Thomas and Van Damme (2011), useful plants can be protected, tolerated in fields, transplanted from the wild into gardens, encouraged to grow in hedges, etc. without ever becoming crops. However, when we discussed plant management within our focus groups, we found that most of the wild edible species on our list were not actively managed. In some rare cases, farmers allow a useful tree to stay where it grows when clearing new fields (tolerating), whereas edible weeds are mostly tolerated in the fields as long as they do not hinder the growth of the main crops. Nonetheless, we did not find particular species whose growth is actively enhanced through e.g. fertilization, transplantation or pruning, nor WEPs that are protected through removal of competing plants or pests.

Continuum foods - medicines

The difficulty that the Turumbu sometimes have in distinguishing between food and medicinal plants is not surprising. People who traditionally gather wild plants often know about additional properties, especially those that are beneficial for health. For example, *Piper guineense* fruits are used to season dishes, whereas a decoction from the leaves and/or lianescent stems is consumed with sugar as a tea substitute. The same decoction is used to treat general pain, lumbago, cold or cough. Similarly, the decoction of dried *Alchornea cordifolia* leaves is consumed as a tea substitute and/or as a treatment for anaemia.

With us, different other authors (i.e. Frison et al. 2006; Johns 1995; Leonti et al. 2006; Srinivasan 2005) recognized that in traditional African communities, medicine can be food and food can be medicine. It has not only been documented that different plant parts of the same plant can be used for different purposes, but also that people eat certain foods 'to stay in good health' (dualism of food as medicine) (Flyman and Afolayan 2006). Wild-gathered vegetables and fruits may, therefore, not only be good supplements to the mainly starchy diets (providing additional proteins, vitamins and minerals), but can also compensate for the lack of pharmacologically active substances, which cultivated species may have lost during domestication (Leonti et al. 2006). *Solanum nigrum*, e.g., an indigenous vegetable used by the Luo people of Western Kenya is also recognized by the Luo to protect against gastrointestinal disturbances (Johns et al. 1995). Similarly, Frison et al. (2006) and Srinivasan (2005) found that African spices and sauce condiments not only contribute to the daily intakes of iron, zinc and calcium, but have been reported to contain antioxidant and insulin-modulating properties. In addition, Srinivasan (2005) reported anti-inflammatory, antimutagenic and anticarcinogenic potentials of spices.

Consequently, to be able to distinguish between edible and purely medicinal or hallucinogenic species within the scope of our WEP project, it was necessary to agree upon a working definition of 'edible' (which is presented above in *chapter 2, section 2.5*).

Nutritional potential

Not all WEPs known by local populations are consumed on a regular basis (Lykke et al. 2002). Takeda (1990) observed that only 47.8 % of WEPs known by the Ngandu were regularly consumed. Similarly, the Mbuti use 84 WEPs, but 80% of their consumption comes from just 8 species (Ichikawa 1993). In some regions, children consume a lot more WEPs

than adults (Redzic 2006). These differences between knowledge and use of WEPs and the real contributions of WEPs to local diets in thee village Yaoseko and Kisangani city will be further investigated and discussed in *chapter 7*.

Numerous authors stress the high nutritional values of wild foods (e.g. Burlingame 2000; Ogoye-Ndegwa and Aagaard-Hansen 2003; Keller et al. 2006). For our own study area, we may cite the case of the overexploited wild vegetable *Gnetum africanum*, which is very rich in proteins and minerals (Na, K, Ca, Mg, Fe) and contains all essential amino acids (Okafor 1995). Herzog et al. (1994) argue that it is not only the high nutrient content, but mainly the fact that wild fruits provide rare nutrients and are an important source of dietary diversity and complementation, that make them so important in the African diets. However, wild foods are more and more 'forgotten' and disappear due to social change, urbanization and westernization of African cultures. As a consequence, diets will become more monotonous and deficiencies in nutrients that are now available in adequate amounts may develop (Herzog et al. 1994).

In our own research area, we found a huge lack of information concerning the nutritional values of wild food species. With regard to the four locally 'most-preferred' species, the only reliable and formal, but outdated nutritional information available was for waterleaf (*Talinum triangulare*) from Leung et al. (1968). Matsumoto-Oda and Hayashi (1999) report values on macro-elements in a fruit pulp and seeds mix of *Landolphia owariensis*, but the Turumbu do not eat the seeds, only the pulp of these *Landolphia* fruits. Although they are very much appreciated, no nutritional data are available for *Anonidium mannii* nor *Megaphrynium macrostachyum.* On the one hand, providing reliable information about nutritional values of wild plants should help (re)valorize these WEPs and preserve them from becoming forgotten. On the other hand, less 'healthy' wild foods could also be detected. *Pteridium aquilinum*, for example, which is also consumed by the Turumbu, contains a number of poisonous and antinutritional compounds such as sesquiterpenoids, ecdysone, cyanogenic glycosides, tannins and phenolic acids (van der Burg 2004). Nutritional analyses of 'promising' species are thus essential before implementing wider programs to promote WEP consumption.

Commercial potential

The fruits of *Landolphia owariensis*, the bark and fruits of *Anonidium mannii* and the leaves of *Megaphrynium macrostachyum* (wrapping material) can be found in Central African

markets (Hoare 2007; Everaert 2008). Leaves of Marantaceae species traded in the Mbandaka market (Equatorial Province, DRC) yielded on average a net monthly revenue of US $44 per trader (Ndoyo and Awono 2005). Although very little information is available, the four locally 'most-appreciated' species seem to have a certain potential for income generation. Obviously, more research is needed to assess their actual performance and future opportunities in local and regional markets. Hence, *Chapter 6* is dedicated to the further study of WEP markets in Kisangani.

Market surveys and value chain analyses should be used to evaluate commercial potential of WEPs (Leakey 1999). Farmers who are informed about nutritional characteristics, market demand and consumer preferences can make a well-informed choice of which wild foods to gather or domesticate/cultivate. In addition, they would be able to set their own price for these niche products instead of 'taking' international market prices as for coffee or cocoa. As it is, the latter prices are far often too low if one cannot rely on economies of scale (Van Damme and Termote 2008). Given the growing interest in new foods, essential oils, pharmaceutical products, etc. in the west, some species may also have potential to enter international markets in the long-term (e.g. the (essential) oils of *Canarium schweinfurthii* for shampooing, biofuels or pharmaceutical applications).

Evaluating the nutritional value, the economic potential and cultural preferences together with an assessment of the pressure on natural resources as a consequence of overexploitation of WEP stands will allow for priority setting and thus choosing the 'right' species for participatory domestication and value chain development. According to Leakey (1999), Leakey et al. (2003) and Tchoundjeu et al. (2006), participatory domestication of high potential WEPs is a viable strategy to 1) ameliorate nutrition security; 2) increase and diversify farmers' income; and 3) protect the natural environment from overexploitation, thus conserving biodiversity. However, to provide the incentives to actively plant and manage trees, markets have to be developed and expanded. Clearly, increased dialogue and collaboration between ethnobotanists, agroforestry researchers, food scientists, socio-economists and marketing specialists is necessary to ensure that WEPs can be valorised and (re)adopted.

4.5. Conclusion

This study contributes to the documentation of WEP knowledge by the Turumbu of the Isangi Territory, DRC. Focus group discussions in 3 Turumbu villages resulted in a comprehensive list of 85 WEPs and their different uses. Participatory ranking exercises, mapping preferences in taste, economic, nutritional and cultural values, revealed that the fruits of *Anonidium mannii* and *Landolphia owariensis*, the unfolded leaves of *Megaphrynium macrostachyum* and leaves of *Talinum triangulare* are most-appreciated by the Turumbu.

Although we used a qualitative approach, we were able to document 27 WEPs more than Liengola (2001), who used a quantitative approach by interviewing 31 individual informants within the Turumbu community. This confirms the hypothesis that qualitative techniques are especially valuable in regions where basic ethnobotanical data are hardly available and when one is interested in obtaining a global overview of plants used for certain purposes, rather than in the mean knowledge of individual informants. Results of qualitative investigations can then further be used in developing tools for quantitative research. However, the fact that Liengola (2001) documented 14 species we could not confirm in our study indicates that even our list is not complete yet: multiplying research sites could add new information.

Besides continued documentation of WEPs and mapping of cultural preferences, there is a huge need for further research on nutritional values of WEPs, dietary patterns and the role of wild foods herein as well as market studies to assess the economic potential and future opportunities of these wild foods. More attention should also be given to studies on the impact of gathering wild plants on the natural environment in the region, in order to develop harvest and use options. All these elements will help to set priorities for participatory domestication and further development of the most ‘promising’ species.

CHAPTER FIVE

COMPARISON OF TURUMBU, MBOLE AND BALI INDIGENOUS KNOWLEDGE ON WILD EDIBLE PLANTS IN TSHOPO DISTRICT

Figure 5.1: Preference ranking exercises with women and men in Bafwabula (above) and Bavoy (below)

Abstract

Knowledge on sustainable wild edible plant (WEP) use is very important for the long-term survival of many African communities, whereas the plant material itself may constitute a genetic resource pool for the development of novel food crops and products. Only very limited and mostly general information on WEPs of the Tshopo District, DRC, is available in international literature. To fill this gap, ethnobotanical research was carried out in 3 ethnic groups, Turumbu, Mbole and Bali, in 3 different territories of the Tshopo District. In 3 villages per ethnic group, WEPs were inventoried and their properties discussed in focus groups. Via 'walks-in-the-woods' with key informants all WEPs were collected to constitute a reference herbarium. Preferences in taste and commercial, nutritional and cultural value, were discussed during participatory ranking exercises. A total of 166 WEPs (165 species and 2 varieties) in 71 families, together with their uses, preparation methods, seasonal availability and commercialization possibilities were documented. Comparisons between the 3 ethnic groups showed that knowledge on WEPs is highly diverse between ethnic groups. Therefore, we should make a difference between species with regional importance and ethnospecific species when it comes to priority setting for further study and participatory domestication. Based upon preference ranking exercises, *Anonidium mannii*, *Landolphia owariensis* and *Megaphrynium macrostachyum* are some of the species with regional importance which can be considered for further research, participatory domestication and value chain development.

Céline Termote, Patrick Van Damme, Benoît Dhed'a Djailo

Eating from the wild: Turumbu, Mbole and Bali traditional knowledge on noncultivated edible plants, Tshopo District, DRC. Genetic Resources and Crop Evolution, 2011, 58(4): 585-618 (Impact Factor: 1.538).

5.1. Introduction

Chapter 4 discussed some generalities on WEPs and the process of documenting indigenous knowledge on them within the Turumbu ethnic group. Writing two similar chapters for the Mbole, resp., Bali ethnic groups, would lead to a lot of repetitions, so we opted to combine all our ethnobotanical research results in *chapter 5*. As a result, the discussion in *chapter 5* is oriented towards the comparison of ethnobotanical knowledge between the different ethnic groups investigated. Therefore, the data used in *chapter 4* have also been integrated into the present chapter. Comparison of ethnobotanical knowledge between communities and ethnicities has been done before by several authors for different reasons (e.g. Arenas and Scarpa 2007; Dansi et al. 2008; Ichakawa 1993; Koura et al. 2011; Macía 2004; Sheil and Salim 2012). Nonetheless, clarifying the differences found might be quite challenging; ethnobotanical knowledge being the result of a mix of biological and cultural factors and historical linkages (Dansi et al. 2008; Maxia et al. 2008; Sheil and Salim 2012). The main purpose of our thesis being to contribute to the valorization of WEPs, we wanted to know if biocultural differences in WEP knowledge and preferences exist. If so, this means that they should be taken into account in future WEP promotion for trade and consumption in the District (species with regional importance and species with ethnospecific importance should be identified (Dansi et al. 2008)). In addition, we conceived this PhD in such a way that the different article chapters stand on their own (each with a material and methods, results and discussion section): in other words, this chapter can be read and understood independently from *chapter 4*.

The objectives of the present chapter were to 1) document WEPs known by the Turumbu, Mbole and Bali, three of the major ethnic groups in Tshopo District; 2) compare plant knowledge between these three groups; and 3) document and compare local preferences in taste and economic, nutritional and socio-cultural values of the WEPs.

Scientific and vernacular names, plant parts used, modes of preparation, specific uses, seasonality patterns in collection and use, and commercialisation possibilities of the different WEPs are presented, together with participatory ranking exercises' results.

5.2. Material and methods

For a detailed description of the study area and the different ethnic groups, we refer to *chapter 3* and for the definition of non-cultivated edible plants to *chapter 2, section 2.5*.

Data collection

To achieve maximum diversity in plant species and utilisations, we selected 3 different ethnic groups in 3 different territories of the Tshopo district, namely the Turumbu, Mbole and Bali. This selection was based on literature reviews and earlier explorative research.

Given the lack of reliable information on number and exact location of villages, we opted for a non-probabilistic reasoned selection of 3 research villages per ethnic group (De Pelsmacker and Van Kenhove 2006), with sampling directed by:

1) accessibility (villages in the region are mostly situated along the main road);

2) mono-ethnicity (no co-habitation of different tribes in one village, because this might influence WEP knowledge and use patterns through intercultural exchange);

3) a minimum of 30 households living in the village;

4) full consent and collaboration of the village chief (and participants) after clear presentation of research objectives and protocols.

Ethnobotanical research was carried out in July-September 2006, July-September 2007 and July-September 2008 in Yaoseko, Yasekwe and Yalungu for the Turumbu; in Yaleko Village, Olife and Lefundelo for the Mbole; and in Bafwabula, Bavoy and Bafwambalu for the Bali. Geographic and socio-demographic village characteristics are presented in table 5.1.

An exploratory qualitative approach, via focus group discussions, was used to document all WEPs known at village level and to gain insight in their uses, preparation methods, seasonality patterns and commercialization. Focus group discussions have been used before in ethnobotanical research by, e.g., Addis et al. (2005), Dansi et al. (2008) or Lykke et al. (2004). The decision to opt for participatory focus group discussions stems from the fact that we were interested in an inventory of all WEPs known and used per village/ethnic group, rather than in more in depth individual informants' knowledge.

In each village, we organized focus group discussions that lasted for 5 to 7 days. Each focus group was composed of key informants knowledgeable in plant uses, chosen in collaboration

Table 5.1: Geographic and socio-demographic characteristics of the Turumbu, Mbole and Bali study villages

	Turumbu			Mbole			Bali		
	Yaoseko	Yasekwe	Yalungu	Yaleko Village	Olife	Lefundelo	Bafwabula	Bavoy	Bafwambalu
GPS Coordinates + elevation (m)	0°35'03"N 24°56'14"E 400	0°37'16"N 24°37'16"E 400	0°46'22"N 24°32'59"E 400	0°03'07"N 24°16'26"E 400	0°17'00"S 24°12'24"E 400	0°25'43"S 24°06'45"E 400	0°49'37"N 26°22'41"E 500	0°52'52"N 26°38'30"E 550	0°54'34"N 27°03'55"E 600
Distance (in km) to Kisangani +orientation	34 W	61 W	92 W	144 S	192 S	223 S	161-162 E	193 E	246 E
Number of Households	184	115	120	240	171	78	59	47	48
Territory	Isangi	Isangi	Isangi	Opala	Opala	Opala	Bafwasende	Bafwasende	Bafwasende
'*Collectivité*'	Turumbu	Turumbu	Turumbu	Tooli	Balinga-Lindja	Yalingo	Bekeni-Kondolole	Bakundumu	Bakundumu
'*Groupement*'	Yawenda	Yawenda	Yelongo	Yangonda	Yalokoli	Yakuma	Bafwatende I	Bafwasola	Boyulu
Village headman	Baruti Abibo	Baelo Mbola Emmanuel	Jean Yaboya Bokomba	Osungi Lokoli Joseph	Ungondo Lokayo	Ndiya Yakuma	Baudouin Aguguma	Mabianga Pierre Salumu	Banganza Mathias
Participants in focus group (♂/♀)	6 / 1	6 / 2	8 / 2	15 / 2	9 / 2	11 / 0	6 / 1	5 / 1	6 / 2
Participants rankings men	5	4	7	10	9	5	7	5	5
Participants rankings women	7	4	9	6	8	4	5	5	5

Source: own work

with the village headman (Cotton 1996). Other villagers expressing their interest to join the focus group, whether or not only during part of the exercise, were not excluded. Table 5.1 presents the number of permanent focus group participants per village according to gender. Some authors argue that women have more knowledge on WEP uses (Hanazaki et al. 2000), but there are as many authors who didn't find differences in WEP knowledge between men and women (Ayantunde et al. 2008; Camou-Guerrero 2008; Lykke et al. 2004; Zambrana et al. 2007) or who found men to be even more knowledgeable on WEPs (Kristensen and Balslev 2003). In this study, women were encouraged but not forced to participate. They generally had multiple other occupations which did not allow them to fully participate in the interviews.

During the first focus group session in each village, we asked participants to enumerate all 'wild' plants they know that could be used as food (via a free listing exercise, Cotton 1996). Plant names were recorded in the native languages '*Turumbu*', '*Kimbole*' or '*Kibali*' resp., and per village a list of WEPs was compiled. Subsequently, all species mentioned on the list were collected during field trips with the key informants ('walks-in-the-wood', *sensu* Alexiades 1996) to constitute a reference herbarium collection. Digital pictures were taken of all plants collected (Thomas et al. 2007). In case, during analyses of data, some doubts remained on local plant names, we went back to the study villages and used the pictures to verify the original information registered during focus groups together with the key informants.

During the subsequent focus group sessions, participants discussed uses, preparation methods, seasonality patterns, trade and possible inconveniences for each species on the list of WEPs of their village. Discussions were conducted in Lingala (Turumbu and Mbole) or Swahili (Bali) (the regional languages commonly known) with the help of a local research assistant for Lingala/Swahili – French translations and guided by a 'topic list' prepared in advance by the researcher (Cotton 1996). Answers were recorded upon group consensus.

Finally, in each village, two new groups were formed (one for each gender group either) for participatory ranking exercises following the same method as described in *chapter 4*. The number of ranking exercises' participants can be seen in table 5.1.

Data analysis

All data collected during the field study were reported in Microsoft Excel and statistical analyses were performed in SPSS 15.

Species used as WEP

Herbarium specimens were identified with the aid of the '*Flore d'Afrique Centrale (Congo-Kinshasa, Rwanda and Burundi)*' (Bamps, 2000 -) and voucher specimens deposited at the National Botanic Garden of Belgium, Meise (acronym BR). Duplicates of the latter were deposited at the herbarium of the host institution (Faculty of Sciences, University of Kisangani, DRC). Species names were verified on the IPNI (International Plant Names Index) website (www.ipni.org) and allocated to botanical families according to the APGII-system (Angiosperm Phylogeny Website; http://www.mobot.org/MOBOT/research/APweb/).

Non-food uses of WEPs

The number of WEPs having uses in categories other than food was counted. The different use categories were adapted from Cook (1996) to meet field realities of the research area.

Secondly, for each plant species, the total number of use citations, food uses included, were calculated (see *chapter 4*).

Finally, we calculated the total number of use citations for each use category. Because non-food uses were not the primary scope of the study, these should be considered as incomplete. Only when a WEP figured on the list of WEPs in the respective villages, did we ask about other, non-food uses of the species.

Comparison between villages and ethnic groups

Sørensen similarity indices were calculated to compare WEP knowledge between paired villages (Kehlenbeck and Maass 2004; Keller et al. 2006; Magurran 1988). A Wilcoxon sum-rank test was used to verify whether Sørensen similarity indices of paired villages from the same ethnic group were significantly different from those of paired villages from different ethnic groups.

Finally, following Dansi (2008), we clustered the 9 studied villages using a hierarchical clustering method (Ward's method) based on the occurrence (present/absent) of the 166 inventoried species. Clusters were formed applying the binary squared Euclidean distance as measure of dissimilarity (Dansi et al. 2008; Kehlenbeck and Maass 2004; Wijnen et al. 2002).

Participatory rankings

The same procedure was used as described in *chapter 4*.

5.3. Results

Species used

We documented 166 WEPs (165 species and 2 varieties of 1 species, i.e. *Solanum aethiopicum* L."Shum group" and *S. aethiopicum* L."Gilo group") in 71 families for the 3 ethnic groups taken together (see table 5.2). Two WEPs mentioned during interviews, i.e. *nelo* and *wodho,* could not be found during subsequent collection trips with key informants and could thus not be identified. 7 WEPs could only be identified on to genus level, whereas for 1 WEP we were only able to ascertain the family level. The family of the Apocynaceae is best represented with 12 species, followed by the Malvaceae (10), Rubiaceae (8), Zingiberaceae and Dioscoreaceae (each 6).

The fruits of *Anonidium mannii* (Oliv.) Engl. & Diels, *Landolphia owariensis* P.Beauv., *Canarium schweinfurthii* Engl., *Tristemma mauritianum* J.F.Gmel., *Piper guineense* Schumach. & Thonn., *Chrysophyllum lacourtianum* De Wild., *Myrianthus arboreus* P.Beauv. and *Aframomum laurentii* (De Wild. & T.Durand) K.Schum.; the nuts of *Tetracarpidium conophorum* (Müll.Arg.) Hutch. & Dalziel, *Treculia africana* Decne.and *Panda oleosa* Pierre; the stem of *Costus lucanosianus* J.Braun & K.Schum., the leaves and bark of *Scorodophloeus zenkeri* Harms and the leaf buds of *Megaphrynium macrostachyum* (Benth.) Milne-Redh. are known in all villages studied. Eleven other WEPs are known in 8 villages and five more in 7 villages (table 5.2). In total, knowledge on 35 WEPs is shared in at least one village of each ethnic group.

According to growth form, 26.2% of the WEPs inventoried are trees, 25.0% lianas, 21.3% shrubs or sub-shrubs, 23.2% herbs and 4.3% ferns. The habitat of most WEPs is the primary rainforest (76 species), followed by secondary forest (40 species) and herbaceous fallow (32 species). We found a small number of swamp forest species (8) and 1 aquatic species in addition to 9 semi-cultivated spontaneous or sub-spontaneous species.

Table 5.2: Wild Edible Plants known by the Turumbu, Mbole and Bali, Tshopo District, Oriental Province, DRC

Botanical family	Scientific name[a]	Vernacular names[b]	Herbarium reference[c]	Plant part(s) used as food[d]	Raw or cooked[d]	Specific use[d]	Habitat[e]	Morpho-logy[f]	Harvest Period	Total use citations[g]	Trade[h]
Acanthaceae	**Justicia insularis* T.Anderson	ophole (l)	1039	young leaves	cooked	condiment	hFa	Hp	permanent	0+3+0= 3	/
Achariaceae	*Caloncoba subtomentosa* Gilg	lisende (o) lisakele, liphephele (f), lisene, liphephele (l)	196 150, 1065	pulp	raw	fruit	SF	Sh/T	permanent	3+17+0= 20	/
Amaranthaceae	**Amaranthus dubius* Mart. ex Thell.	ngbelengbele (o), lonenge (w,o) odikimombolobi (a,v,m)	249, 302 96, 1117	leaves	cooked	leafy vegetable	hFa	Han	permanent	6+0+3= 9	m
	**Celosia leptostachya* Benth.	iphowuphowu (w,o)	1006	leaves	cooked	leafy vegetable	hFa	Han	permanent	2+0+0= 2	o
	Celosia trigyna L.	iphowuphowu (w,o)	218	leaves	cooked	leafy vegetable	hFa	Han	permanent	2+0+0 =2	o
Anacardiaceae	*Antrocaryon nannanii* De Wild.	bokongo, kongo (u,w,o) okongo (k) utiongo (a,v,m)	993 1139	- seeds - fruit pulp	raw or roasted raw	- nut - condiment - oil fruit	PF	T	permanent (July-Oct.)	4+4+6= 14	/
	**Pseudospondias microcarpa* Engl.	agombe (m)	1152	fruit pulp	raw	fruit	PF	T	Aug.-Oct.	0+0+4 = 4	/
	**Trichoscypha acuminata* Engl.	naola (l)	1031	fruit pulp	raw	fruit	PF	T	July-Dec	0+3+0= 3	/
Annonaceae	*Anonidium mannii* (Oliv.) Engl. & Diels	anguto (u,w,o) ombi (k,f), oomi (l) upombi (a,v,m)	198, 270 52, 1022 87, 1108	pulp	raw	fruit	PF	T	July-Oct.	12+13+17 =42	u,w,o, k,f ,l, m
	**Artabotrys thomsonii* Oliv.	liyomomi (l) dandi (v)	1059 1126	stem sap	raw	water	PF	L	permanent	0+1+3= 4	/
	**Isolona hexaloba* Engl. & Diels	unkosakosa (a)	104, 1216	bark	raw	strenghtener	PF	T	permanent	0+0+5= 5	/
	**Monodora myristica* (Gaertn.) Dunal	ophaningo (f)	146	bark	cooked	strenghtener (tea)	PF	T	permanent	0+4+0= 4	f
Apocynaceae	*Clitandra cymulosa* Benth.	inono (u,w,o) linono (k), lilolo (f) mbado (a,v,m)	263, 337 1078 1215, 1121	fruit pulp (and seeds)	raw	fruit	PF	L	July-Oct.	12+5+6= 23	u,w,o, k, v,m
	**Dictyophleba lucida* (K.Schum.) Pierre	iyoyoliki (u), liyoliyoliki (w), iyayawoliki (o) liyoyoliki (k), tolekyayo (l)	122, 235	fruit pulp	raw	fruit	PF	L	July-Oct.	3+2+0= 5	w

Botanical family	Scientific name[a]	Vernacular names[b]	Herbarium reference[c]	Plant part(s) used as food[d]	Raw or cooked[d]	Specific use[d]	Habitat[e]	Morpho-logy[f]	Harvest Period	Total use citations[g]	Trade[h]
	**Dictyophleba ochracea* (K.Schum. ex Hallier f.) Pichon	mandolo (a), mandolo (v) nambedumbedu (m)	1822, 1113, 1847, 1881	fruit pulp (and seeds)	raw	fruit	PF	L	July-Oct.	0+0+3= 3	a
	Landolphia foretiana (Pierre ex Jum.) Pichon	lingbotoma (o) mandolo (a), angolo (a), maligbo, nambedumbedu (m)	197 117, 1208, 1185, 1188	fruit pulp	raw	fruit	SF	L	July-Oct.	3+0+2= 5	u
	**Landolphia mannii* Dyer	mesisi (v)	1205, 1854	fruit pulp and seeds	raw	fruit	PF	L	Aug.-Oct.	0+0+6= 6	v
	Landolphia owariensis P.Beauv.	lilolo (u), liyo (w,o) liyo (k,l), liyo, itophe (f) nekala (v,m), nekala, lisisa (a)	336, 984 1085, 151 1130, 1853	fruit pulp (and seeds)	raw	fruit	PF	L	July-Oct.	12+11+19= 42	u,w,o k,f,l a,v,m
	**Landolphia robustior* (K.Schum.) J.G.M.Pers.	angolo (a,v,m)	85, 1832	fruit pulp	raw	fruit	PF	L	July-Oct.	0+0+2= 2	a,v,m
	**Landolphia villosa* J.G.M.Pers.	libii (u), lilombo (w), inono (w) lisenda, limbi (f), limbi (k), liphi(l) maligbo (a,v,m)	293, 1001 165, 1062 113, 1211	pulp (and seeds)	raw	fruit	PF	L	July-Oct.	5+8+13= 26	u,w k a,v,m
	Landolphia sp1	ngilaseka (u,w)	327	pulp	raw	fruit	PF	L	July-Oct.	5+0+0= 5	w
	**Picralima nitida* (Stapf) T.Durand & H.Durand	agbodu (v)	1851	bark	raw	strenghtener (tea)	PF	T	permanent	0+0+4= 4	/
	Saba comorensis (Bojer ex A.DC.) Pichon	lilombo (u,o), libii (w) ambedumbedu (a)	240, 303 1212	fruit pulp	raw	fruit	PF	L	July-Oct.	5+0+1= 6	u,w a
	**Vahadenia laurentii* (De Wild.) Stapf	lituku (k) ambedumbedu (v)	1089 1858	fruit pulp(and seeds)	raw	fruit	PF	L	July-Sept.	0+1+1= 2	k
Araceae	*Anchomanes giganteus* Engl.	likondoyaolimo (o) libugudebezili (a)	222 116	young sprouts	cooked	vegetable	SF	Hp	permanent	1+0+2= 3	/
	Colocasia esculenta (L.) Schott	maniango (o)		tubers	cooked	starch (staple)	Cult-spp	Hp	permanent	1+0+0= 1	o
	Lasimorpha senegalense (Schott) Engl.	owaka (l)	1056	- leaves - roots	cooked burned	condiment, ind. vinegar	SF	Hp	permanent	0+5+0= 5	l
	Xanthosoma sagittifolium (L.) Schott	yopho (o)		- tubers - leaves	cooked cooked	starch (staple) leafy vegetable	Cult-spp	Hp	permanent	2+0+0= 2	o

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Arecaceae	*Elaeis guineensis* Jacq.	atchichi (f), loombo (f) balia, libala (a,v,m)	173 1128	- palm hart - fruit pulp - stem sap - trunk - male inflorescence	cooked transf. raw burned burned	vegetable palm oil palm wine ind. vinegar ind. vinegar	SF-Cult	T	permanent	0+8+17= 25	f a,v,m
	Laccosperma secundiflorum (P.Beauv.) Kuntze	likawu (u,o) okawu (k,f,l) ukawu, ongonga (a), unkawu (v,m)	229, 319 134, 1027 91, 1104	leaf buds	cooked, raw or roasted	vegetable	PF	L	permanent	8+24+14= 46	f,l
	Raphia gilletii Becc.	balia, lisingo (v)	1146	- palm hart - stem sap	cooked raw	vegetable palm wine	PF	T	permanent	0+0+10= 10	v
	Raphia sese De Wild.	ikolo, fande (u) ikolo (k,f)	312 154	- fruit pulp - stem sap	cooked raw	fruit palm wine	PF	T	permanent	6+15+0= 21	v
Asteraceae	**Bidens pilosa* L.	mbelembele (v)	1131	leaves	cooked	tea subst.	hFa	Han	permanent	0+0+3= 3	/
	Crassocephalum crepidioides (Benth.) S.Moore	limbiti (u,w,o) lisahuka (l)	20, 332 1061	young leaves	cooked	leafy vegetable	hFa	Han	permanent	4+1+0= 5	o
	Crassocephalum montuosum (S.Moore) Milne-Redh.	agili (a,v,m)	92, 1095	young leaves	cooked	leafy vegetable	hFa	Han	permanent	0+0+5= 5	/
Begoniaceae	**Begonia eminii* Warb.	likaliyokoko (l)	1051	leaves	cooked	leafy vegetable	PF	sSh	permanent	0+2+0= 2	/
Burseraceae	*Canarium schweinfurthii* Engl.	bobele, ibele (u,w,o) oyele,shele (k,l), owele, tchwele(f) mbele, limbini (a,v), kasuku (m)	232 1090 1841, 1124	fruit pulp and skin	cooked or roasted	fruit	PF	T	July-Oct.	9+23+15= 47	u,w l m
	Dacryodes osika (Guillaumin) H.J.Lam.	ibele sawu, isawusawu (u,w,o) okololo (k), osukukelele (f, l) ugbagba, ngiangia, usowu (v)	239 175, 1029 1133	fruit pulp and skin	cooked or roasted	fruit	PF	T	July-Oct.	5+9+2= 16	u,w
Celastraceae	**Loeseneriella africana* (Willd) R.Wilczek ex N. Hallé	namamili (a,v,m)	82, 1204	bark, liana	raw or cooked	strenghtener (tea)	PF	L	permanent	0+0+14= 14	m
Clusiaceae	**Garcinia epunctata* Stapf	oluho/londuho (k), otchuwo (f) undandi (a,v,m)	160 1213, 1835	- fruit pulp - bark	raw	fruit strenghtener (tea)	PF	T	June-Oct.	0+4+11= 15	/
	Garcinia kola Heckel	oyale (k), onale (l) agambo (a), mbongo (v), akbatuwé, umbongo (m)	69, 1063 1835, 1186	seeds without skin	raw	nut	PF	T	Permanent (July-Sept.)	0+ 13+12= 25	l,m

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	Mammea africana Sabine	boliti (o) b'huliti (v,m)	244	fruit pulp	raw	fruit	PF	T	July-Oct.	2+0+8= 10	/
Combretaceae	**Combretum paniculatum* Vent.	akoti (v)	1140, 1852	stem sap	raw	water	PF	L	permanent	0+0+1=1	/
Connaraceae	**Manotes expansa* Sol. ex Planch.	tokayikayi (f)	132	young leaves	raw or cooked	leafy vegetables	hFa	L	permanent	0+3+0= 3	/
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	agietu (v)	1142	tubers	cooked	starch (staple)	Cult-spp	Hp	March-April	0+0+1= 1	/
Costaceae	*Costus lucanusianus* J.Braun & K.Schum.	bokako (bobaye) (u,w,o) okako (k,f,l) makakokako (a,v,m)	13, 224 1087, 135 105	- stem - flower	raw - raw - cooked	fruit fruit condiment	hFa	Hp	permanent	12+18+16= 46	/
	**Costus phyllocephalus* K.Schum.	tulukako (l)	1040	stem	raw	fruit	hFa	Hp	permanent	0+6+0= 6	/
Cucurbitaceae	*Momordica foetida* Schumach.	ngoza (a,v,m)	98, 1096	young leaves	cooked	leafy vegetables	SF	Hp Cl	permanent	0+0+7= 7	/
Dichapetalaceae	*Dichapetalum mombuttense* Engl.	ekpalanganga (u,o); lisungulingba/lisunguliteti (w,o)	11, 211	fruit pulp	raw	fruit	SF	L	permanent	5+0+0+= 5	/
Dilleniaceae	**Tetracera alnifolia* Willd.	mbembi (m)	1183	stem sap	raw	water	PF	L	permanent	0+0+4= 4	/
	**Tetracera potatoria* Afzel. ex G.Don	mbembi (a,v)	1209, 1115	stem sap	raw	water	PF	L	permanent	0+0+3= 3	/
Dioscoreaceae	**Dioscorea alata* L.	lengu (o), ilumbelumbe (w) liko (a)	243 1833	tubers	cooked	starch (staple)	SF	Ltu	permanent	2+0+1= 3	o,w
	**Dioscorea baya* De Wild.	ikuse (u,w,o)	989, 1000	tubers	cooked	starch (staple)	SF	Ltu	permanent	3+0+0= 3	u,w
	**Dioscorea burkilliana* Miège	liphe, ipheli (l), epheli, yuphe (k)	1042, 1083	tubers	cooked	starch (staple)	SF	Ltu	permanent	0+6+0= 6	/
	Dioscorea dumetorum (Kunth) Pax	elenge (u), yayii (w,o)	119, 290	tubers	cooked	starch (staple)	SF	Ltu	permanent	3+0+0=3	u,w,o
	Dioscorea minutiflora Engl.	ikeke (u,w,o) opheyipheyi, lepheyi (f), lewa (l)	277,987 127, 1066	tubers	cooked	starch (staple)	SF	Ltu	permanent	3+4+0= 7	w,o
	**Dioscorea praehensilis* Benth.	bosondi (u,w,o) lilungu (l), ikuse (k) kpegu (a,v), begpegu (m)	330, 996 1015, 1092 1207, 1839	tubers	cooked	starch (staple)	SF	Ltu	permanent	3+4+3= 10	u,w,o l a,v,m

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Euphorbiaceae	**Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg.	liondje (u,w,o) lionje (k,l), liyotche (f) kopata (v,m)	16, 297 1086, 126 1112, 1169	dry leaves	cooked	decoction (tea stubst.)	SF	Sh/T	permanent	9+17+9= 35	f
	Erythrococca atrovirens (Pax) Prain var. *flaccida* (Pax) Radcl.-Sm.	likile (w,o) mbileteke(k), mbeteke(f),meteke(l) ponyonyo (m)	241 44, 74, 1181	leaves	cooked	leafy vegetable	SF	Sh/T	permanent	5+5+1= 11	/
	Euphorbia hirta L.	ngotoindika (o)	226	flower	raw	fruit	hFa	Han	permanent	3+0+0= 3	/
	Ricinodendron heudelotii (Baill.) Heckel	agele, ngoza (a), agele, ungozo (v,m)	108, 1107	seeds	cooked or roasted	- nut - condiment	PF	T	July-Sept.	0+0+12= 12	/
	Tetracarpidium conophorum (Müll.Arg.) Hutch. & Dalziel	botito, tito (u,w,o) tito (k,l), lokaso (f) ngezi (a,v,m)	262, 338 59, 1008	seeds without skin	cooked or roasted	- nut - condiment	PF	Sh Cl	July-Oct.	4+6+8= 18	u,w,o k,f,l a,v,m
Fabaceae (Caesalpinioideae)	*Gilbertiodendron dewevrei* (De Wild.) J.Léonard	mbolu, lofete (u,w,o) mbele, omongo (k) akiengie, umbolu, ambalakata(a,v,m)	118, 245 55 1110, 1162	seeds without skin	cooked	starch (staple)	PF	T	July-Oct.	15+1+21= 37	/
	**Normandiodendron romii* (De Wild.) J.Léonard	ikumbo (k,f), shofa (k), yopha (l)	176, 1023	young leaves	raw or cooked	- tea - leafy vegetable	PF	Sh/T	permanent	0+11+0=11	l[j]
	Scorodophloeus zenkeri Harms	bofili (u,w,o) ophili (k,f,l) bioli, adolombi (a), afe (v,m)	259, 283 145, 1025	- young leaves - bark	cooked	- leafy vegetable - condiment - tea condiment	PF	T	permanent	10+17+7= 34	u,w,o m
Fabaceae (Mimosoideae)	**Entada gigas* (L.) Fawc. & Rendle	lute (l)	1053	stem sap	raw	water	SF	L	permanent	0+2+0= 2	/
	Pentaclethra macrophylla Benth.	owala (k) ukelede (a,m)	1079 1834, 1161	- seeds without skin - fruit shell	- cooked or roasted - fermented burned	- condiment - nut condiment ind. vinegar	PF	T	July-Oct.	0+8+10= 18	/
Fabaceae (Papilionoideae)	**Desmodium setigerum* (E.Mey.) Benth. ex Harv.	ikpesaamuku (o)	217	roots	raw	fruit	hFa	sSh	permanent	2+0+0=2	/
	Dewevrea bilabiata Micheli	lofembembo (u,o) okoyo (l)	201,319 1047	young leaves	cooked	- condiment - leafy vegetable	PF	L	permanent	2+1+0= 3	/
Gnetaceae	*Gnetum africanum* Welw.	fumbwa (u,w,o)	247	leaves	cooked	leafy vegetable	PF	L	permanent	5+0+0= 5	u,w,o

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Huaceae	**Afrostyrax* sp.	longoho (k)	77	young leaves	cooked	condiment	PF	Sh/T	permanent	0+4+0= 4	/
	Hua gabonii Pierre ex De Wild.	lofiongi (u,w), longowu (w,o) longoho (k), oyenge (f, l)	248, 276 1049	young leaves	cooked	- leafy vegetable - condiment	PF	Sh/T	permanent	9+8+0= 17	w,o
Hydrocharitaceae	*Hydrocharis chevalieri* (De Wild.) Dandy	opha (l)	1055	roots	burned	ind. vinegar	aquatic	Haqua	permanent	0+1+0= 1	l
Icacinaceae	**Alsodeiopsis rowlandii* Engl.	lokembya (k), lokeya (f)	1074, 128	roots	raw	strenghtener	hFa	Sh	permanent	0+3+0= 3	/
Irvingiaceae	**Irvingia excelsa* Mildbr.	abele aselele (v, m)	1875	seeds	raw or roasted	nut	PF	T	Aug.-Oct.	0+0+4= 4	/
	Irvingia grandifolia (Engl.) Engl.	alube (a,v,m)	1831, 1136, 1846, 1878	- fruit pulp, - seeds without skin	raw raw or roasted	fruit nut	PF	T	July-sept.	0+0+11= 11	/
	**Irvingia robur* Mildbr.	otchili (f), ondili (k) abele akabula (a,v,m)	141 1823, 1132	seeds	raw or roasted	nut	PF	T	July-Oct.	0+2+9= 11	/
	Irvingia smithii Hook.f.	bosombo (w,o)	255, 301	- seeds - fruit pulp	raw raw	nut fruit	SwF	T	June-Oct.	5+0+0= 5	/
	**Irvingia wombolu* Vermoesen	madohu (v)	1857	seeds	raw or roasted	nut	PF	T	July-sept.	0+0+1= 1	/
Lauraceae	**Cinnamomum zeylanicum* Blume	kalafulu (f)	168	leaves	cooked	condiment	Cult-ssp	T	permanent	0+1+0= 1	f
Loganiaceae	**Strychnos* cfr. *aculeata* Soler.	agbodu (m)	1880	bark	cooked	tea subst.	PF	L	permanent	0+0+5= 5	m
Malvaceae	*Cola acuminata* (P.Beauv.) Schott. & Endl.	angbongbo(lia) (u,w,o) liyelu (k,f) ligo (a,v,m)	261, 265 109, 1103	seeds without skin	raw	- nut - strenghtener - tea subst.	PF	Sh/T	June-Oct.	10+6+18= 34	u,w,o k a,v,m
	**Cola ballayi* Cornu ex Heckel	likapu (a,v,m)	1838, 1855	seeds without skin	raw	- strenghtener - nut	PF	Sh/T	July-Nov.	0+0+11= 11	/
	Cola bruneelii De Wild.	losakanu, sakanu (u,**w,o**) limbabaliyekondo (w,o) alembe, okowa (k), alembe, litaphala (f, l)	123, 306 1075, 130	- fruit pulp - leaves	raw cooked	fruit leafy vegetable	PF	Sh	permanent	10+14+0= 24	/

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	**Cola congolana* De Wild. & T.Durand	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o) ongando oïtchi (f), tongombo (k)	4, 289 174	- fruit pulp - leaves	raw cooked	fruit leafy vegetable	PF	Sh	permanent	8+5+0= 13	/
	Cola marsupium K.Schum.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o) koloko (k)	204 43	fruit pulp	raw	fruit	PF	Sh/T	permanent	8+1+0= 9	/
	Cola urceolata K.Schum.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o) tongombo (k), ongando oïtchi (f) nzanzalinza (a,v m)	124, 194 1081 106, 1101	- fruit pulp - leaves	raw, cooked	fruit leafy vegetable	PF	Sh	Permanent (July-Nov.)	8+5+9= 22	/
	**Grewia louisii* R.Wilczek	iphimbo, ndolo (k,f)	139	fruit pulp with skin	raw	fruit	PF	T	June-sept.	0+7+0= 7	/
	**Grewia pinnatifida* Mast.	iphimbo (k)	1077	fruit pulp with skin	raw	fruit	SF	Sh/T	June-sept.	0+2+0= 2	/
	Hibiscus acetosella Welw. ex Hiern	damudamu (u) toyawo (f,l)	335 157, 1054	leaves	cooked	- tea subst. - leafy vegetable	hFa	sSh	permanent	3+5+0= 8	/
	Hibiscus sabdariffa L.	lokeke (l)	1034	young leaves	cooked	leafy vegetable	Cult-spp	Han	permanent	0+2+0= 2	/
Marantaceae	*Megaphrynium macrostachyum* (Benth.) Milne-Redh.	likongo, beye (u,w,o) oheye, likongo (k,f), meye, okongoto (l) angule, ungoli (a,v,m)	275, 323 149, 1030 1100, 1164	- leaf button - stem fibres - fruit pulp	cooked burned raw	vegetable indigenous salt fruit	SF	Hp	permanent	12+26+16= 54	u,w,o k,l v,m
	**Sarcophrynium prionogonium* (K.Schum.) K.Schum.	magbegbe (v)	1120	fruit pulp	raw	fruit	SF	Hp	June-Sept.	0+0+1= 1	/
	*Thaumatococcus danielii (*Benn.) Benth. & Hook.f.	nzilizili (a,v,m)	1098, 1182	fruit pulp	raw	fruit	SF	Hp	June-Sept.	0+0+12= 12	/
	Trachyphrynium braunianum (K. Schum.) Baker	ikokombeshalia, bolikabwalima (w), ikokombeibaye (o)	281, 223	seeds	raw	fruit	SwF	Hp	permanent	4+0+0= 4	/
Melastomataceae	**Dissotis hensii* Cogn.	itele (l)	1057bis	young leaves	cooked	leafy vegetable	hFa	sSh	permanent	0+1+0= 1	/
	**Ochthocharis dicellandroides* (Gilg) C.Hansen & Wickens	itele (l)	1057	young leaves	cooked	leafy vegetable	SwF	sSh	permanent	0+1+0= 1	/

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	Tristemma mauritianum J.F.Gmel.	lituma lilokonda (u,w,o) etele (k,f), okama (l) ekba (a,m), limbodidi (v)	214, 286 170, 1038 1166, 1143	- whole fruit - young leaves	raw, cooked	fruit leafy vegetable	hFa	sSh	permanent	6+7+6= 19	/
Menispermaceae	*Chasmanthera welwitschii* Troupin	ndénde (u), tongatobolondi (w) adumasa (a), agietu (v), agbetu (m)	331 1836, 1864	fruit pulp	raw	fruit	SF	L	June-Sept. Dec.-March.	2+0+3= 5	/
	**Penianthus longifolius* Miers	lokumbo (o) lokumbo (k,f) kosombo (a,v,m)	200 76, 143 83, 1122	- fruit pulp - roots	raw raw	fruit strenghtener	PF	Sh	permanent	4+10+18= 32	/
	**Stephania laetificata* (Miers) Benth. & Hook.f.	tolelehe (k)	1091	- fruit pulp - leaves	raw raw	fruit fruit	SF	L	permanent	0+1+0= 1	/
Moraceae	**Musanga cecropioides* R.Br. ex Tedlie	bokombo (o) litumbe (k)	221 67	- sprouts - air root sap	cooked raw	vegetable water	SF	T	permanent	3+8+0= 11	/
	Treculia africana Decne. ssp. *africana* var. *africana*	bombimbo, limbimbo (u,w,o) oimbo (k,f), oimo (l) opiso (a,v,m)	203, 296 1084, 1036 1180	seeds without skin	roasted or cooked	- nut - condinment	PF	T	June – Dec.	3+9+7= 19	f,l
	**Trilepisium madagascariensis* DC.	indoli, anziga (v)	1856	seeds without skin	roasted	nut	PF	T	April-Mai	0+0+4= 4	/
Pandaceae	*Panda oleosa* Pierre	bakale (u,w,o) lopha (k), leteko (f, l) angele (a,v,m)	199, 285 39, 148 1138	seeds	raw or roasted	- nut - condiment	PF	T	permanent[i]	5+8+5= 18	u,w k,f,l
Passifloraceae	*Passiflora foetida* L.	maveve (u,w,o) maveve (k,l) maveve (a,v,m)	225, 292 41, 1045 93, 1118	whole fruit	raw	fruit	hFa	H Cl	permanent	4+2+6= 12	/
Pentadiplandraceae	*Pentadiplandra brazzeana* Baill.	etekele, amelalokulu (u,w,o) tophanda (k,f), ophana (l) dingabi (m)	210, 282 63, 1043 1199	fruit pulp	raw	fruit	SF	L	permanent	15+11+3= 29	u,w,o f,l[j]
Phyllantaceae	**Bridelia stenocarpa* Müll.Arg.	olanga (f)	125	bark	raw	strenghtener	hFa	Sh	permanent	0+5+0= 5	/
	Hymenocardia ulmoides Oliv.	bokelele(w,o) okelia (k), okele (f), yonga (l)	227, 280 79, 1071	leaves	cooked	- tea subst. - condiment - leafy vegetable	PF	Sh/T	permanent	8+11+0= 19	/
	**Maesobotrya longipes* (Pax) Hutch.	ndako ya hongo (k),sokokolongo (f), salasala (l)	35, 1014	whole fruit	raw	fruit	SF	T	July-Sept.	0+6+0= 6	/

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	**Phyllanthus polyanthus* Pax	okolo (k,f)	172	fruit	cooked	- tea subst. - vegetable	PF	T	permanent	0+6+0= 6	/
Phytolaccaceae	*Hilleria latifolia* (Lam.) H.Walter	lokobo (u,w,o) lokowo (k), loko (l)	14, 333 27, 1050	leaves	cooked	leafy vegetable	SF	sSh	permanent	6+5+0= 11	/
	Phytolacca dodecandra L'Hér.	lisingo (u,w,o) lisasingo (k), lisilingo (f,l)	322 66, 164	leaves	cooked	leafy vegetable	SF	sSh Cl	permanent	4+5+0= 9	l
Piperaceae	*Peperomia pellucida* (L.) Kunth	lombaye lolitoko (u)	120	leaves	cooked	leafy vegetable	hFa	Han	permanent	1+0+0= 1	/
	Piper guineense Schumach. & Thonn.	iketu (u,w,o) toketu, ohaya (k), olokoloko, toketchu (f), Toketu, oleleko (l) mbikondi (a,v,m)	19, 233 163, 1024 90, 1154	- leaves - liana - whole fruits	cooked cooked raw	tea subst. tea subst. condiment	PF	L	permanent; fruits: July-Jan.	12+18+16= 46	u,w,o k,f,l a,v
	Piper umbellatum L.	bogolo (a,v,m)	94, 1097	young leaves	cooked	leafy vegetable	SF	Sh	permanent	0+0+16= 16	/
plantaginaceae	**Bacopa* sp.	ingawungawu (w) liseli (f)	295, 995 166	leaves	cooked	- tea subst. - leaf vegetable	hFa	Han	permanent	1+6+0= 7	/
Polygalaceae	*Carpolobia alba* G.Don	lokembia (w,o) liyambaliyekondo (k), isekya (k,l), iseke (f) lindiko (a,v,m)	288 78, 1018, 1206, 1197	- roots - fruit pulp (and seeds)	raw or roasted raw	strenghtener fruit	PF	Sh	Permanent (Aug.-Dec. for fruits)	3+12+7= 22	w,o
Portulacaceae	*Talinum triangulare* (Jacq.) Willd.	melelu (u), sese (w,o) ambioko (k), alengalenga (f, l) ngolu (a), neputu konkolo (v)	313, 219 1093, 1035 97, 1144	leaves	cooked	leafy vegetable	hFa	Han	permanent	5+5+3= 13	o f
Rubiaceae	**Aidia micrantha* (K.Schum.) Bullock ex F.White var. *micrantha*	okenia (f)	133, 1064	- fruit pulp - bark	raw raw	strenghtener strenghtener	PF	Sh/T	permanent	0+2+0= 2	/
	**Craterispermum schweinfurthii* Hiern	umbatana (a)	1841	bark	raw	strenghtener	SF	Sh	permanent	0+0+2= 2	/
	Heinsia/Mussaenda sp.	liakookenge, ayakpwokenge (k)	75, 1073	roots	raw	strenghtener	SF	sSh	permanent	0+5+0= 5	/
	**Morinda morindoides* (Baker) Milne-Redh.	kumbololo (f)	131	leaves (and liana)	cooked	tea subst.	hFa	L	permanent	0+5+0= 5	/
	**Mussaenda elegans* Schumach. & Thonn.	kombeyekongo (k)	1088	flowers	cooked	tea subst.	hFa	L	permanent	0+3+0= 3	/

Botanical family	Scientific name[a]	Vernacular names[b]	Herbarium reference[c]	Plant part(s) used as food[d]	Raw or cooked[d]	Specific use[d]	Habitat[e]	Morpho-logy[f]	Harvest Period	Total use citations[g]	Trade[h]
	Sabicea johnstonii K.Schum. ex Wernham	damudamu (o)	230	fruit	raw	fruit	hFa	L	permanent	2+0+0= 2	/
	Sherbournia batesii (Wernham) Hepper	ligele (v)	1116	fruit pulp	raw	fruit	SF	L	Aug.	0+0+1= 1	/
	Sherbournia bignoniiflora (Welw.) Hua	losabola (u,w,o) losawola, yekayesenga (k), ayamaysene (l) moyomememi (a)	212, 264 40, 1011 111	- pulp - leaves	raw cooked	fruit tea subst.	SF	L	permanent	7+3+1= 11	/
Rutaceae	**Zanthoxylum macrophyllum* Nutt. var. *preussii* Engl.	bolongo (o)	258	bark	cooked	tea subst.	SF	T	permanent	5+0+0= 5	/
Sapindaceae	*Chytranthus carneus* Radlk.	okene (l)	1060	seeds without skin	cooked or roasted	nut	PF	Sh	July-Oct.	0+3+0= 3	/
	Chytranthus macrobotrys (Gilg) Exell & Mendonça	botokolo, tokolo (u,w,o) okene (k,l) gesumba (a,v,m)	246, 329 32 100, 1127	seeds without skin	cooked or roasted	nut	PF	T	July-Oct.	3+4+5= 12	w
	Pancovia harmsiana Gilg	mangiamangia, undilinga (a,v,m)	84, 1102	fruit pulp (and seeds)	raw	fruit	PF	T	April-Aug.	0+0+12= 12	/
	**Pancovia laurentii* (De Wild.) Gilg ex De Wild.	botende, ntende (u,w,o) ntende (k,f)	260, 1002 1072bis	fruit pulp (and seed)	raw	fruit	PF	T	July-Oct.	5+2+0= 7	o
Sapotaceae	*Chrysophyllum lacourtianum* De Wild.	bolinda, lilinda (u,w,o) lilinda (k), ohambu (f), ohamu (l) ubombi (a,v,m)	291, 334 1134, 1198	fruit pulp	raw	fruit	PF	T	July-Oct.	6+6+7= 19	u,w,o m
	Synsepalum brevipes (Baker) T.D.Penn.	bokokolo, ikokolo (w,o)	254	fruit pulp	raw	fruit	PF	T	June-Aug.	3+0+0= 3	w,o
	Synsepalum stipulatum (Radlk.) Engl.	bonga, tonga (u,w,o)	9, 287	fruit pulp	raw	fruit	PF	T	April-July	4+0+0= 4	u,w,o
	Synsepalum subcordatum De Wild.	phunga (k)	56	fruit pulp	raw	fruit	PF	T	June-Sept.	0+1+0= 1	k
Smilacaceae	**Smilax anceps* Willd.	likako (u,w,o) akpu, masesa (a), iko, masesa (v,m)	252, 1005 1825, 1141	tubers	cooked	starch (staple)	SF	L	permanent	4+0+7= 11	u,w

Botanical family	Scientific name[a]	Vernacular names[b]	Herbarium reference[c]	Plant part(s) used as food[d]	Raw or cooked[d]	Specific use[d]	Habitat[e]	Morpho-logy[f]	Harvest Period	Total use citations[g]	Trade[h]
Solanaceae	*Capsicum frutescens* L.	mbase ikukunde (w,o)	220, 274	fruit	raw	condiment	Cult-ssp	sSh	permanent	7+0+0= 7	w,o
	Physalis pubescens L.	bumaloko (a), ifofo (m)	99, 1170	fruit pulp	raw	fruit	hFa	Han	permanent	0+0+2= 2	/
	Solanum aethiopicum L. "gilo group"	losuke (w,o)	994	fruit	cooked	- vegetable - condiment	Cult-ssp	Han	permanent	5+0+0= 5	o
	Solanum aethiopicum L. "Shum group"	azoko (v,m)	1149, 1873	- leaves - whole fruit	cooked cooked	leafy vegetable tea subst.	Cult-ssp	Han	permanent	0+0+3= 3	m
	Solanum distichum[k] Schumach. & Thonn.	ikalu (w,o) ngbaku (k) anzuwe (a), atanga (v,m)	278, 992 37 115, 1860	fruit	cooked	- tea subst. - condiment - vegetable	hFa	sSh	permanent	2+2+7= 11	/
	Solanum nigrum group: *Solanum americanum* Mill.	mbiti (v,m)	1129, 1879	leaves	cooked	leafy vegetable	hFa	Han	permanent	0+0+2= 2	m
Tiliaceae	*Desplatsia dewevrei* (De Wild. & T.Durand) Burret	bokomba, likamba (u), lisuli (w,o)	257, 271	seed	raw	nut	PF	T	permanent	8+0+0= 8	/
Urticaceae	*Myrianthus arboreus* P.Beauv.	bongunguna (u); bohuma (w,o) ohuma (k,f,l) unkawa (a,v,m)	304, 209 65, 136 114, 1155	fruit pulp	raw	fruit	SF	T	permanent (April-Oct.)	6+9+9= 24	w,o
	Myrianthus preussii Engl.	bohuma bolukund (w), bohuma petit (o) obukiengie (a,v,m)	990, 238 101, 1168	fruit pulp	raw	fruit	PF	Sh	July-Oct.	1+0+5= 6	/
	Urera thonneri De Wild. & T.Durand	likile (u)	22, 985	leaves	cooked	leafy vegetable	SF	L	permanent	1+0+0= 1	/
Verbenaceae	**Lippia multiflora* Moldenke	liyangalombo (f)	171	leaves	cooked	tea subst.	hFa	Han	permanent	0+3+0= 3	/
	**Vitex congolensis* De Wild. & T.Durand	ebite (o)	242	leaves	cooked	tea subst.	SF	T	permanent	3+0+0= 3	/
Vitaceae	**Cissus dinklagei* Gilg & M.Brandt	wese (o) limiambia (k,f), lahola (l) aliga (a,v), nambodo (m)	202 51, 1041 81, 1111	stem sap	raw	water	PF	L	permanent	1+10+7= 18	/
	Cyphostemma adenocaule (Steud. ex A.Rich.) Desc. ex Wild & R.B.Drumm.	bombeye (o) ombeye (k), awuliakongo (l) mendengele (m)	215 26, 1033 1159	- whole plant - young leaves	cooked cooked	tea subst. leafy vegetable	SF	Hp Cl	permanent	3+5+3= 11	/

Botanical family	Scientific name[a]	Vernacular names[b]	Herbarium reference[c]	Plant part(s) used as food[d]	Raw or cooked[d]	Specific use[d]	Habitat[e]	Morpho-logy[f]	Harvest Period	Total use citations[g]	Trade[h]
Zingiberaceae	*Aframomum laurentii* (De Wild. & T.Durand) K.Schum.	bongongoo, soso (u,w,o) lososo, lihoho (k,l), osomboko, loole (f) limbalu, lidulu (a,v,m)	234,308 1076, 1017, 153 107, 1828	- pulp and seeds - flower	- raw - cooked cooked	fruit tea subst. condiment	SF	Hp	permanent	7+31+19= 57	o l v,m
	**Aframomum subsericeum* K.Schum.	nadeye, lidulu (v,m)	1094, 1848	fruit pulp and seeds	raw	fruit	PF	Hp	permanent	0+0+3= 3	/
	**Aframomum verrucosum* Lock	kobasa, lidulu (v)	1201	fruit pulp and seeds	raw	fruit	hFa	Hp	permanent	0+0+3= 3	/
	Aframomum sp.2	onongo (k,f,l)	1052	fruit pulp and seeds	raw	fruit, pilipili	PF	Hp	permanent	0+8+0= 8	/
	Aframomum sp.3	tokanga soso (k,f), osomboko yasi (f)	1069	fruit pulp and seeds	- raw - cooked	fruit tea subst.	SwF	Hp	permanent	0+3+0= 3	/
	Aframomum sp.4	ndala, lidulu (v)	1200, 1865	fruit pulp and seeds	raw	fruit	hFa	Hp	permanent	0+0+4= 4	/
	Indéterminé	nelo (l)		fruit pulp	raw	fruit	PF	?	permanent	0+1+0= 1	/
	indéterminé	wodho (a,v,m)		young leaves	cooked	- tea subst. - leafy vegetable	hFa	?	permanent	0+0+4= 4	/
Pteridophyta											
Cyatheaceae	**Cyathea manniana* Hook.	oyaele (l)	1046	young leaves	cooked	leafy vegetable	SwF	fern	permanent	0+2+0= 2	/
Dennsteadtiaceae	**Blotiella glabra* (Bory) R.M.Tryon	asaha (k), oheyi yasi (f), oheyi (l)	1082, 138	young leaves	raw or cooked	leafy vegetable	SwF	fern	permanent	0+6+0= 6	/
	Pteridium aquilinum (L.) Kuhn	lilele (o) isili (f)	205 1070	immature fronds	cooked	- condiment - vegetable	hFa	fern	permanent	4+1+0= 5	/
Dryopteridaceae	**Diplazium sammatii* (Kuhn) C.Chr.	andole (f), aneke (l)	156, 1072	young leaves	cooked	leafy vegetables	SwF	fern	permanent	0+3+0= 3	/
Lomariopsidaceae	**Lomariopsis* sp.	asaha (k)	71	young leaves	cooked	condiment	SwF	fern	permanent	0+3+0= 3	/
Nephrolepidaceae	**Nephrolepis biserrata* (Sw.) Schott	asaha (k), likekele (l)	73, 1013	young leaves	cooked	- condiment - leafy vegetable	SF*	fern	permanent	0+5+0= 5	/
Thelypteridaceae	**Cyclosorus dentatus* (Forssk.) Ching	anole (l)	1037	young leaves	cooked	leafy vegetable	SwF	fern	permanent	0+1+0= 1	l

[a] * Species cited for the first time as edible in the Tshopo District and thus not mentioned by Bokdam and Droogers (1975), Bola and Szafranski (1991), Liengola (2001), Mosango and Isosi (1998), Mosango and Szafranski (1985), Nyakabwa et al. (1990) and Kawukpa and Angoyo (1994)

[b] (u), (w), (o), (k) , (f), (l), (a), (v) and (m) vernacular name(s) under which the plant species is known and used in Yalungu, Yasekwe ,Yaoseko, Yaleko Village, Olife, Lefundelo, Bafwabula, Bavoy and Bafwambalu, respectively. All vernacular names have their corresponding plurals by changing the prefixes, e.g. 'ikeke' becomes 'tokeke', 'liyo' becomes 'ayo', etc.

[c] Vouchers are stored in the herbarium of the National Botanic Garden, Belgium (BR) under the reference: PAS followed by their respective numbers;

[d] When more than 1 plant part is used per plant species, these are separated with dashes, idem for more than one preparation method per plant part used and more than one specific use per preparation method.

[e] Habitat: PF= Primary Forest species; SF= Secundary Forest species; hFa: herbaceous fallow species; SwF: Swamp Forest species; aquatic: aquatic species; Cult-ssp: species is cultivated and subspontanous in the region (grows spontaneously after first being introduced as crop); sp-Cutl: spontaneous in the region, but also grown as crop; SF*: species is saprophytic on palms of the Secondary Forest

[f] Morphology: T: Tree; Sh: Shrub; sSh: subShrub; L: liana; Hp: perennial herb: Han: annual herb; Cl: climber; Ltub; tuberous liana

[g] Number of use citations within Turumbu villages (u,w,o) + number of use citations in Mbole villages (k,f,l) + number of use citations in Bali villages (a,v,m) = total number of use citations

[h] Villages where the species are traded are indicated with their respective symbol (see [b])

[i] Fruits mature between June and Oct., they rot the whole year round on the ground and can be gathered at any time of the year. The more the fruit flesh is rotten, the easier the access to the kernel.

[j] Not the edible leaves of *Normandiodendron romii* are sold here, but the branches in form of handles for axes, machetes, hoes, etc.
Not the edible fruits of *Pentadiplandra brazzeana* are commercialized here, but the roots for medicinal purposes.

[k] The non-prickly, semi-domesticated *Solanum distichum* may well be treated as a cultivar group of the prickly wild progenitor *Solanum anguivi* Lam. (Lester and Seck 2004).

Plant parts used - specific uses

The 166 WEPs have 198 different plant parts that are used for 228 different specific food uses (see tables 5.3 and 5.4). Most WEPs are used for their fruits (68), followed by leaves (53), seeds (20) and trunk/stem or stem sap (15). WEPs are mainly used as fruits (67 specific uses), followed by their use as leafy vegetables (40), condiments (25) or tea substitutes (24).

Table 5.3: WEP parts used by the Turumbu, Mbole and Bali, Tshopo District, DRC

Plant parts used	Number of species
fruits	68
seeds	20
leaves	53
tubers	10
trunk, stem & stem sap	15
bark	11
leaf buds	2
young sprouts	2
flowers	5
roots	7
immature fronds (ferns)	1
whole plant	1
palm heart	2
fruit shell	1
TOTAL	**198**

Table 5.4: Specific uses of WEPs known by the Turumbu, Mbole and Bali, Tshopo District, DRC

Specific use	Number of species
fruit	67
leafy vegetables	40
condiment	25
tea substitute	24
nut	18
starch	11
other vegetables	10
strenghtener	15
water substitute	7
indigenous vinegar	6
palm wine	3
oil	2
TOTAL	**228**

Preparation methods

WEP preparation methods of the Turumbu have already been described in *chapter 4*. Only some interesting or new findings are highlighted here.

Despite the diversity of species used as leafy vegetable, they are basically all consumed in the same way. We registered three ways of preparation for fresh leaves and they were already described in *chapter 4*.

Seeds of *Tetracarpidium conophorum* (conophor nut) are boiled (rarely roasted) to reduce bitterness. When water is drunk within one hour after consumption, one experiences a very bitter sensation in the mouth. Some people claim that the raw nuts are poisonous and should thus not be eaten.

Roots of *Lasimorpha senegalensis* (Schott.) Engl., trunk or male inflorescences of *Elaeis guineensis* Jacq., fruit shells of *Pentaclethra macrophylla* Benth., roots of *Hydrocharis chevalieri* (De Wild.) Dandy and stem fibers of *Megaphrynium macrostachyum* are incinerated and the ash is used for seasoning dishes. This ash can be used directly on food or else it is dissolved in water. The resulting liquid can then be added to any dish. Locally they call this mixture indigenous salt or vinegar.

Some roots or herbal teas made from barks are said to be chewed (fresh or roasted) or drunk for the purpose of restoring strength, for example, during intensive labour. Local people explained that they give them the courage to continue hard field work. When chewed or drunk, they act as mild stimulants and suppress hunger, thirst, pain, and fatigue. One can discuss whether such plants should be added to a list of edible plants, but for completeness we decided to integrate them and followed the working definition as defined in Termote (2010a): 'wild food plants are plants of which a part is consumed as vegetable, fruit, spice, strengthener, etc., and not only in case of a (self-) diagnosed illness nor for narcotic or hallucinogen purposes'.

Seasonality

Most fruits are available from July till October. Tubers and (leafy) vegetables are available the whole year round (table 5.2).

Trade

Although sometimes rather occasionally, 64 WEPs can be sold locally within one or more of the studied villages, to passing travelers or on local rural markets (see last column table 5.2). Seeds of *Tetracarpidium conophorum* and fruits of *Landolphia owariensis* are sold in all villages, fruits of *Piper guineense* in 8 of the 9 villages; and leaf buds of *Megaphrynium macrostachyum*, seeds of *Cola acuminata* (P.Beauv.) Schott. & Endl., tubers of *Dioscorea praehensilis* Benth. and fruits of *Anonidium mannii* in 7 of the 9.

Non-food uses of WEPs

In total, 1684 use citations were recorded, i.e. 444 in the Turumbu villages, 631 in the Mbole villages and 609 in the Bali villages. We registered 507 medicinal use citations for 109 WEP species, 275 use citations in the category material, technology and arts (66 species), 108 cultural use citations (49 species), 80 use citations in the construction category (32 species),

59 use citations as fuel (29 species), 23 as bait (15 species), 17 as fodder (10 species) and 4 as poison (3 species). An overview of all uses is given in annex 1.
Over all villages, the following species are the most 'useful', *Aframomum laurentii* with 57 use citations, *Canarium schweinfurhtii* (47), *Laccosperma secundiflorum* (P.Beauv.) Kuntze, *Costus lucanosianus* and *Piper guineense* with 46 citations *Megaphrynium macrostachyum* (44), and *Landolphia owariensis* and *Anonidium mannii* both with 42 use citations (see last but one column table 5.2).

Comparison of WEP knowledge between villages

The Turumbu know in total 85 WEPs, the Bali 86 and the Mbole 99. Of all plants inventoried, 21% are known in all 3 ethnic groups. The Turumbu and Mbole share 40.5% of the total number of WEPs inventoried in both ethnic groups, the Mbole - Bali, 29.4% and the Turumbu - Bali, 34.7%.

Per ethnic group, the number of plants known in all 3 villages, in paired villages and in each simple village is shown in figure 5.2. The mean number of WEPs known per village for the Turumbu is 64.7, for the Mbole 56 and for the Bali 64.3. Although the Mbole know on average less WEPs per village, the total number of WEPs documented for this ethnic group is the highest (99 WEPs versus 85 and 86). This indicates a more diverse plant knowledge between Mbole villages.

Sørensen similarity indices between paired villages of the same ethnic group vary from 0.58 to 0.84. Similarities between paired villages from different ethnic groups vary from 0.38 to 0.62. Intra-ethnic Sørensen similarity indices are significantly higher than inter-ethnic Sørensen similarity indices (Wilcoxon rank-sum test, $p<0,001$).

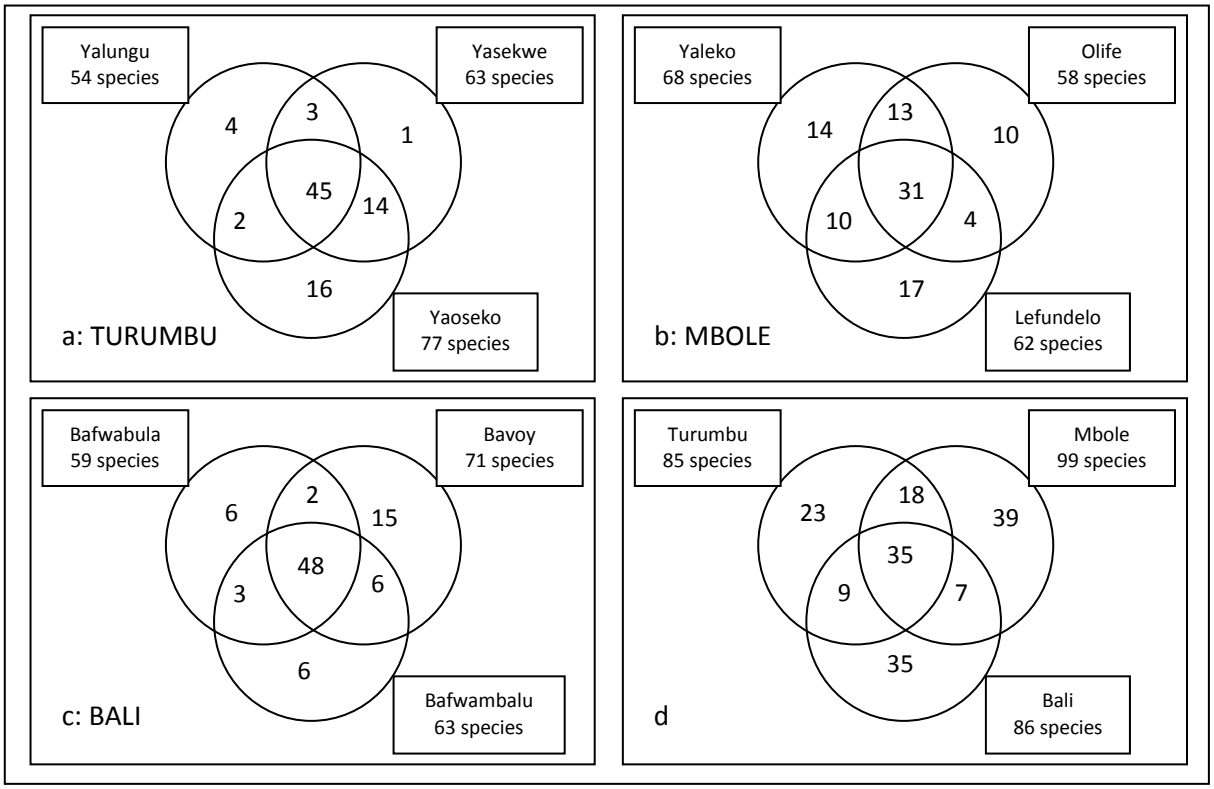

Figure 5.2: a-b-c: Number of WEP species known in all three Turumbu (resp. Mbole and Bali) villages surveyed (innermost circle), and in only two or one village (outer circle segments); behind the village name, the total number of species identified in this village is given
d: Number of WEP species known in all three ethnic groups surveyed (innermost circle), and in only two or one group (outer circle segments); behind the ethic group name, the total number of species identified in this group is given

This result is confirmed in figure 5.3 which shows the results of the clustering exercise in a dendrogram. At first, Bafwabula and Bafwambalu together with Yasekwe and Yalungu are grouped together through the clustering method, indicating that they have the highest similarities in WEPs known. Subsequently Bavoy, respectively Yaoseko join the other villages of their ethnic group. Only then, Yaleko Village and Olife join each other followed by Lefundelo. At an Euclidean distance of 15, the Turumbu villages join the Mbole villages, indicating that the Turumbu and Mbole have more WEP knowledge in common with each other than with the Bali. However, one should refrain from generalizing this last finding because of the small sample size (only 3 villages per ethnic group).

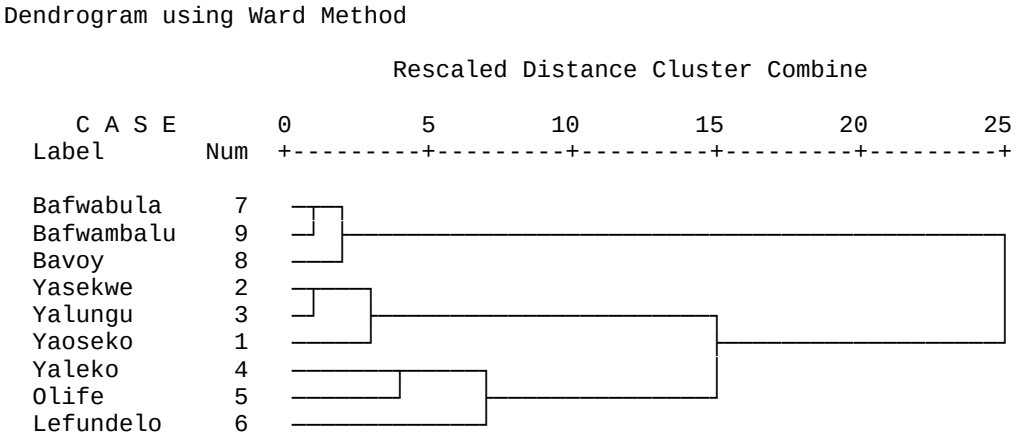

Figure 5.3: Dendrogram presenting the results of the clustering of the 9 study villages based upon occurence (present/absent) of the 166 WEPs inventoried, using Ward's Hierarchical Clustering Method

Looking at the plant parts used, the Turumbu know the highest number of wild tubers, the Bali the highest number of nuts and fruits, whereas the Mbole know the highest diversity of edible leaves (figure 5.4). Figure 5.5 presents the specific uses per ethnic group. The Mbole know more wild leafy vegetables and condiments than the others, the Bali know more about nuts and the Turumbu more about staple foods rich in starch.

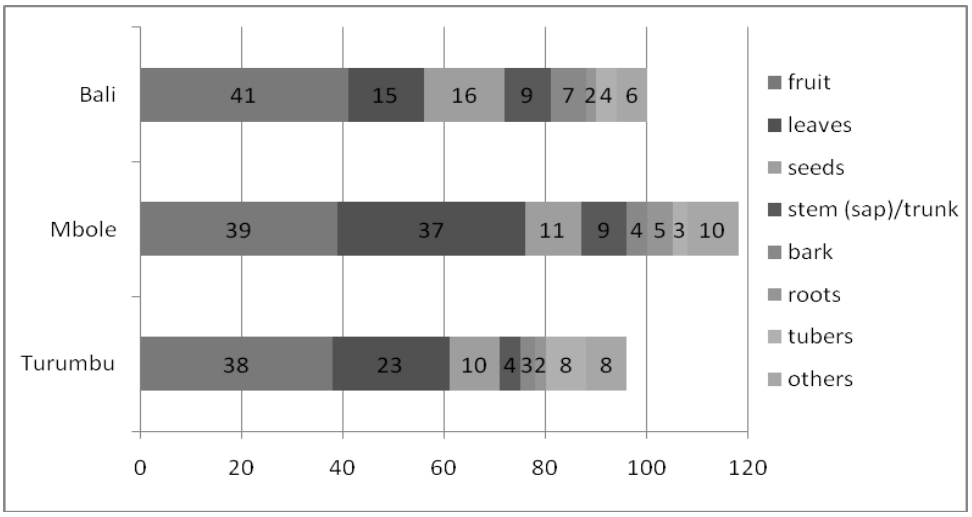

Figure 5.4: Different WEP parts used separated per ethnic group (Turumbu, Mbole and Bali), District Tshopo, DRC

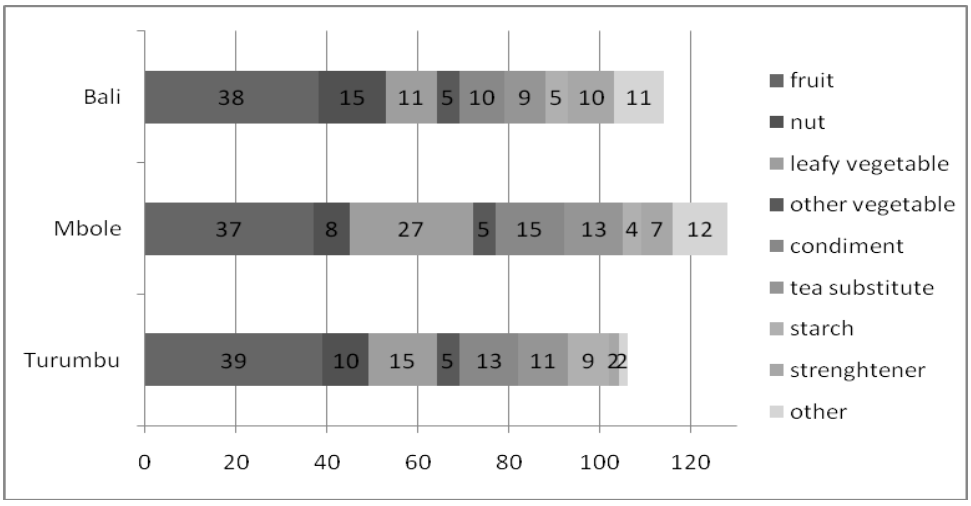

Figure 5.5: WEP specific uses separated per ethnic group (Turumbu, Mbole and Bali), District Tshopo, DRC

Participatory ranking

The aggregated results of the ranking exercises are shown in tables 5.5 and 5.6. Only species which appeared more than once in the top three for at least one characteristic are included in the tables. Although we can trace some similarities between the different ethnic groups, each group also has its own specificities. In all ethnic groups, *Anonidium mannii* scores best in the category fruits, whereas *Megaphrynium macrostachyum* comes first in the category vegetables. *Landolpia owariensis* ranks second in the category fruits for the Turumbu, whereas *Panda oleosa* ranks second for the Mbole. The latter species is not present in the Bali or Turumbu tables. Bali rankings show *L. owariensis* together with *L. robustior* (K.Schum.) J.G.M.Pers. and *Tetracarpidium conophorum* to be second most important. *L. owariensis* and *T. conophorum* also belong to the most-preferred species of the Turumbu and Mbole. Another species present in all 3 fruit preference tables is *Aframomum laurentii*. In the vegetables category, *Talinum triangulare* (Jacq.) Willd. ranks second for the Turumbu, *Scorodophloeus zenkeri* for the Mbole and *Amaranthus dubius* Mart. ex Thell. for the Bali. Apart from *M. macrostachyum* and *S. zenkeri*, none of the most-preferred vegetable species are present in the tables of more than 1 ethnic group.

Table 5.5: Aggregated results of the participatory ranking exercises for fruits

Turumbu						Mbole						Bali					
	T	**E**	**S**	**N**	**Gw**		**T**	**E**	**S**	**N**	**Gw**		**T**	**E**	**S**	**N**	**Gw**
Aframomum laurentii	0	1	2	0	0	*Aframomum laurentii*	0	0	2	0	0	*Aframomum laurentii*	0	0	2	0	0
Anonidium mannii	**4**	**5**	**4**	**6**	**6**	***Anonidium mannii***	**5**	2	**4**	**5**	**5**	***Anonidium mannii***	4	0	**3**	**4**	**5**
Chrysophyllum lacourtianum	0	3	1	4	2	*Carpolobia alba*	0	0	2	0	0	*Clitandra cymulosa*	0	0	0	3	0
Landolphia owariensis	**4**	**5**	0	3	4	*Landolphia owariensis*	3	**5**	1	3	2	*Cola acuminata*	1	2	**3**	0	1
Pentadiplandra brazzeana	3	1	2	0	1	***Panda oleosa***	**5**	4	0	4	**5**	***Landolphia owariensis***	**6**	**6**	1	2	**3**
Synsepalum stipulatum	3	1	1	0	0	*Pentadiplandra brazzeana*	2	1	3	0	2	***Landolophia robustior***	5	4	1	3	**3**
Tetracarpidium conophorum	2	2	0	3	2	*Piper guineense*	0	1	2	0	0	*Landolphia villosa*	1	2	1	2	1
						Tetracarpidium conophorum	3	**4**	1	**4**	3	*Myrianthus arboreus*	0	0	2	0	0
												Tetracarpidium conophorum	3	**6**	0	**3**	**3**

Numbers represent number of times a plant species appeared in the top three for the different characteristics (T = taste, E = economic value, S = socio-cultural value or N = nutritional value) and in the global weighted ranking (Gw); in bold = highest score obtained per categorie and for the global weighted ranking

Table 5.6: Aggregated results of the participatory ranking exercises for vegetables

Turumbu						Mbole						Bali					
	T	**E**	**S**	**N**	**Gw**		**T**	**E**	**S**	**N**	**Gw**		**T**	**E**	**S**	**N**	**Gw**
Celosia spp.	3	1	0	4	2	*Hibiscus acetosella*	2	1	1	2	2	*Alchornea cordifolia*	1	0	2	0	0
Crassocephalum crepidioides	0	0	2	1	0	*Laccosperma secundiflora*	0	2	2	2	2	***Amaranthus dubius***	4	3	2	5	**5**
Gnetum africanum	0	2	1	0	2	***Megaphrynium macrostachyum***	**6**	**6**	**4**	**5**	**6**	*Elaeis guineensis*	1	0	1	2	2
Hilleria latifolia	0	0	2	0	0	*Phytolacca dodecandra*	1	0	0	2	1	***Megaphrynium macrostachyum***	**6**	**5**	**6**	**6**	**6**
Hua gaboni	5	4	**5**	1	2	***Scorodophloeus zenkeri***	4	2	3	1	**3**	*Momordica foetida*	1	0	3	1	0
Megaphrynium macrostachyum	4	**6**	2	**6**	**6**							*Piper umbellatum*	1	0	3	0	0
Scorodophloeus zenkeri	1	4	4	1	1							*Solanum aethiopicum*	4	3	0	4	4
Talinum triangulare	**6**	2	0	**6**	**4**							*Solanum americanum* Mill.	2	1	1	1	1

Numbers represent number of times a plant species appeared in the top three for the different characteristics (T = taste, E = economic value, S = socio-cultural value or N = nutritional value) and in the global weighted ranking (Gw); in bold = highest score obtained per categorie and for the global weighted ranking

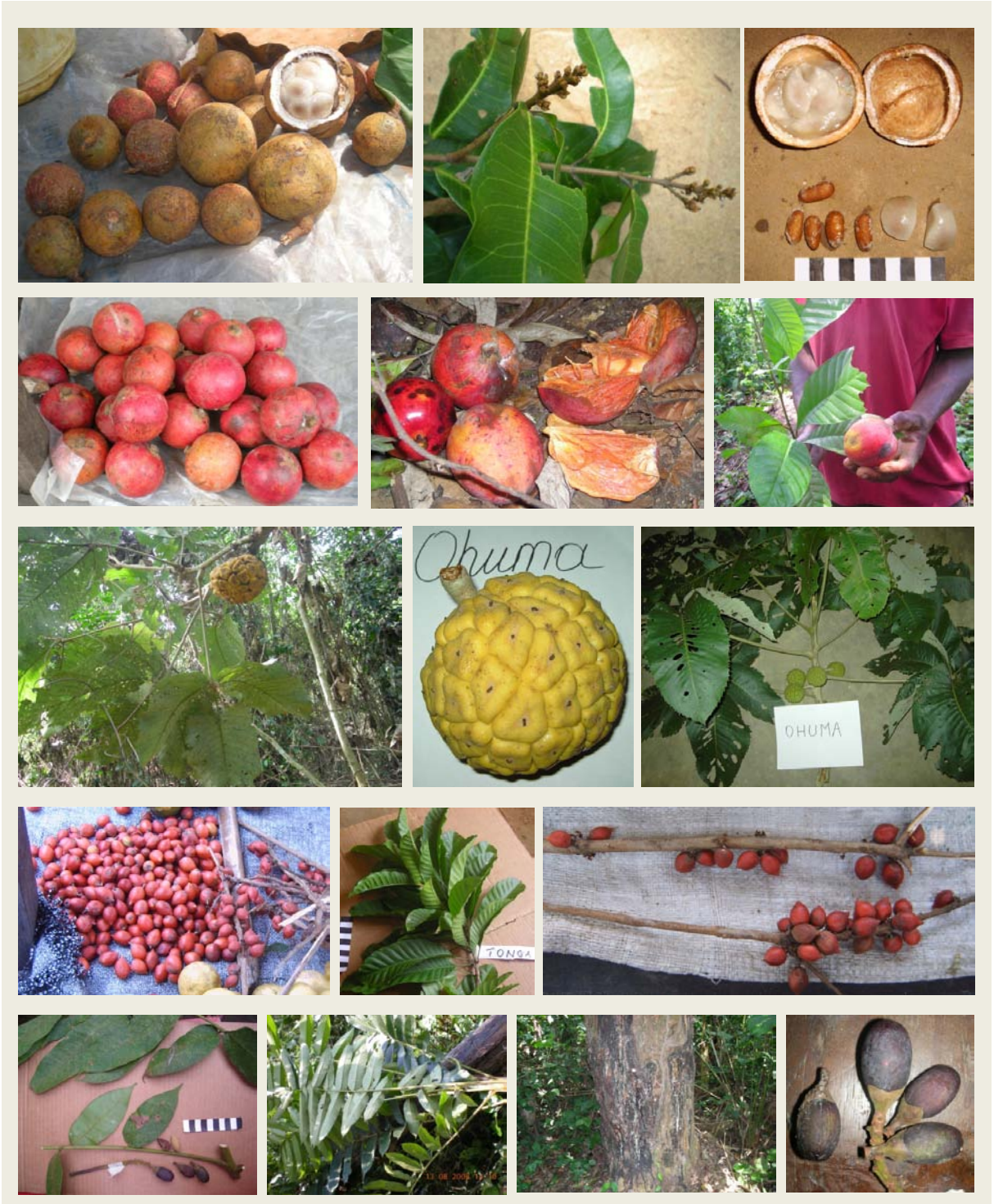

Figure 5.6: Wild fruits: *Landolphia owariensis* (above), *Chrysophyllum lacourtianum* (2nd line), *Myrianthus arboreus* (3rd line), *Synsepalum stipulatum* (4th line), *Canarium schweinfurthii* (below)

5.4. Discussion

Species used

Compared to the inventories of Bokdam and Droogers (1975), Bola and Szafranski (1991), Liengola (2001), Mosango and Isosi (1998), Mosango and Szafranski (1985), Nyakabwa et al. (1990) and Kawukpa and Angoyo (1994), 72 species were cited for the first time as WEP in the region. This is almost half of the species presented in table 5.2, where they are marked with an asterisk. All ethnobotanical studies cited above were carried out in multi-ethnic settings, in and around Kisangani. Apart from Liengola (2001), who studied Turumbu and Lokele WEPs, no inventories have ever been done before within the Mbole and Bali ethnic groups living in, resp., the Opala and Bafwasende territories. However, the above-cited publications mention another 61 WEPs not found in our study. Investigating the other 11 major ethnic groups of the District (Balengola, Basoko, Bangando, Babua, Lokele, Topoke, Bamanga, Bakumu, Bango, Bangelema and Bambesa) would thus certainly add new and valuable ethnobotanical information.

Inter- and intra-ethnic comparisons of WEP knowledge

Villages belonging to the same ethnic group first cluster together in the dendrogram in fig. 5.3 to clearly form 3 ‘ethnic’ clusters. Just like many other authors (e.g., Dansi et al. 2008; Macía 2004; Arenas and Scarpa 2007), we found that ethnobotanical knowledge was highly different between the ethnical groups studied, even though our 3 ethnic groups practise almost the same system of subsistence agriculture and share the same ecological environment (at least at first sight, see under: biological or cultural differences?). Only at a large Euclidian distance, the Turumbu and Mbole villages become grouped together. The percentage of species shared by the Turumbu, Mbole and Bali vary from 29% to 40% when ethnic groups are paired, whereas only 21% of the species is known in the 3 groups. These figures are quite low in comparison to a study comparing palm uses of 6 indigenous groups in the Amazonian Ecuador (% shared species ranging 44-65%; Macía 2004), or a study comparing WEPs of 5 indigenous groups in the Gran Chaco Region, South America (% shared species ranging 54-86%; Arenas and Scarpa 2007). This indicates that WEP knowledge in the Tshopo District is highly diverse between different indigenous groups and again corroborates the need to study the other ethnic groups if we want to document all WEP knowledge of the whole district.

WEP knowledge of the Bali is the most homogenous (see dendrogram, fig.5.3); that of the Mbole is most diverse. Studying another Mbole village will thus have the most added value to find new WEP species and/or uses (compared to the Turumbu and Bali). Based upon some dialectical differences, the Mbole are separated into 2 different groups, Mbole Ima and Mbole Ngoya (Opala Territory Report 2008). We studied one Ima village (Yaleko Village) and two Ngoya villages (Olife and Lefundelo). These inherent cultural differences could be among the explanatory factors for the higher diversity in plant knowledge encountered for the Mbole, because the latter are part of the biocultural heritage of indigenous populations. Another factor that could limit the exchange of information and knowledge between the Mbole communities, may be the very bad road conditions together with the isolated geographical position and huge extent of the Mbole living territory (Opala). In addition, some natural barriers such as the Lobayi and Lomami rivers could have had their impact on species distribution, but also on the sharing of knowledge. Although Yaleko Village and Olife belong to different Mbole groups, the differences in plant use and knowledge are highest with Lefundelo, situated on the other side of the big Lomami barrier.

Biological and/or cultural differences?

The diversity of plants known and used by human populations is probably affected by the plant diversity in their direct environment (Hanazaki et al. 2000). In our project, we did not perform vegetation studies, thus we cannot say whether differences in plant uses between ethnic groups are due to differences in species abundances or if they are cultural. For instance, we do not know whether *Grewia* spp. and *Maesobotrya longipes* (Pax) Hutch. are not available in the vegetation surrounding the Turumbu and Bali, or if they are simply not known nor used. At first sight, Tshopo District is covered by the same block of mixed moist semi-evergreen forests (White 1983), but as in other tropical forests, species composition in small plots is likely to differ from place to place (Ichakawa 1993). Moreover, the fact that WEP knowledge between the Bali and both other groups shows higher differences than WEP knowledge between Turumbu and Mbole can probably not be solely attributed to cultural differences. The climate might be slightly different (the very northeast of the Bafwasende Territory experiences a transition climate between Af and Aw) and there is also a small altitude distinction (500 to 600m in Bafwasende Territory versus 400m in Opala and Isangi Territory). These factors may have an influence on the vegetation and thus the species occurrences in the different Territories. Hence the term biocultural differences may be better indicated to refer to differences in WEP knowledge originating from cultural traditions

making use of a particular natural environment. Still, with almost no data on ethnical groups or vegetation available for Tshopo District to clarify the differences found, it remains important to know that biocultural differences exist in the district. The main purpose of our study being to contribute to the valorisation of WEPs, we should be able to take into account differences and similarities when promoting WEP consumption and trade in the region.

In other cases, some species are known by the villagers, whereas they are not regularly used because they are not available in the vicinity of the village. This is, e.g. the case for *Scorodophloeus zenkeri* in Bavoy and Bafwambalu. We included them in the list, because they are part of the cultural heritage of the inhabitants of Bavoy and Bafwambalu, but it should be stressed that not all known WEPs are necessarily consumed on a regular basis. Takeda (1990) observed that only 47.8 % of WEPs known by the Ngandu, Bantou agriculturalists of the Equator Province, DRC, were regularly consumed. Similarly, Mbuti Pygmies, hunther-gatherers of the Ituri forest, DRC, were shown to use 84 WEPs, but 80% of their consumption came from just 8 species (Ichikawa 1993). WEP's physical availability, as cited above, may be one of the reasons for regularly using or not certain species (Arenas and Scarpa 2007; Camou-Guerrero 2008). Bonet and Vallès (2002) as well as Pardo-de-Santayana et al. (2005) found that the most-used WEPs are those being readily available, e.g., growing in the vicinity of the village near the home. However, there are other factors, local populations also have clear preferences for consuming certain species. These preferences are imbedded in the cultural traditions and sometimes even define their 'cultural identity' (Pieroni et al. 2005).

Cultural significance, cultural preferences and priority setting

Many authors tried to measure the concept of cultural significance or cultural value to set priorities for further study, conservation or domestication. Probably the best known is the Use Value index of Philips and Gentry (1993), which measures the mean number of use citations of plant species. Other indices consider aspects such as knowledge of utilitarian properties, local perception of plant resource abundance, plant species quality (contribution of a species to people's survival), intensity and exclusivity of use, and taste (Camou-Guerrero et al. 2008). More recently, Reyes-García et al. (2006) developed a method to value plant species based on their cultural, practical, and economic characteristics.

In our opinion, many aspects should be evaluated when it comes to priority setting for further study and domestication of WEPs. Some useful parameters such as the number of villages

where the WEPs are known, the number of villages where they are sold, the number of use citations per plant (as a parameter for the multi-purpose use of the species) and the preferences of the local populations themselves have been investigated here. For instance, the species known and used in almost all villages and having more than 30 total use citations and being sold in 7 or more villages are *Anonidium mannii*, *Landolphia owariensis*, *Megaphrynium macrostachyum*, *Piper guineense* and *Cola acuminata*. *Canarium schweinfurthii*, *Scorodophloeus zenkeri* and *Aframomum laurentii*, sold in 4 villages and having more than 30 use citations can furthermore be added to this list. Even though *Tetracarpidium conophorum* shows less total use citations, it can also be added to the priority list for domestication because of its very high commercial potential (one of the 2 species sold in all 9 villages surveyed). *Costus lucanosianus*, *Laccosperma secundiflorum*, *Gilbertiodendron dewevrei* (De Wild.) J.Léonard and *Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg. have very high total use citations, but are not subject to trade and thus less interesting to generate an income through participatory domestication. Nevertheless, their high use values could be used as teasers in educational programs dealing with biodiversity conservation, since people are more motivated to conserve more important species (Byg and Balslev 2001).

However, the above-cited parameters are not strong enough to construct a reliable priority list. Market surveys and value chain analyses should be used to thoroughly assess the commercial potential of these WEPs (Leakey 1999). Some other aspects such as nutritional values, pressure on natural resources due to overexploitation and domestication possibilities of the species or families should also be integrated when it comes to setting priorities for further study and domestication.

In addition, the preferences, perceptions and choices of the local populations themselves should always form a basic starting point (‘emic approach’; Byg and Balslev 2001). When they are asked to rank WEPs according to preferences, local people can take into account all or some of the above-cited aspects along with others (sometimes less obvious for western minds). Agea et al. (2007) found that taste and nutritional value were the most important factors in ranking indigenous fruit trees in Uganda, followed by potential cash and/or medicinal value. According to Dansi et al. (2008), taste is usually the first criterion sought after for all types of food. In his study on traditional leafy vegetables in Benin, taste, ease of preparation, availability, quantity of condiments required, sliminess, nutritional value, high

market value and medicinal value were amongst the most cited preference criteria when his respondents were asked why they preferred certain species.

Looking at our study results, local preferences expressed in the ranking exercises correspond very well with the tentative ranking based upon total use citations and number of villages where the respective species are sold. *Anonidium mannii, Landolphia owariensis* and *Megaphrynium macrostachyum* are amongst the highest-ranked species in both rankings. *Piper guineense* and *Cola acuminata* might be omitted from the preference ranking exercises because of the methodology used. Participants in the preference ranking exercises were asked to cite the 10 most important wild fruits and 10 most important wild vegetables whereupon they were ranked. *Piper guineense* is used as spice and tea substitute and *Cola acuminata* is not really seen as a fruit (rather a nut chewed as strengthener or stimulant). So they were simply not mentioned at the beginning of the exercises and were thus not considered in the preference rankings. Nonetheless, *Cola acuminata* is sold in 7 villages and has a lot of cultural significances. The Turumbu, e.g., use it as a luck charm or to bless their children. *Piper guineense* comes on the third place after *L. owariensis* and *T. conophorum* for commercial potential and has the fifth most total use citations. Both species have also regional trade importance in Central Africa (Hoare 2007).
Therefore we argue that the local preference rankings in this study should be refined for further study and that scientific insights should be combined with expressions of local preferences when constructing species priority lists.

Another important issue in priority setting, is that different ethnic groups have different possibilities and constraints such as market access, and different cultural habits and preferences, as seen above. The nuts of *Ricinodendron heudelotii* (Baill.) Heckel, e.g., are only known by the Bali. The nuts of *Panda oleosa* are sold in the Turumbu and Mbole villages, but not by the Bali. The leaves of *Gnetum africanum* Welw., the tubers of *Dioscorea dumetorum* (Kunth) Pax and the fruits of *Synsepalum stipulatum* (Radlk.) Engl. are sold in all three Turumbu villages, but not in any other village. In comparison with the Mbole and Bali, the Turumbu live nearer to Kisangani (max. 100 km) and are able to sell their products on the city markets. *G. africanum* does not belong to the cultural identity or habits of the Turumbu (nor the other ethnic groups in Tshopo District), but they learned that other people in Kisangani (Kinshasa, Goma, etc.) have a strong preference for this nutritious vegetable. Today, *Gnetum africanum* constitutes a big source of income for the Turumbu households,

Figure 5.7: Wild spices and stimulant nuts: *Piper guineense* (above), *Cola acuminata* (2nd line), *Scorodolphoeus zenkeri* (3rd line), *Garcinia kola* (below)

although they don't even know how it tastes. In 2006, 54 tons of *Gnetum* were exported to Kinshasa by the different air companies operating at that time in Kisangani (CAA, HBA and WBD; Bwama et al. 2007; Van Damme and Termote 2008). *G. africanum* is one of the species that is in urgent need for domestication because of the overexploitation of the wild resource, but the Mbole and Bali will probably not have the incentives to domesticate this species, because their access to the Kisangani markets is too difficult. Other interesting

species the Turumbu sell on the Kisangani markets are the roots of *Pentadiplandra brazzeana* Baill. and the fruits of *Chrysophyllum lacourtianum* De Wild.

Since January 2010, preliminary domestication trials with *Gnetum africanum*, *Anonidium mannii*, *Piper guineense* and *Cola acuminata* are going on with a local farmer organization in the Turumbu village Yaoseko.

5.5. Conclusion

This study inventoried WEP knowledge of the Turumbu, Mbole and Bali, 3 Bantou ethnic groups of the District Tshopo, DRC. To our knowledge, this was the first ethnobotanical study in the Opala and Bafwasende Territories. In Total 166 WEPs (165 species and 2 varieties) were inventoried in 71 families. Only 21% of the species were used in the 3 ethnic groups. The WEPs knowledge was most homogenous in the Bali tribe and least in the Mbole tribe.

Some similarities could be found between the different ethnic groups, but each group also clearly has its own peculiarities, defined by their biological environment, cultural habits and traditions. We should keep this in mind when constructing species priority lists for domestication (and/or conservation). A difference should be made between species with regional importance (as, e.g. for the Tshopo District) and ethnospecific species. The need for domestication or sustainable harvest regulations for *Gnetum africanum* in the Turumbu territory is obvious, but has so far no sense for the Mbole and Bali. Based upon the participatory ranking exercises, *Anonidium mannii*, *Landolphia owariensis* and *Megaphrynium macrostachyum* are some of the species with regional importance.

Further multidisciplinary study is needed to inventory the WEPs of the other major ethnic groups of the Tshopo District, to assess the importance of WEPs in the daily life of households and to refine preference ranking exercises, to detect the market potential of the WEPs, to analyze the nutritional value of the WEPs and their contribution to the local diets, to construct priority species lists and to evaluate the domestication possibilities or to propose sustainable harvest techniques.

CHAPTER SIX

WILD EDIBLE PLANT MARKETS IN KISANGANI

Figure 6.1: Djubudjubu (Tshopo) and IAT (Makiso) markets located on the river banks of the Tshopo and Congo rivers, respectively; canoes with products from the hinterlands arrive at these markets and products are sold for a first time at the water line.

Abstract

Benefits from wild edible plants (WEP) are multiple for both rural households and urban traders. To set species priorities for WEP market development and domestication, we performed an inventory of WEP species and traders in 5 markets and 1 road-side selling point in Kisangani city. In order to cover a whole calendar year, we interviewed all WEP traders present in the target markets during four one-month sessions between September 2007 and July 2008. In total, we registered 119 unique sellers, offering 15 different WEPs. The September-October period and *Marché Central* were most important for WEP trade in Kisangani. Added values and net incomes generated through respective WEP sales were very divergent. Based on the species sold and socio-economic characteristics of our interviewees, we identified four types of traders, i.e. subsistence traders, traders diversifying in WEPs sold, traders diversifying in income activities and specialized traders. International, national as well as local markets exist for *Gnetum africanum* leaves, *Piper guineense* fruits and nuts of *Cola acuminata* and *Garcinia kola*. The species with highest demand for and most dynamic traders was shown to be *G. africanum*. The wild spices and stimulant nuts (*P. guineense, C. acuminata* and *G. kola*), on the other hand, are so far only locally sold and mainly in micro-quantities by extremely poor elderly widows. Within the wild fruits category, we can propose *Landolphia owariensis* and *Tetracarpidium conophorum* as priority species for local market development.

Céline Termote, Gert Everaert, Marcel Bwama Meyi, Benoît Dhed'a Djailo, Patrick Van Damme. *Wild Edible Plant markets in Kisangani, Democratic Republic of Congo. Human Ecology, 2012, 40(2): 269-285* (Impact Factor: 1.923*).*

6.1. Introduction

Another objective of the WEP project (see *chapter 1*) was to assess the socio-economic value of the WEPs inventoried during ethnobotanical investigations. We, therefore, performed socio-economic household interviews in the study villages (not described in this thesis) and studied WEP plant markets in Kisangani.

To our knowledge, studies on either WEP or NTFP markets in Kisangani are limited to two local unpublished student research surveys (Bagula 1977; Bhua 1991) and to a preliminary report prepared for the international expert meeting on non-wood forest products in Central Africa (Limbe, Cameroon, May 1998; Liengola 1999). Although these documents present lists of NTFP species sold on Kisangani markets, they do not mention prices nor quantities sold.

Notwithstanding the importance of emerging NTFP markets in DRC, only very scattered information is available. Both potential and value of NTFPs with regard to income generation and poverty alleviation are not fully known by the local population nor by socio-political decision makers (Bamoninga 2007). As a consequence it is useful to address this knowledge gap and to document motivations and constraints faced by traders (and gatherers), which should help to set priorities in WEP species conservation and market development.

This chapter focuses on WEP trade in Kisangani markets. Its objectives were to: 1) inventory WEPs traded on Kisangani markets, their (seasonal) availability and harvest origins; 2) evaluate current market value (quantities, prices and added values) per WEP; 3) identify the different types of traders according to plant species traded, socio-economic characteristics and incomes; and finally 4) propose some 'promising' species for further research and market development.

6.2. Materials and methods

Study area

Kisangani is administratively divided in six municipalities (Makiso, Tshopo, Mangobo, Kabondo, Kisangani and Lubunga) and has 12 official market places: *Marché Central, IAT, Djubudjubu, Tshopo 11ième avenue, Tshopo 15ième avenue, Lubunga beach, Mangobo Christ-Roi, Mangobo Balese, Marché annuarite, Kabondo Foyer, Kikongo and Sotexki*. The city's commercial centre is situated in Makiso, around *Marché Central*, the biggest market in the city with the highest number of sellers and products offered. *IAT* (Makiso) and *Djubudjubu* (Tshopo) are markets located on the river banks of the Congo and Tshopo rivers, respectively. Canoes with products from the hinterland arrive at these markets and products are basically sold to intermediaries immediately at the water line. These products are then brought to the *Marché Central* or resold on the same market, some meters away from the waterline. The remaining markets are smaller, municipal markets. Sellers on the latter markets mostly buy their merchandise at the *Marché Central*, sometimes at *IAT* or *Djubudjubu* markets and occasionally directly from gatherers/traders coming from the hinterland.

Data collection

Interviews were performed at *Marché Central, IAT, Djubudjubu*, two municipal markets *(*i.e. *Tshopo 11ième avenue* and *Kabondo Foyer*) and *Libanga*, a road-side selling point (figure 6.2). We opted for a non-probabilistic reasoned sample (De Pelsmacker and Van Kenhove 2006) covering the principal market (*Marché Central*), the two riverside supply markets (*IAT* and *Djubudjubu*), two of the nine municipal markets and the most important road-selling point *Libanga*. Choice of municipal markets was based on:

1) number of WEPs counted during initial inventories (Monteiro et al. 2010); and

2) accessibility/operationality of markets (some municipal markets were under reconstruction at time of field research).

During September-October 2007, all WEP sellers at the five selected markets and *Libanga* were interviewed. Since WEP availability, especially for wild fruits, is seasonal (Termote et al. 2010b, 2011), we repeated this exercise three times more in December 2007-January 2008, March-April 2008 and June-July 2008 to try to cover variability within one year.

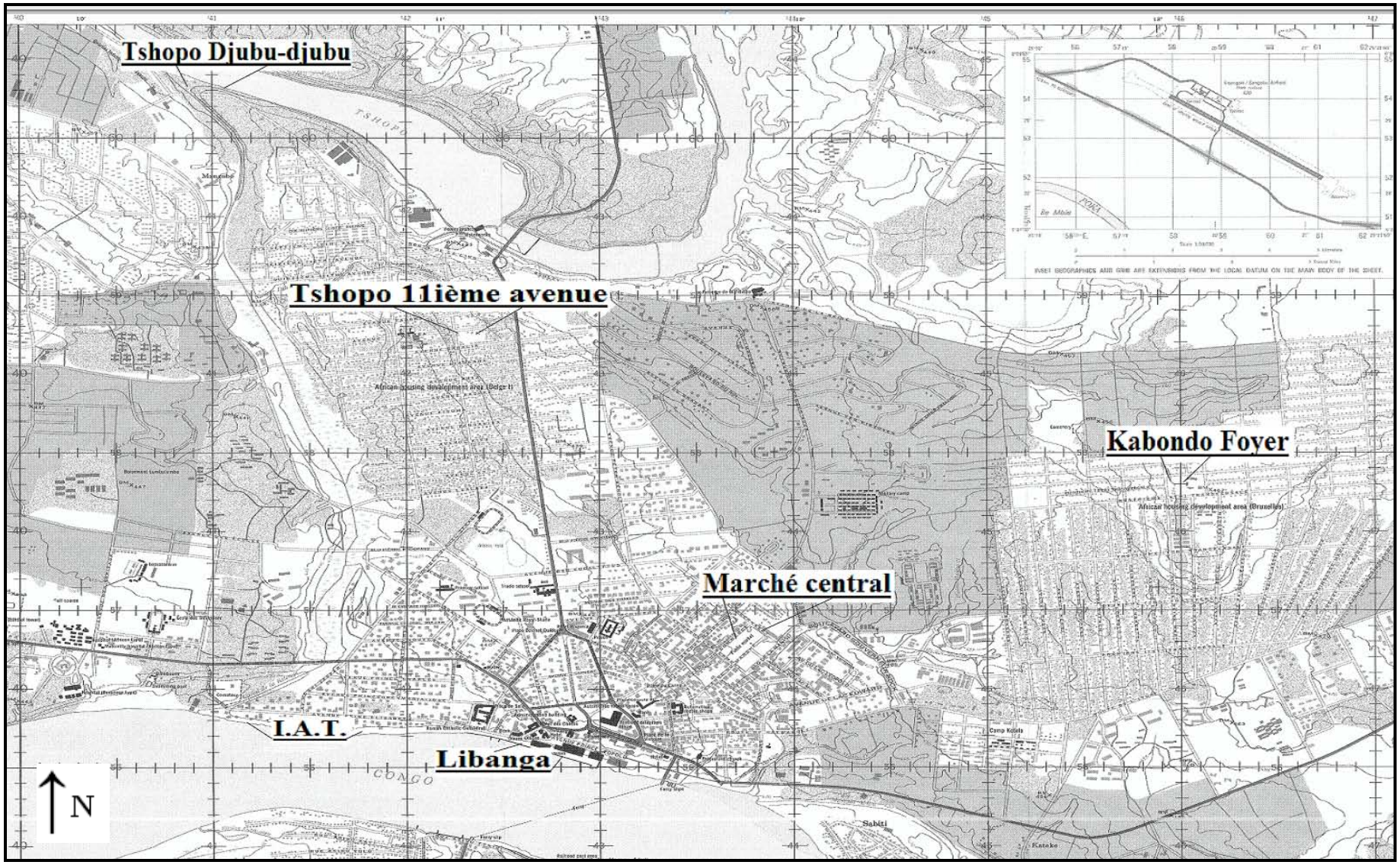

Figure 6.2: Geographical position of the markets studied (based on National Imagery and Mapping Agency, map series number Z901 edition 2-NIMA Kisangani); (Everaert, 2008)

Prior to any interview, we clearly presented research objectives and methods, and asked the participant's full consent and collaboration. We used a structured questionnaire with open-ended questions treating:

1) socio-economic household characteristics of the respondent; and

2) the process of buying and selling WEPs, recalling the year preceding the interview (WEP species offered on the interview day, other species sold but not present at the day of interview, quantities bought/sold per week, buying/selling prices, trading period per species and place of collection, storage and processing practices, (il)legal taxes and other costs related to WEP marketing, and problems encountered (Sundryal and Sundryal 2004)).

Interviews were conducted in French, Lingala or Kiswahili (the main regional languages) according to the participant's preferences. For each trader, buying and selling prices per kg of product were calculated after weighing the products available in the market with a digital dietary scale and asking prices (5 samples per price category per product for each trader; Sundryal and Sundryal 2004). When products were not available on the day of interview, we applied the mean weights of local units (basket, sac, heap, bundle, piece, etc.) using a self-composed conversion list. Prices were converted into US dollars using the customary exchange rate of the moment (1 US dollar = 550 FC).

Data analysis

Data were recorded in Microsoft Excel and statistical analyses performed in SPSS 17. We constructed two databases: the full database pooled all interviews irrespective of the person interviewed; in the restricted database, we deleted interviews with persons who had already been interviewed during a previous interview round to avoid double counting of cases (each questionnaire covered WEP selling activities over one year). The full database was used for analysis of WEP availability in the markets at the moment of interview, whereas the restricted database was used for all other analyses.

First, we analyzed data in terms of number of WEP traders and availability of species per market and per interview period. Thereafter, harvest origins of the different WEPs are presented, followed by the analyses of quantities, prices and added values per WEP species.

KIT and IIRR (2008) define added value as '*the amount of value that each actor in the value chain adds; thus, the difference between the price the actor sells the produce for and the price he pays for the produce'*. We calculated weekly added values as:

$$x_{ij} = Q.(P_s - P_b),$$

with:
- x_{ij} weekly added value generated for plant i by trader j;
- Q weekly quantity traded (we did not take into account any losses due to perishability and/or autoconsumption and hypothesized quantity sold equals quantity bought);
- P_s selling price per unit of produce; and
- P_b buying price per unit of produce.

Yearly added value takes into account the number of months the respective plant is traded by the WEP seller and was calculated as:

$$y_{ij} = x_{ij}.4.m_{ij}$$

with:
- y_{ij} yearly added value generated for plant i by trader j;
- x_{ij} weekly added value generated for plant i by trader j; and
- m_{ij} number of months plant i is sold by trader j.

Subsequently, we identified different types of traders based on the species they sell and then analyzed if selling particular WEP species is linked to specific socio-economic or WEP trade characteristics of the sellers.

We first clustered the interviewed WEP sellers using Ward's hierarchical clustering method based on the occurrence (traded or not by the respective sellers) of the 15 WEPs inventoried during the four market survey rounds. Clusters were formed applying the binary squared Euclidean distance as measure of dissimilarity (Wijnen et al. 2002). The four clusters we obtained defined groups of traders selling similar sets of WEPs.

For each of the four clusters, we determined the average socio-economic characteristics of the respective trader groups; i.e. gender, age, number of household members, dependency ratio, education level, marital status, ethnicity, residence, whether or not trade is their main activity and whether or not traders have other income generating activities. Dependency ratio (%)

was calculated as the number of non-active household members (younger than 15 or older than 65 years) over the number of active household members (15-65 years) multiplied by 100.

WEP trade characteristics considered were total number of WEPs traded, number of trading days per week, market place, respondents' perception of the contribution of WEPs to total household cash income, yearly added value and yearly net income generated through WEP trade. Yearly added value generated per trader is calculated as the sum of the yearly added values generated by the different WEPs (s)he sold. Net income is defined by KIT and IIRR (2008) as revenues minus total costs (variable and fixed). Variable costs in our study were purchase costs of WEPs, transport costs, daily (il)legal taxes and storage costs; fixed costs taken into account were yearly taxes, and construction or purchase costs of shelves/stalls in the market. We did not take into account labour costs, because all sellers worked for themselves and estimating working hours and opportunity costs of labour fell out of the scope of this study. Many WEP traders did not only sell WEPs, but also other products. Consequently, we calculated net incomes from WEPs per trader as the yearly added value generated per trader (= WEP revenue - costs of WEP purchase) minus an estimation of the percentage of all other marketing costs (taxes, fees, transport, conservation and stalls) that could be attributed to these WEPs. This estimation was based on own observations and respondents' interpretations, so the obtained net incomes should be interpreted with care. Further attributing marketing costs to a particular WEP appeared too difficult; especially for those traders selling up to nine WEPs.

Socio-economic and WEP trade characteristics of the sellers in the four clusters were compared using χ^2-tests (Fisher exact-tests if conditions for χ^2 testing were not fulfilled) for factor variables and one-way ANOVA for continuous variables. A Tukey *post-hoc* test [if variable showed equal variances over the four clusters] or Dunnet's C test [if equal variances could not be assumed] was applied in case ANOVA analysis was significant at $p<0.05$.
For ethnobotanical descriptions and herbarium references of the WEPs presented here, we refer to *chapters 4* and *5*.

6.3. Results

Number of WEP sellers interviewed

Over the four periods, we performed 144 interviews with 119 unique persons. The remaining 25 were interviews with WEP sellers who had already been interviewed during one or more previous research periods (table 6.1). The largest market for WEPs was *Marché Central* (61 interviews with 46 unique persons), followed by *IAT* (39 interviews with 36 unique persons). We found most WEP sellers (82) to be present in the markets in the September-October period, whereby 87% of them were only present during that period. On average, during the second, third and fourth interview periods, more than half of the traders interviewed were new, not having been present in a previous period.

Table 6.1: Number of WEP sellers interviewed on the different markets over the 4 interview periods (numbers in parentheses are new persons, not yet interviewed in a previous period)

	1st interview period (Sept.-Oct. 2007)	2nd interview period (Dec. 07-Jan. 08)	3rd interview period (Ma.-Apr. 2008)	4th interview period (June-July 2008)	TOTAL
Marché Central	31	10 (5)	9 (3)	11 (7)	61 (46)
IAT	22	5 (4)	4 (3)	8 (7)	39 (36)
Tshopo 11ième	10	4 (2)	1 (0)	1 (0)	16 (12)
Kabondo Foyer	9	4 (3)	1 (0)	1 (0)	15 (12)
Djubu-djubu	6	0	1 (1)	0	7 (7)
Libanga	4	0	1 (1)	1 (1)	6 (6)
TOTAL	82	23 (14)	17 (8)	22 (15)	144 (119)
Number of persons only present in the respective period (as % of total period interviews)	71 (87%)	13 (57%)	7 (41%)	15 (68%)	106 (73.6%)

Availability of WEPs in Kisangani markets

In total, we registered 14 WEPs in Kisangani markets, i.e. six wild fruits (*Aframomum* spp., *Landolphia* spp. (mainly *Landolphia owariensis* P.Beauv.), *Synsepalum stipulatum* (Radlk.) Engl., *Dacryodes osika* (Guillaumin) H.J.Lam., *Myrianthus arboreus* P.Beauv., and *Chrysophyllum lacourtianum* De Wild.); three wild leafy vegetables (*Gnetum africanum* Welw., *Solanum distichum* Schumach. et Thonn, and *Solanum americanum* Mill.); three wild nuts (*Tetracarpidium conophorum* (Müll.Arg.) Hutch. et Dalziel, *Cola acuminata* (P.Beauv.) Schott. et Endl., and *Garcinia kola* Heckel); and two wild spices (*Piper guineense* Schumach. et Thonn, and *Capsicum frutescens* L.). In addition, 16 retailers reported they occasionally sell *Anonidium mannii* (Oliv.) Engl. et Diels fruits, during the period from August to October, but these were not observed during our interviews.

Figure 6.3 presents the number of sellers present on the Kisangani markets per WEP, per period of interview and per market. The greatest diversity of WEPs was found on *Marché Central*. Some species such as *P. guineense* and *C. frutescens* were present at all four interview moments in all markets. *G. africanum* was especially present in *Marché Central* and *IAT*-market, whereas *Marché Central* seems to be 'the' market place for *C. acuminata* and *G. kola*. *Landolphia* fruits were sold in almost all markets during the first period of interviews. Very few traders offered *S. americanum* (3), *C. lacourtianum* (1), *D. osika* (1) or *M. arboreus* (1) during our interviews.

Leafy vegetables were available during the four interview periods (except for *S. americanum* which was only marginally present in the markets). *G. africanum* was sold in fresh or dried form, the other vegetables only as fresh leaves. In all periods, we found fresh and dried products of the spices *P. guineense* and *C. frutescens*. Availability of wild fruit appeared to be more seasonally determined. To better conserve freshness and thus enlarge the trading season, our interviewees sometimes burry the nuts of *C. acuminata* and *G. kola* into the soil.

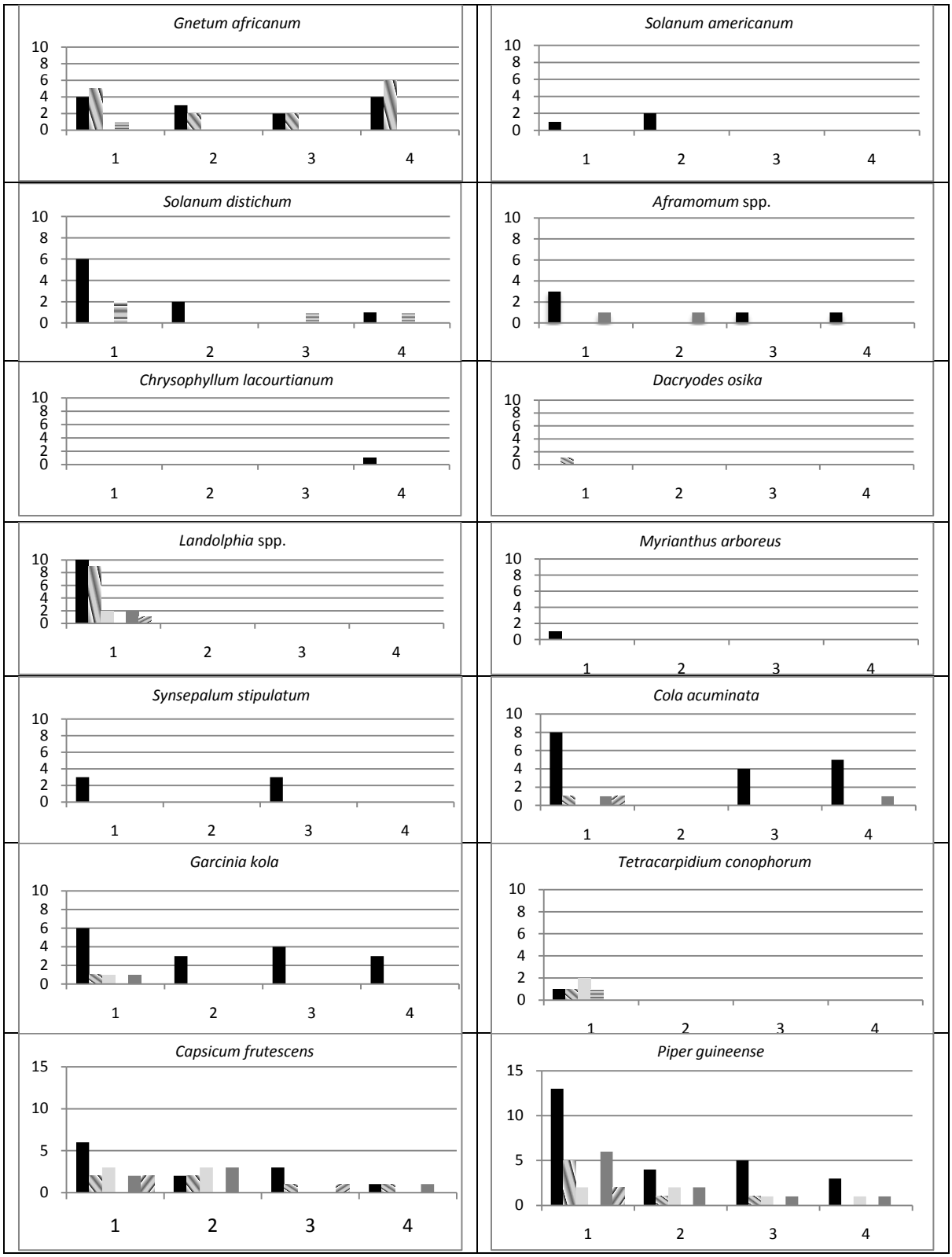

Figure 6.3: Number of persons selling the respective WEPs (plant present at the moment of interview) per market and per period of interview

X- axis: 1 = Sept.-Oct. 2007; 2 = Dec.'07-Jan.2008; 3 = March-April 2008; 4 = June-July 2008;

Y-axis: number of traders

Figure 6.4: Women selling wild edible plants in *Marché Central* (above) and along the roadside (below); 1: *Landolphia owariensis*, 2: *Dacroyodes edulis*, 3: *Aframomum* spp., 4: *Cola acuminata*, 5: *Garcinia kola*, 6: *Piper guineense*, 7: *Synsepalum stipulatum*, 8: *Myrianthus arboreus*

Origins of WEPs sold

Availability in natural stands, accessibility of sourcing villages, connections traders have with the hinterland and ethnic preferences for certain species determine, amongst others, the origins of WEPs sold on Kisangani markets. Figure 6.5 presents the different origins (harvest regions) of the WEPs inventoried per main access routes to Kisangani and figure 6.6 shows a map on which these main access routes are indicated.

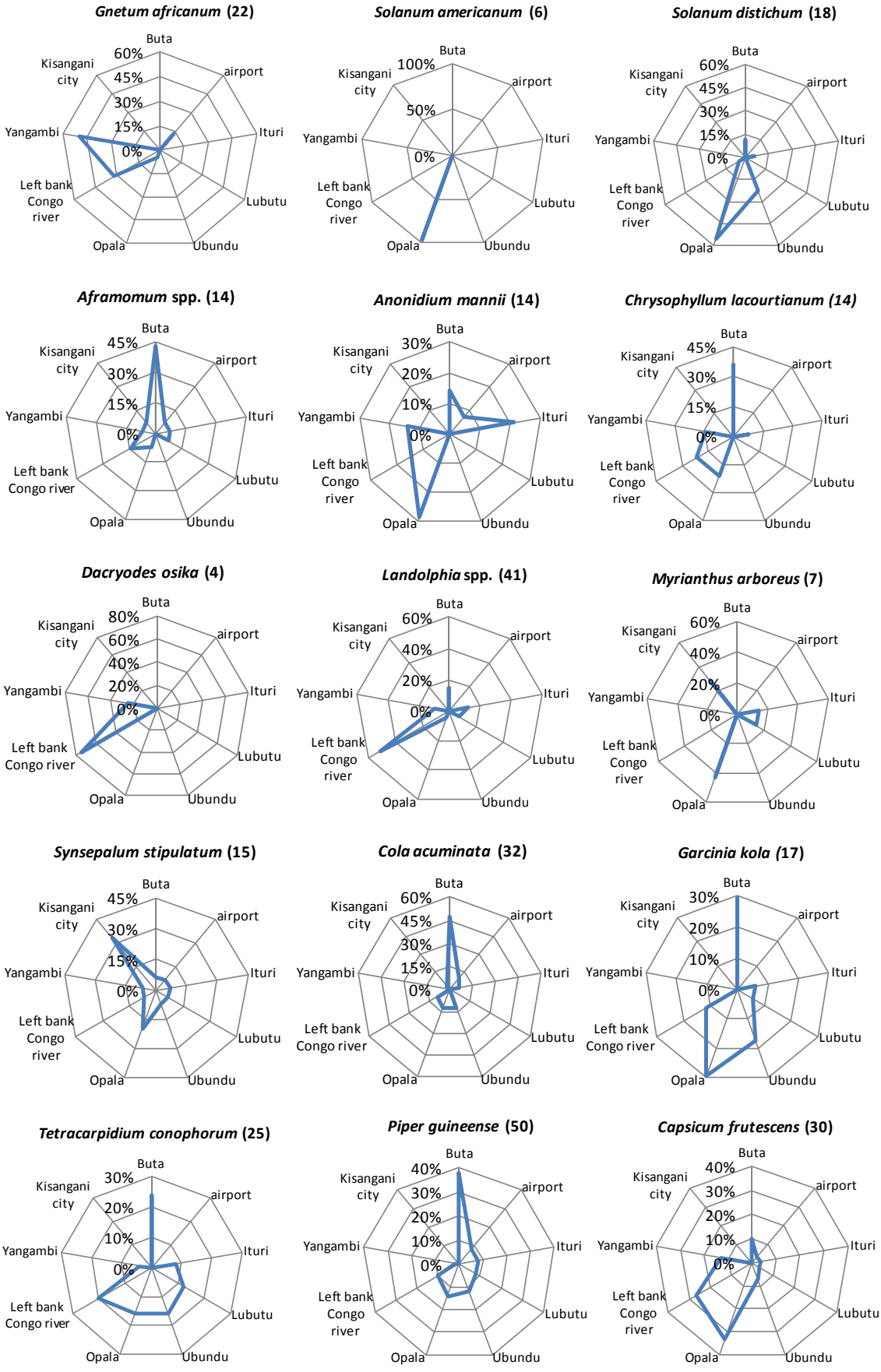

Figure 6.5: Origins of WEPs sold as per main access routes to Kisangani; in brackets: total number of times traders cited an origin for the species; axes: % of species coming from that particular direction

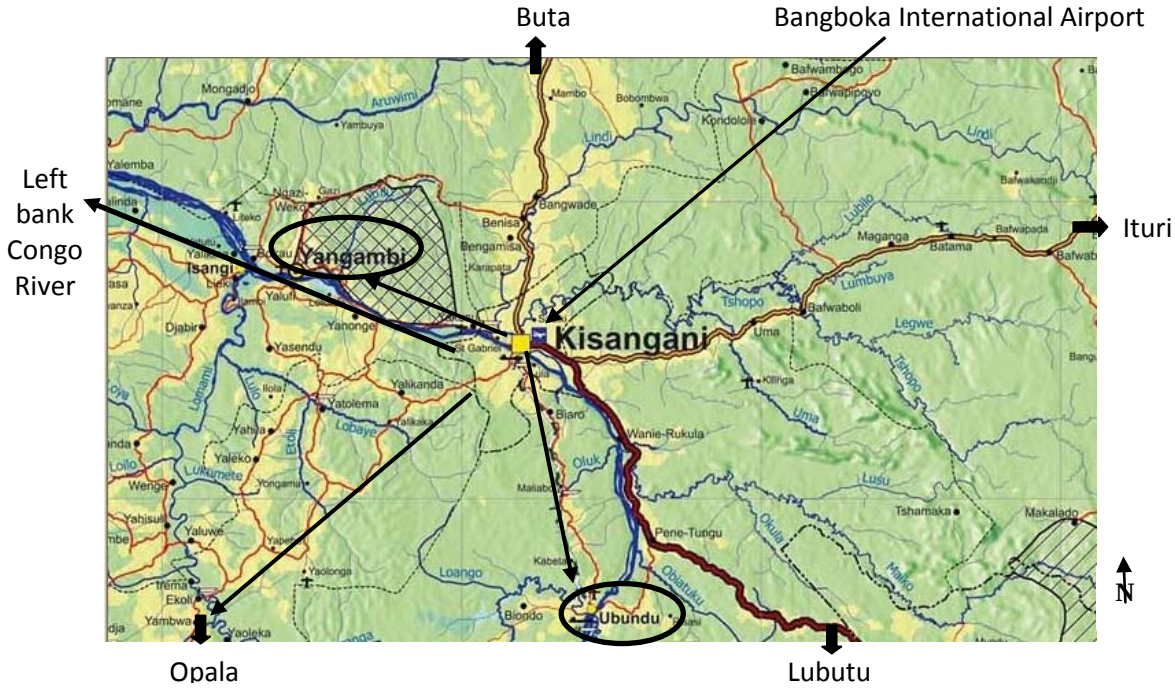

Figure 6.6: Map illustrating the main access routes to Kisangani; based on http://www.enge.ucl.ac.be/cartes-RDC

Only two WEPs were harvested within the area of Kisangani city itself, i.e. *M. arboreus* and *S. stipulatum*. The other WEPs were only harvested outside the city.

The villages along the road to Yangambi provide most of the *G. africanum* sold in Kisangani, followed by villages along the left bank of the Congo River. Transport of *G. africanum* from these villages to Kisangani is facilitated by the nearness of the Congo River. Canoes transport huge quantities of *G. africanum* and mainly arrive at *IAT* market, from where wholesale traders purchase as much as they can to bring the fresh produce to the airflight companies for shipment to Kinshasa. A number of villages around the international airport of Bangboka also supply part of the *G. africanum*.

The leafy vegetables *S. americanum* and *S. distichum* as well as the fruits *A. mannii* and *M. arboreus*, *G. kola* nuts and the spice *C. frutescens* mainly come from villages along the road to Opala. In addition, the fruits of *C. lacourtianum*, nuts of *T. conophorum* and *P. guineense* spice have the villages along the Opala axis as second most important origin. Villages on the road to Buta are important for the supply of *Aframomum* spp., *C. lacourtianum*, *C. acuminata*, *G. kola*, *T. conophorum* and *P. guineense*, and to a lesser extent also for *A. mannii*,

Landolphia spp., *C. frutescens* and *S. distichum*. Villages along the left bank of the Congo River are the main suppliers of *D. osika* and *Landolphia* spp., but are also important for the supply of *Aframomum* spp., *A. mannii, C. lacourtianum, G. kola, T. conophorum* and *C. frutescens*. The other main access routes such as those coming from Ituri, Lubutu and Ubundu seem to be less important for the supply of WEPs, although they provide some of the *A. mannii* fruits, *T. conophorum* nuts and *P. guineense* spices.

Annex 2 provides a more detailed overview of WEP harvest origins with an indication of the distances along the respective access routes. Most WEPs are sourced within a distance of 60 km from Kisangani. This is probably due to the very bad road conditions and thus difficult market access. Nuts and spices can be harvested over longer distances because they are less perishable than leafy vegetables or fruits. Thanks to the access to watertransport via the Congo River, some vegetables and fruits can even be harvested over longer distances along the Yangambi and left Congo River bank axes.

Almost all WEP sellers buy their supply from other intermediaries or gatherers. Only 4 sellers declared to collect WEPs themselves. The place of purchase was mainly the market where they are selling themselves or another market in town, except for *G. africanum* leaves, and *Landolphia* spp. and *A. mannii* fruits.

WEP market performances

Dried products fetch the highest prices per kg (*P. guineense* ($13.41/kg), *C. frutescens* ($11.5/kg) and *G. africanum* ($7.7/kg)). For fresh products, we registered the highest mean yearly prices for *C. acuminata* ($6.36/kg) and *S. stipulatum* ($5.80/kg). Leafy vegetables and fruits (except *S. stipulatum*) get the lowest prices per kg (table 6.2).

When taking the 15 species sold in the markets, *G. africanum* was sold in the highest quantities during the whole year. Our 23 interviewees sold on average 275.3 kg of *G. africanum* on a fresh weight basis per week. However, there is a huge difference in quantities traded between those trading fresh *G. africanum* leaves (374.0 kg/week) or those selling dried *G. africanum* on the *Marché Central* (49.7 kg fresh *G. africanum* transformed into 7.7 kg dried *G. africanum*/week). *G. africanum* traders specialize in either fresh or dried product, so we could differentiate these two types of traders and calculate mean fresh and mean dried quantities sold. *P. guineense* or *C. frutescens* spices, however, are purchased and sold fresh,

but if product quality decreases, retailers dry and pound the leftovers to obtain a powder that can also be sold. Traders were not able to give an estimation of the average quantities of spices they dry per week, therefore, no differentiation could be made between fresh and dried quantities sold.

During the fruit harvesting season, *D. osika* (on average 72.7 kg/week) and *L. owariensis* (51.5 kg/week), followed by *C. lacourtianum* (36.1 kg/week), *M. arboreus* (32.4 kg/week), *A. mannii* (26.6 kg/week) and *T. conophorum* (26.7 kg/week) are sold in considerable quantities (table 6.2). Except for *M. arboreus*, these fruits are sold during less than three months (August-October). Average quantities sold of the leafy vegetables *S. distichum* and *S. americanum* are 51.0 kg/week and 22.3 kg/week respectively over a mean period of around 8 months. Spices were sold in smaller quantities (resp. 2.2 and 6.8 kg/week on a fresh weight basis for *C. frutescens* and *P. guineense*) over longer periods (from 2 to 12 months for fresh spices).

Looking at the added values generated by the sellers, we see that *G. africanum* is able to generate the highest added value per week (on average $86.6/week and even $105.6/week for fresh *G. africanum* traders), followed by *T. conophorum* ($86.5/week). However, we registered a very broad range of added values, even between traders of the same product, going from negative values to $906.8/week for one trader of fresh *G. africanum* (table 6.2).

Taking into account seasonality, *G. africanum* generated on average the highest added value on a yearly basis ($4165.4), followed by *T. conophorum* ($1924.2/year), *P. guineense* ($653.3/year) and *S. distichum* ($549.8/year) (table 6.2).

Table 6.2: Number of sellers, mean prices, quantities sold, weekly and yearly added values per WEP

	Local name	Number of sellers interviewed[1]	Shelflife[2]	Number of months traded[2]	Mean selling price ($/kg)[2]	Quantity sold/week (kg)[2]	Weekly added value within selling period ($)[2, 3]	Yearly added value ($)[2]
Leafy vegetables								
Gnetum africanum[4]	fumbwa	23				275.3 ± 255.2 *min. 9.6* *max. 960.0*	86.8 ± 186.5 *min. 3.8* *max. 906.8*	4165.4 ± 8953.5 *min. 183.7* *max. 43527.3*
* fresh		16	5.1 ± 1.7 days *min. 2* *max. 8*	12 ± 0	0.29 ± 0.05* *min. 0.2* *max. 0.4*	374.0 ± 245.0 *min. 37.5* *max. 960.0*	105.6 ± 219.6 *min. 5.45* *max. 906.8*	5066.7 ± 10543.0 *min. 261.8* *max. 43527.3*
* dried		7	7.8 ± 4.6 months *min. 1.5* *max. 12*	12 ± 0	7.7 ± 1.6 *min. 6.6* *max. 11.3*	7.8 ± 10.6 *min. 1.8* *max. 31.4*	43.9 ± 62.3 *min. 3.82* *max. 181.8*	2105.3 ± 2988.8 *min. 183.3* *max. 8727.3*
Solanum americanum	mboka muchunga	7	2.8 ± 0.4 days *min. 2* *max 3*	8.1 ± 3.5 *min. 3* *max. 12*	0.60 ± 0.21 *min. 0.14* *max. 0.76*	22.3 ± 25.2 *min. 1.6* *max. 60.0*	5.8 ± 7.2 *min. 0.33* *max. 21.8*	231.9 ± 364.1 *min. 7.85* *max. 1047.3*
Solanum distichum	bilolo	18	2.4 ± 0.6 days *min. 2* *max. 4*	8.8 ± 3.5 *min. 3* *max. 12*	0.74 ± 0.35 *min. 0.16* *max. 1.52*	51.0 ± 85.6 *min. 0.72* *max. 287*	12.8 ± 21.8 *min. -1.45* *max. 81.82*	549.8 ± 1053.7 *min. -69.8* *max. 3927.3*
Fruits								
Aframomum spp.	soso	13	5.0 ± 2.4 days *min. 2* *max. 7*	5.5 ± 4.0 *min.2* *max. 12*	1.08 ± 0.38 *min. 0.36* *max. 1.82*	7.6 ± 20.3 *min. 0.19* *max. 75.0*	1.3 ± 1.5 *min. -0.8* *max. 4.6*	44.3 ± 73.3 *min. -16.7* *max. 218.2*
Anonidium mannii	bombi	15	1.0 day **	2.2 ± 1.5 *min. 1* *max. 5*	0.30 ± 0.19 *min. 0.10* *max. 0.75*	26.6 ± 35.5 *min. 4.4* *max. 140.0*	2.8 ± 4.5 *min. -0.2* *max. 18.2*	18.0 ± 21.0 *min. -1.82* *max. 72.7*
Chrysophyllum lacourtianum	lilinda	16	3.0 ± 1.7 days *min. 2* *max. 5*	2.2 ± 1.3 *min. 1* *max. 5*	0.44 ± 0.19 *min. 0.16* *max. 0.74*	36.1 ± 45.1 *min. 2.0* *max. 180.0*	9.4 ± 17.4 *min. 0.27* *max. 65.5*	55.5 ± 76.2 *min. 1.1* *max. 261.8*

	Local name	Number of sellers interviewed[1]	Shelflife[2]	Number of months traded[2]	Mean selling price ($/kg)[2]	Quantity sold/week (kg)[2]	Weekly added value within selling period ($)[2, 3]	Yearly added value ($)[2]
Dacryodes osika	tobele	5	- **	2.0 ± 0.0 *min.2* *max. 2*	0.60 ± 0.26 *min. 0.36* *max. 0.87*	72.7 ± 63.8 *min. 13.0* *max. 140.0*	13.3 ± 10.4 *min. 2.7* *max. 25.5*	106.4 ± 83.3 *min. 21.8* *max. 203.6*
Landolphia spp. (mainly *L. owariensis*)	mabongo	36	5.3 ± 1.7 days *min. 2* *max. 7*	2.6 ± 1.0 *min. 1* *max. 5*	0.49 ± 0.18 *min. 0.18* *max. 0.91*	51.5 ± 41.3 *min. 3.1* *max. 198.0*	11.3 ± 12.8 *min. -1.6* *max. 59.3*	128.7 ± 218.8 *min. -18.6* *max. 1185.1*
Myrianthus arboreus	bokomu	7	- **	8.3 ± 4.3 *min. 2* *max. 12*	0.19 ± 0.09 *min. .014* *max. 0.32*	32.4 ± 26.4 *min. 9.9* *max. 70.0*	3.2 ± 2.7 *min. 0.6* *max. 6.8*	131.8 ± 136.3 *min. 10.9* *max. 327.3*
Synsepalum stipulatum	tonga	12	4.0 ± 1.4 days *min. 2* *max. 6*	3.5 ± 1.7 *min. 2* *max. 7*	5.80 ± 2.67 *min. 0.63* *max. 10.10*	0.7 ± 0.7 *min. 0.05* *max. 2.3*	1.7 ± 2.4 *min. -0.5* *max. 8.3*	18.3 ± 28.6 *min. -9.1* *max. 99.3*
Nuts								
Cola acuminata	angbongbolia	28	43.0 ± 93.3 days *min. 4* *max. 365*	4.5 ± 2.2 *min. 1* *max. 12*	6.36 ± 3.30 *min. 2.27* *max. 16.43*	1.4 ± 1.6 *min. 0.05* *max. 7.0*	4.6 ± 5.3 *min. 0.05* *max. 16.0*	93.2 ± 128.7 *min. 0.9* *max. 432.0*
Garcinia kola	ngadjadja	16	96.6 ± 128.5 days *min. 3* *max. 365*	4.6 ± 2.5 *min. 1* *max. 12*	3.9 ± 3.2 *min.0.75* *max. 9.09*	4.2 ± 4.1 *min. 0.04* *max. 11.6*	8.6 ± 16.6 *min. 0.0* *max. 59.7*	82.4 ± 127.9 *min. 0.0* *max. 477.8*
Tetracarpidium conophorum	kasu	25	10.8 ± 13.0 days *min. 2* *max. 30*	3.3 ± 1.5 *min. 1.0* *max. 6.0*	2.08 ± 1.6 *min. 0.84* *max. 8.36*	26.7 ± 43.7 *min. 0.3* *max. 208.0*	86.5 ± 337.2 *min. 0.3* *max. 1665.8*	1924.2 ± 8120.2 *min. 4.4* *max. 39977.9*

	Local name	Number of sellers interviewed[1]	Shelflife[2]	Number of months traded[2]	Mean selling price ($/kg)[2]	Quantity sold/week (kg)[2]	Weekly added value within selling period ($)[2, 3]	Yearly added value ($)[2]
Spices								
Capsicum frutescens[4]	pilipili	27				2.2 ± 2.6 *min. 0.1* *max. 11.0*	1.8 ± 2.2 *min. 0.2* *max. 8.2*	78.5 ± 102.9 *min. 2.9* *max. 392.7*
* fresh		21	3.4 ± 1.4 days *min. 2* *max. 7*	5.5 ± 2.6 *min. 2* *max. 12*	2.24 ± 0.79 *min 0.95* *max. 3.98*			
* dried		8	12.0 ± 0.0 months *min. 12* *max. 12*	12.0 ± 0.0 *min. 12.* *max. 12*	11.50 ± 2.39 *min. 9.09* *max. 15.07*			
Piper guineense[4]	ketchu	43				6.8 ± 11.8 *min. 0.03* *max. 61.2*	16.2 ± 32.2 *min. -1.36* *max. 147.3*	653.3 ± 1401.9 *min. -65.5* *max. 7069.1*
* fresh		41	4.4 ± 1.7 days *min. 1* *max. 7*	5.4 ± 3.4 *min. 2* *max. 12*	2.76 ± 1.52 *min. 0.86* *max.7.70*			
* dried		8	12.0 ± 0.0 months *min. 12* *max. 12*	12.0 ± 0.0 *min. 12* *max. 12*	13.41 ± 5.68 *min. 6.80* *max. 23.51*			

[1] Including all sellers who declared selling the plant, thus also those who did not have the WEP on the shelf at the day of interview
[2] Numbers presented are means ± standard deviation with their respective min. and max.
[3] Added value per week is defined here as: (quantity sold per week x selling price) – (quantity bought per week x buying price); we supposed quantity sold = quantity bought, we did not take into account any possible losses due to perishability or auto-consumption
[4] Expressed on a fresh weight basis for total sales of the WEP
*price of 1 trader selling directly to traders in Kinshasa at 1.9$/kg not taken into account

Typology of WEP sellers in Kisangani

A typology was made to see if different types of traders could be distinguished based on species sold and their respective socio-economic characteristics.

After clustering individual traders based on species sold, using Ward's method, we examined how traders were divided over the different clusters for the three, four, five and six-cluster options. The four-cluster option (table 6.3) showed clear clusters of traders selling the same sets of WEPs. Consequently, cluster one could be defined as those traders selling spices and/or stimulant nuts (*C. acuminata* and *G. kola*). Cluster two comprises traders selling spices/stimulant nuts with in addition one or more wild fruits (including *T. conophorum* nuts). Cluster three consists of traders selling leafy vegetables (except *G. africanum*) whether or not combined with some *Landolphia* fruits and/or *T. conophorum* nuts. Cluster four is singularly composed of the *G. africanum* traders.

Table 6.3: Cluster membership of the 119 WEP traders as a result of the clustering of traders based upon occurrence (trading a specific WEP or not) of the 15 WEPs traded on Kisangani markets

	Cluster 1 (spices only)	**Cluster 2** (fruits and spices)	**Cluster 3** (other leafy vegetables; kasu/mabongo)	**Cluster 4** (fumbwa)	**Total**
Number of subjects	35	22	37	22	119
fumbwa *(Gnetum africanum)*	0	0	1	**22**	23
mboka muchungu *(Solanum americanum)*	0	0	**7**	0	7
bilolo *(Solanum distichum)*	1	0	**17**	0	18
kasu *(Tetracarpidium conophorum)*	0	19	6	0	25
mabongo *(Landolphia* spp.)	0	20	16	0	36
bombi *(Anonidium mannii)*	0	**15**	0	0	15
tonga (*Synsepalum stipulatum*)	0	**11**	1	0	12
lilinda *(Chrysophyllum lacourtianum)*	0	**16**	0	0	16
tobele *(Dacryodes osika)*	0	**4**	1	0	5
bokomu *(Myrianthus arboreus)*	0	**7**	0	0	7
soso *(Aframomum* spp.)	4	5	4	0	13
angbongbolia *(Cola acuminata)*	15	12	1	0	28
ngadjadja *(Garcinia kola)*	10	6	0	0	16
pilipili *(Capsicum frutescens)*	24	1	2	0	27
ketchu *(Piper guineense)*	26	14	3	0	43

Table 6.4 shows the socio-economic and WEP trade characteristics of traders per cluster. All characteristics except number of household members and dependency ratio were significantly different over the four clusters at least at $p<0.1$. Consequently, we could clearly distinguish four types of WEP traders.

Table 6.4: Socio-economic and WEP trade characteristics of all WEP sellers together (whole sample) and per cluster

	Whole sample n(%)	**Cluster 1:** spices n(%)	**Cluster 2**: fruits and spices n(%)	**Cluster 3:** other leafy vegetables n(%)	**Cluster 4:** fumbwa n(%)	**p-value**
Total number of subjects	119	38	22	37	22	
Socio-economics						
Sexe						0.000***
* male	10 (8.4)	0	1 (4.5)	1 (2.7)	8 (36.4)	
* female	109 (91.6)	38 (100)	21 (95.5)	36 (97.3)	14 (63.6)	
Age[1]	41.8 ± 14.2	48.9 ± 12.8 [a]	44.2 ± 15.5 [a, b]	38.0 ± 13.5 [b, c]	33.3 ± 9.5 [c]	0.000***
Nr of household members[1]	10.2 ± 6.2	9.4 ± 7.2	9.5 ± 4.3	11.5 ± 7.0	10.3 ± 4.5	0.507
Dependency ratio[1]	146.7 ± 128.5	164.2 ± 155.6	121.7 ± 101.2	147.9 ± 126.3	140.7 ± 107.9	0.672
Education level						0.071*
*illiterate	23 (20)	11 (29.7)	4 (18.2)	7 (20.0)	1 (4.8)	
*primary school	39 (33.9)	14 (37.8)	8 (36.4)	13 (37.1)	4 (19.0)	
*secondary school	35 (46.1)	12 (32.4)	10 (45.5)	15 (42.9)	16 (76.2)	
*higher level	0	0	0	0	0	
Marital status						0.01**
*married	72 (61.5)	20 (52.6)	13 (59.1)	22 (62.9)	17 (77.3)	
*widow	28 (23.9)	16 (42.1)	6 (27.3)	6 (17.1)	0	
*divorced/single	17(14.5)	2 (5.3)	3 (13.6)	7 (20.0)	5 (22.7)	
Ethnicity						0.038**
* Lokele	60 (50.4)	16 (42.1)	16 (72.7)	16 (43.2)	12 (54.5)	
* Topoke	17 (14.3)	7 (18.4)	0	9 (24.3)	1 (4.5)	
*others within Tshopo Distr.	21 (17.6)	7 (18.4)	4 (18.2)	5 (13.5)	5 (22.7)	
*other within Oriental Prov.	6 (5.0)	1 (2.6)	0	5 (13.5)	0	
* other	15 (12.6)	7 (18.4)	2 (9.2)	2 (5.4)	4 (18.2)	
Residence						0.000***
* Kisangani	90 (76.9)	36 (94.7)	20 (90.9)	26 (74.3)	8 (36.4)	
* hinterlands	27 (23.1)	2 (7.4)	2 (7.4)	9 (25.7)	14 (63.6)	
WEP-selling principal activity						0.057*
* yes	103 (88.0)	36 (94.7)	21 (95.5)	30 (85.7)	16 (72.7)	
* no	14 (12.0)	2 (5.3)	1 (4.5)	5 (14.3)	6 (27.3)	
Other activities of WEP-seller						0.011**
*yes	28 (23.9)	5 (13.2)	4 (18.2)	8 (22.9)	11 (50.0)	
*no	89 (76.1)	33 (86.8)	18 (81.8)	27 (77.1)	11 (50.0)	

	Whole sample n(%)	**Cluster 1:** spices n(%)	**Cluster 2**: fruits and spices n(%)	**Cluster 3:** other leafy vegetables n(%)	**Cluster 4:** fumbwa n(%)	**p-value**
WEP-trade characteristics						
Nr of WEPs sold[1]	2.4 ± 2.0	2.1 ± 1.2 [a]	5.8 ± 1.6[b]	1.7 ± 0.88 [a]	1.0 ± 0.0 [c]	0.000***
Selling days/week						0.000***
* 1-2 times/week	30 (25.4)	5 (13.2)	1 (4.5)	10 (27.8)	14 (63.6)	
* 3-5 times/week	17 (14.4)	3 (7.9)	5 (22.7)	8 (22.2)	1 (4.5)	
* 6-7 times./week	71 (60.2)	30 (78.9)	16 (72.7)	18 (50.0)	7 (31.8)	
Market						
* Marché Central	46 (38.7)	13 (34.2)	15 (68.2)	11 (29.7)	7 (31.8)	
* IAT	36 (30.3)	7 (18.4)	4 (18.2)	11 (29.7)	14 (63.6)	
* Djubudjubu	7 (5.9)	3 (7.9)	2 (9.1)	2 (5.4)	0	
* Libanga	6 (5.0)	0	5 (13.5)	5 (13.5)	1 (4.5)	
* Kabondo Foyer	12 (10.1)	8 (21.1)	0	4 (10.8)	0	
* Tshopo 11ième	12 (10.1)	7 (18.4)	1 (4.5)	4 (10.8)	0	
Yearly added value WEPs[1]	1567.5 ± 5933.3 [a]	198.7 ± 355.4	3066.6 ± 9846.4	4067.3 ± 899.8	4283.3 ± 9145.9	0.023**
Yearly net income WEPs[1]	1393.0 ± 5772.8	163.9 ± 346.4	2986.4 ± 9857.2	393.1 ± 796.8	3604.2 ± 8747.1	0.05*
Contribution WEPs to total HH cash income						0.031**
* < 5%	18 (15.1)	9 (23.7)	2 (9.1)	7 (18.9)	0	
* 5-25%	73 (61.3)	18 (47.4)	16 (72.7)	26 (70.3)	13 (59.1)	
* 25-50%	24 (20.2)	10 (26.3)	4 (18.2)	3 (8.1)	7 (31.8)	
* > 50%	4 (3.4)	1 (2.6)	0	1 (2.7)	2 (9.1)	

[1] Mean with standard deviation;
*** Significant at p< 0.01, ** significant at p< 0.05, * significant at p< 0.1; one-way ANOVA for continuous variables; χ^2 or Fisher exact-test (if conditions for χ^2 were not fulfilled) for factor variables;
[a, b, c] Means with different superscript are significantly different (p<0.05)

Cluster one or the 'spices/stimulant nuts' cluster comprises the less-educated, oldest women (on average 48.9 years old). They mainly live in Kisangani city and selling WEPs is their main activity: 86.8 % has no other income generating activity. This cluster counts the highest number of widows (42.1%). They sell on average 2.1 WEPs and are present at the market almost every day of the week. They generate both the lowest yearly added values and net incomes through the sales of WEPs (respectively, on average $198.7 and $163.9 /year).

Cluster two or the 'spices/stimulant nuts and fruits' cluster comprises mainly women with an intermediate education level. About one fourth are widows, whereas they are slightly younger than the women of cluster one. They live mainly in Kisangani city and selling WEPs is their main activity. They sell on average 5.8 WEPs and are present six or more days per week at the market. They generate on average $3066.6 of added value per year through WEP sales, which accounts for $2986.4 yearly net income.

Cluster three or the 'leafy vegetables (other than *G. africanum*)' cluster comprises mainly women with an intermediate education level. Less than one fifth are widow and they are significantly younger than women in cluster one and slightly younger than women in cluster two. About one fourth lives in rural areas around Kisangani whereby for 14.3% WEP trade is not their main income generating activity. They sell on average 1.7 WEPs. They generate on average a yearly added value of $4067.3 through WEP trade, but after deducting the costs of transport, taxes and other fees, their net income decreases to $393.1/year.

Cluster four or the '*G. africanum*' cluster is composed of approximately one third of men, and represents almost all of the men involved in WEP trade interviewed during this study. Traders are significantly younger than traders in the other groups and have the highest education level. No widows were found in this group. More than half of the traders live in rural areas. For one fourth of them, WEP trade is not the main activity and half of them have other income generating activities. They exclusively sell *G. africanum*, mostly only one to two times per week, except for the seven traders selling dried *G. africanum* on *Marché Central* every day of the week. They generate the highest yearly added values (on average $4283.3) and obtain the highest net incomes (on average $3604.2) through their sales of *G. africanum*.

Figure 6.7: *Gnetum africanum* trade; above: left: bundle of *Gnetum africanum*, right: canoe filled with *Gnetum africanum* bundles arriving at IAT market; middle: left: fresh *Gnetum africanum* leaves at IAT market, right: selling dried *Gnetum africanum* at the Central Market; below: transport of *Gnetum africanum* to the airflight companies

6.4. Discussion

WEP market organization

Despite the high number of WEPs documented (166 species) during ethnobotanical inventories in Tshopo District (Termote et al. 2010b, 2011), only 15 of them seem to be traded in Kisangani markets. More than 50 wild vegetables are known by the Bali, Mbole and Turumbu ethnic groups (Termote et al. 2011), but only three of them (*G. africanum, S. americanum a*nd *S. distichum)* were seen to be sold in Kisangani markets. Yet, in several city markets in Kinshasa, Biloso and Lejoly (2006) inventoried at least 11 wild vegetables[1] from which only *Gnetum africanum* figured in our Kisangani market study.

Bagula (1977) found 9 (no study period mentioned) and Bhua (1991) 11 WEPs (Febr.–Sept. 1991) to occur on markets in Kisangani. However, due to the punctual character of these studies, we cannot conclude whether number of traders and WEPs offered are increasing or not. In addition to our WEPs, Bagula (1977) and Bhua (1991) registered the bark of *Scorodophloeus zenkeri* Harms and young leaf shoots of *Megaphrynium macrostachyum* (Benth.) Milne-Redh., but did not report on *A. mannii, C. frutescens, S. distichum, D. osika, C. lacourtianum* nor *S. stipulatum*. Liengola (2000), in his preliminary market study, documented only five of the above-mentioned WEPs plus palm wines from *Raphia* spp. and *Elaeis guineensis*. The bark of *S. zenkeri* can be used as spice, but has in addition a lot of medicinal uses, e.g. against hernia, filariasis or ascaris infections (Termote et al. 2010b). Young leaf shoots of *M. macrostachyum* are highly appreciated, although many consumers complain that they are only found 'by chance' on the market. One trader mentioned to have sold *M. macrostachyum* before. We regularly observed this vegetable in rural markets near Kisangani, but never saw it on Kisangani markets. The high work load to extract *M. macrostachyum* shoots and their perishability may explain their absence from city markets, although there is a demand for the product.

In total, we found 119 unique sellers in the six market places over the four research periods, whereby only three of them were present in all four periods. WEP trade seems thus to be

[1] *Gnetum africanum* Welw., *Dracaena camerooniana* Baker, *Pteridium aquilinum* (L.) Kuhn, *Megaphrynium macrostachyum* (Benth.) Milne-Redh., *Dioscorea praehensilis* Benth., *Mondia whitei* (Hook.f.) Skeels, *Talinum triangulare* (Jacq.) Willd., *Psophocarpus scandens* (Endl.) Verdc., *Phytolacca dodecandra* L'Hér., *Ipomoea aquatica* Forssk. and *Cucurbita maxima* Duchesne

highly volatile with traders easily switching between products according to availability. If we extrapolate to the seven other municipal markets not surveyed (119 unique traders interviewed + 7 x 12 (=mean number of unique sellers found in the two sampled municipal markets)), we find a total number of 203 WEP sellers, who can best be termed 'ad hoc' traders (KIT and IIRR 2008). These figures remain very low for a city of almost one million inhabitants. However, a number of *G. africanum* traders directly selling their products to intermediaries in Kinshasa via the airport or airflight companies did not figure in our study. As it is, *G. africanum* does not belong to the traditional diets of Kisangani inhabitants. The bulk of production is designated for Kinshasa, where the enormous demand for this nutritious vegetable makes the transport by air even reasonable (Manirakiza et al. 2009). Our primary objective was to assess local markets in Kisangani, so no information was gathered from traders only operating at the airport or airflight companies.

The attributes of NTFPs with regard to poverty alleviation are strongly related to their respective income generation potential for the different actors in the value chain. The highest mean monthly added values and net incomes were generated by the *G. africanum* traders, respectively $347.2 and $300 (tables 6.3 and 6.4). Net incomes generated in 2005 through the sale of *G. africanum* in the Mbandaka, Central Kikwit and Idiofa markets were, respectively, $131, $142 and $11/month (Ndoye and Awono 2005). Biloso and Lejoly (2006) estimated the monthly household revenue from *G. africanum* trade in peri-urban Kinshasa at $275.

However, large disparities in the volumes of *G. africanum* traded and traders' incomes were found: three traders had negative net incomes, another two generated net incomes below the poverty line of $1/day, whereas one trader, the only person in our sample selling *G. africanum* leaves to an intermediary in Kinshasa, obtained a monthly net income of $3,436 or more than four times the second highest net income ($752/month). Omitting this trader selling directly to Kinshasa, the average net income of all *G. africanum* sellers would have been $147/month. The 2 traders exporting *G. africanum* to Kinshasa interviewed by Ndoye and Awono (2005) in Mbandaka earned $1352 per month in 2005, confirming the potential of *G. africanum* trade with Kinshasa. Nevertheless, trade between Kisangani and Kinshasa brings along a lot of risks and thus high transaction costs, the only transport possibility being by plane. It often happens that cargo flights are cancelled or that *G. africanum* leaves, occupying a bigger volume per kg, are refused in favour of another, less bulky load. The leaves are perishable and as a consequence have to be thrown away if not shipped within three days to Kinshasa.

Apart from *G. africanum*, the individual sale of seven other WEPs (*T. conophorum*, *P. guineense, S. distichum, C. lacourtianum, D. osika, Landolphia* spp and, *G. kola,*) was able to generate mean weekly added values above the poverty line of $1/day. Due to the seasonal availability of many products, only the first four were also able to generate mean yearly added values above the poverty line of $365/year. Nonetheless, we observed that (1) most traders offer a combination of WEPs and other products on the market; and (2) there are huge differences in incomes between traders of a same product. Extreme poverty leads to a category of traders purchasing and selling very small quantities, called 'micro-retailers' by Mbumba (2008). We especially found them in cluster 1, selling *P. guineense*, *C. frutescens*, *C. acuminata* and/or *G. kola*.

Looking at net incomes generated per WEP trader, we see that only 38% of the traders generated incomes (from WEP sales) above the poverty line of $1/day. Many WEP traders in Kisangani are poor urban dwellers striving for some (additional) cash income, challenging the conventional belief that in all cases traders unfairly exploit NTFP gatherers. Moreover, in some cases, traders carry out many useful marketing functions such as 'risk taking' and costly transport and play a pivotal role that enables farmers/gatherers to valorize NTFPs in their environment (Ndoye et al. 1997). Consequently, we should look beyond the narrow famer/gatherers' perspective and take into account the complex livelihoods of all actors (gatherers *and* traders) involved along the value chain, when proposing strategies or policies to promote NTFP commercialization for the benefit of the poor. Ndoye and Awono (2005) found that gatherers of *C. acuminata* and *G. kola* received resp. up to 70 and 75% of retail prices in the Equateur and Bandundu provinces. *G. africanum* gatherers obtained 49 to 57% of per kg retail prices in the Equateur and Bandundu provinces (Ndoye and Awono 2005). The difference in incomes between *Gnetum* gatherers and traders are mainly due to the long distances gatherers have to walk into the forest to collect *Gnetum* leaves. They can only harvest what they can carry to the village (Manirakiza et al. 2009). Traders, on the other hand, are able to deal with bigger quantities.

Many uncertainties contribute to high transaction costs in the mainly unorganized WEP markets. Apart from difficulties with transport, (il)legal taxes and storage, many traders complained about the non-availability of enough WEPs to purchase or the low purchasing power of consumers. This leads to long and tiring discussions about prices and volumes with providers as well as customers. Other constraints mentioned by our interviewees were the

lack of credit facilities and inadequate transport and market infrastructure. In his analyses of Kinshasa NTFP markets, Mbumba (2008) highlights the lack of a clear legal framework with regard to NTFP exploitation and commercialization, the lack of political will to promote the NTFP sector and the lack of scientific knowledge on resource availability, use potential as well as harvesting and processing techniques (Bamoninga 2007).

Until now, WEP markets in the region remain underdeveloped. Harvesters and traders are unspecialized and mainly working solitarily. Just like Bamoninga (2007), Mbumba (2008) and Manirakiza et al. (2009), we did not register any organisational or professional structure dealing with WEP commercialisation. However, a kind of social assistance exists in a way that many widows and elderly women are exempted of daily market taxes (oral communication by the respective interviewees). Ndoye et al. (1997) in a market study in the humid forest zone of Cameroon found that women created a traditional institution resembling the informal 'tontine' or ROSCA[2] credit system to finance the purchase of products. It would be very interesting to better understand such local organization systems and use them as an entry point to support the creation of traders' organizations for more efficiency along the value chain. According to Scherr et al. (2002), Gruère et al. (2006) and KIT and IIRR (2008) the creation (if not yet existing) and empowerment of legally registered associations at all levels (producers, transporters, wholesalers, retailers and consumers) is a necessary condition for successful development of WEP markets for poverty alleviation and livelihood improvement. Through these groups, individual actors can:

(1) gain market information on specific product availability, prices, quality, demand, etc.;
(2) defend their rights and lobby for better-adapted policies and regulations ('advocacy');
(3) become sensitized about sustainable harvest levels and techniques, and the beneficial effects of WEPs on income and nutrition security;
(4) build their capacities with regard to product quality monitoring, cost effective processing techniques, entrepreneurial skills, etc.;
(5) cont(r)act traders in export markets;
(6) gain more easy access to credit;
(7) organize group sellings with more bargaining power;
(8) etc.

[2]A ROSCA or Rotating Savings and Credit Association consists of a group of individuals who agree to meet regularly for a defined period in order to save and borrow together. Each member contributes the same amount at each meeting, and per cycle everyone takes the whole sum once. As a result, upon his (her) turn, each member can access a larger sum of money and use it for whatever purpose (s)he wishes.

In the specific case of DRC, capacity building and official registration of this kind of groups is essential in order not to create ghost or 'ad hoc' associations (Mbumba 2008). The latter arise when people think they can easily gain money if they are member of a group, but collapse soon due to multiple disagreements.

WEP trader types

Prioritizing species based on actual income generation figures is not sufficient to guarantee success in NTFP promotion. Many other factors, such as the characteristics of the traders, product characteristics, (inter)national trade trends and markets, and the local, regional and global socio-economic environment, play their role in successful development of NTFP commercialization (Marshall et al. 2003, Ruiz-Perèz et al. 2004). A clear understanding of motivations and constraints faced by traders can provide valuable insights to define market priorities.

The four trader types we identified here can be matched with the typology of Ruiz-Pérez et al. (2004) who compared 61 NTFP commercialization case studies from Africa, Asia and Latin America. Although Ruiz-Pérez et al. (2004) studied NTFP-producing households, while we interviewed traders, some similar patterns were found in the economic strategies used by the actors (subsistence, diversified or specialized).

Our first cluster compares with the 'subsistence strategy households' in Ruiz-Pérez et al. (2004). Elderly women, mostly widows, use WEP trade as a last resort. They sell *P. guineense, C. acuminata* and *G. kola,* which are locally much-appreciated and strongly embedded in traditional culture (lucky charms or benedictions are pronounced while chewing *C. acuminata* nuts; *P. guineense* is used as a spice in coffee and tea, and is believed to have a whole range of medicinal virtues against cold, fever, backache, etc.; Termote 2010b, 2011). Net incomes earned by these traders are low due to the very small quantities traded ('micro-retail').

Our second and third cluster would seem to coincide with the 'diversified strategy households' in Ruiz-Pérez et al. (2004). Traders belonging to cluster two diversify in number of WEPs, selling wild fruits in addition to spices and stimulant nuts, and are able to gain higher incomes than those in cluster one. A third category of traders sells wild vegetables (except *G. africanum*) and seems to diversify in number of income generating activities. This

category of traders experiences a high burden of marketing costs. In particular for this group, a thorough study on cost attributions for transport, taxes, etc. seems necessary.

Finally, the fourth cluster compares well with the 'specialized-strategy households' in Ruiz-Pérez et al. (2004). The *G. africanum* trade is dominated by young dynamic traders who can fully benefit from interventions for more efficient market chain organization. As seen in other studies: men also enter into the business when an activity becomes lucrative (Abbott et al. 2007).

Species priorities

According to Tabuna (2000) and Bamoninga (2007), international markets exist for *G. africanum*, *C. acuminata*, *G. kola* and *P. guineensis*. These WEPs are internationally exchanged mostly with neighbouring countries, but also with Europe and the USA to fulfill the needs of the growing African diaspora (Tabuna 2000; Bamoninga 2007). However, these exchanges remain rather informal and no official statistics on exported quantities exist.

The species with the highest demand for and most dynamic traders is undoubtedly *G. africanum*. In 2006, 54 tons *G. africanum* were transported from Kisangani to Kinshasa by the local air companies (Bwama et al. 2007). Yet, around Kinshasa, the species' natural resource base is rapidly fading due to high demand and destructive harvest methods. In order to guarantee long-term sustainability of successful NTFP commercialization, (participatory) domestication and integration of *G. africanum* into agroforestry systems is thus needed (Ruiz-Pérez et al. 2004).

On the other hand, organizing the wild spices (*P. guineense*, *C. acuminata* and *G. kola*) market chains for more efficiency will also attract more dynamic traders who are able to specialize (Sunderlin et al. 2005). Thus, notwithstanding the potential of these products for local, regional as well as international commercialization, special strategies should be developed to protect the elderly (widow) women from cluster one; otherwise, they will probably not be able to survive in a more competitive market environment.

During participatory wild fruit ranking exercises in the course of ethnobotanical studies performed in the region, *A. mannii* scored highest followed by *L. owariensis* and *T. conophorum* (Termote 2010b, 2011). Hence, for these fruits there is potential to develop local

markets, even though they may remain seasonal. Our market study shows that *T. conophorum* nuts as well as *Landolphia* spp. fruits were able to generate mean added values above the poverty line of $1/day as long as the season lasts. They are easier to transport and less perishable than the very big *A. mannii* fruits and sold by a relatively higher number of traders in both clusters two and three. Better transport, transformation and/or conservation of *A. mannii* will be necessary for its market to expand. *D. osika* seems less interesting for further development, given the better 'semi-cultivated' substitute *Dacryodes edulis* (G.Don.) H.J.Lam. ('safou'). *M. arboreus* and *C. lacourtianum* fruits were able to generate fair yearly added values for the few traders in our study, but they are locally much less appreciated than *Landolphia* spp. or *A. mannii* (Termote 2010b, 2011). Amongst other reasons, consumers complain about the latex that remains sticking on hands and mouth after eating *C. lacourtianum*.

The low number of wild vegetable species presented on Kisangani markets is very striking. A possible explanation may be that local populations continue to see wild vegetables as 'food for the poor' (Lykke 2002). Sensitization on the nutritional qualities of these vegetables and the importance of variation in diets is thus necessary to expand these wild vegetable markets (Lykke 2002). *S. distichum* leaves were able to generate fair added values for the 15 traders interviewed. In addition, we think that the marketing of *M. macrostachyum*, identified as the most-appreciated wild vegetable during participatory ranking exercises (Termote 2010b, 2011), has some potential.

A logical next step, is an in-depth study of the priority species' value chains to identify pro-poor strategies for further WEP market development and promotion. Studies into consumer behaviour and nutritional education should help to create and sustain local demand for WEPs. In addition, in order to foster sustainable development of WEP trade there is a need to determine sustainable harvest techniques and to develop an appropriate, conducive legal framework. As was shown in other studies (Sundriyal and Sundriyal 2006), traders and harvesters are mainly concerned with returns per unit of labour and less with the availability of resources in the wild. Investigation into participatory domestication will also help to reduce pressure on wild resources (Leakey and Simons 1998; Tchoundjeu et al. 2006). In addition, participatory domestication has many other advantages in function of better marketing, such as a reduced fruiting cycle, a more uniform fruit quality, extension of production season, etc. (Tchoundjeu et al. 2006).

6.5. Conclusion

Until now, research on NTFPs in DRC is scarce and concentrated on inventories or commercialization and domestication of a limited number of interesting products. To our knowledge, this study was the first to provide quantitative data with regard to WEP trade on Kisangani markets over a period of one year. In total, 15 WEPs sold by 119 traders were identified on the markets of Kisangani, and harvest origins, prices, quantities, added values and net incomes were documented in detail. We identified four types of traders based on the range of WEP species sold. Almost all socio-economic characteristics of the four types of traders were significantly different, which has important implications for further market chain organization and development. Participatory intervention strategies e.g. should be stratified according to the respective trader groups' characteristics. A beginning of specialization can be detected in the trade of *G. africanum* with destination Kinshasa markets. This species urgently needs further investigation. Other priority species that can be proposed from this study are *Landolphia* spp., *T. conophorum*, *S. distichum* and probably also *M. macrostachyum* which seem to have potential for local market development. *P. guineense*, *C. acuminata* and *G. kola* have local ánd international market possibilities, but pro-poor market chain organization for these species should be able to protect the elderly widow women trading these species in micro-quantities to survive. There are clearly opportunities for promoting WEP trade in Kisangani, but until now WEP markets remain underdeveloped.

CHAPTER SEVEN

DO WILD EDIBLE PLANTS CONTRIBUTE TO THE DIETS OF WOMEN IN KISANGANI CITY AND YAOSEKO, A RURAL TURUMBU VILLAGE IN TSHOPO DISTRICT?

Figure 7.1: Woman preparing gbedegbede leaves (*Amaranthus dubius* Mart. ex Thell)

Abstract

The potential of biodiversity to increase and sustain nutrition security is increasingly recognized by the international research community. To date however, dietary assessment studies that have addressed how biodiversity actually contributes to human diets are virtually absent. This study measured the contribution of wild edible plants (WEP) to the dietary quality in a highly biodiverse context in DR Congo. The habitual dietary intake was estimated from 2 multiple-pass 24h dietary recalls for 363 urban (Kisangani) and 129 rural (Yaoseko) women in the period with highest WEP availability. All WEPs mentioned during the recalls were collected during previous ethnobotanical investigations, identified and deposited in the herbarium of the National Botanical Garden of Belgium (BR). Results show that in this high biodiverse region which has a precarious food security situation, WEPs are insufficiently consumed to increase nutrition security or dietary adequacy. The highest contribution came from *Dacryodes edulis* in the village sample contributing 4.8% of total daily energy intake and this within the safou season (about 3 months/year). Taking into account the nutrient composition of the many WEPs available in the region and known by the indigenous populations, the potential to increase nutrition security is vast. Additional research regarding the dietary contribution of agricultural biodiversity and the nutrient composition of WEPs would allow to integrate them into appropriate dietary guidelines for the region and pave the way to domesticate the most interesting WEPs.

Céline Termote, Marcel Bwama Meyi, Benoît Dhed'a Djailo, Lieven Huybregts, Carl Lachat, Patrick Kolsteren, Patrick Van Damme. *A Biodiverse Rich Environment does Not Contribute to a Better Diet. A Case Study from DR Congo.* *PLoS ONE* 7(1): e30533. *doi:10.1371/journal.pone.0030533* (Impact Factor: 4.411).

7.1. Introduction

Even though the nature of the evidence is still circumstantial, it is a reasonable and compelling assumption that increased agricultural and forest biological diversity leads to a more varied diet, which in turn improves specific health outcomes (Bélanger and Johns 2008; Johns and Eyzaguirre 2006; Johns and Sthapit 2004; Lutaladio 2010; Toledo and Burlingame 2006).

To date, however, dietary assessment studies that have addressed how WEPs and agricultural biodiversity actually contribute to human diets are virtually absent (Peñafiel et al. 2011). In particular, only a few studies are available that combine correct botanical identification of species (especially wild species) with a proper quantitative dietary assessment. As a consequence, it remains unclear how biodiversity contributes to dietary quality.

As a best case scenario, we carried out our investigations in a highly biodiverse environment, in the Democratic Republic of Congo, estimated to be the 5th most biodiverse country on earth (Counsell 2006). However, despite its enormous agricultural potential, food security remains very precarious in the country (Rossi et al. 2006). In general, information on the current dietary patterns and nutrient intake in DRC is very scarce and no other previous dietary intake study has ever focused on the contribution of WEPs to nutrition.

The present chapter documents the contribution of WEPs to local diets in the city of Kisangani and Yaoseko, a rural village inhabited by the Turumbu. It describes the overall diet in both localities and evaluates the dietary intake of women in the study area in relation to the recommended dietary allowances (RDA) (FAO 2001; FAO and WHO 2004).

7.2. Materials and methods

Sample

The study area comprised the 6 municipalities (Makiso, Tshopo, Lubunga, Kisangani, Mangobo and Kabondo) of Kisangani (capital of the Oriental Province, DRC, 0°31'NB, 25°11'E, 428 m) and the rural Turumbu village Yaoseko (34 km west of Kisangani,

0°35’03”N, 24°56’14”E, 400 m). Yaoseko was chosen because it was the village with the highest documented WEP knowledge during previous ethnobotanical inventories in Tshopo district (in total, 77 WEP species were inventoried; Termote et al. 2010b; Termote et al. 2011).

Data were collected from a cross-sectional survey conducted between July and September 2009 comprising 241 adult women in Kisangani (all ethnic groups mixed, further indicated as ‘overall city sample’), 129 Turumbu women from Yaoseko village (further indicated as ‘Turumbu village sample’) and 122 Turumbu women living in the city of Kisangani (further indicated as ‘Turumbu city sample’).

As the objective was to study actual WEP use and not knowledge, we opted to work with women because of two reasons. Firstly, women are responsible for cooking and are the decision makers when it comes to nutritional choices in the households in DRC (Charlier 2011). Recalling food intake from men might bring about additional bias and underreporting, since they often do not know into detail all the ingredients used to prepare the dishes. Secondly, women are central to address intergenerational effects of malnutrition as their nutrition status not only determines their own health, but also that of future generations through pregnancy and lactation (Lartey 2008).

The research was conducted during the period of highest WEP availability (Termote et al. 2010b; Termote et al. 2011), namely July –October, this corresponds with the end of the small dry season and beginning of the rainy season. More in detail, results of the focus group discussions which were presented in *chapter 5* (Table 5.2), showed that almost all WEPs inventoried during this PhD study were available at the moment of the food consumption survey, except for *Ipomoea batatas* and *Trilepisium madagascariensis*, both cited as WEP in only one study village.

No reliable inhabitants’ lists or population estimates were available for Kisangani so we used a convenience sampling approach. The Kisangani sample was two-stage stratified. For each of the six municipalities of the city, a random sample of 4 boroughs was drawn based on the list of boroughs available at the municipality’s administration. Starting from a central point (hospital, church, etc.) in each sampled borough, a first household was visited. When an adult woman was at home, research goals and methods were clearly explained and oral consent

asked. In case of absence or rejection of participation, the next door household was visited. After each interview, three doors were skipped and the next household visited until reaching the quotum of 10 interviews per borough. This way, 40 women per municipality were selected (41 in Lubunga).

For the Turumbu village sample, households were visited from one end of the village to the other end. Per household, we interviewed one adult woman who was home and agreed to participate. As a result, 129 on a total of 184 households (70%) were interviewed.

For the Turumbu city sample, we relied on the help of the Turumbu *mutuelle* (informal social security system organized by and for the Turumbu living in the city). In the absence of addresses, an administrative member of the *mutuelle* assembled Turumbu women at a central point until reaching the predefined number. Researchers interviewed the women at this central place.

Four interviewers, local women with a university degree, were trained during one week for questionnaire administration and supervised by 2 researchers. Participants could choose the interview language (Lingala, Kiswahili or French). Uniform translations of the questionnaires in Lingala and Kiswahili were agreed upon between the 4 interviewers during the training sessions. All questionnaires and tools were pre-tested and adapted where necessary. Both, questionnaires and research protocols were approved by the local university board (University of Kisangani). The local leaders (mayor of Kisangani, municipality mayors, borough and village leaders) provided their written consent after clear explanation of research goals and methods.

Food intake data

Food intake was assessed by two multiple pass 24-h recalls on non-consecutive days (Jonnalagadda et al. 2000). Portion sizes were estimated using, 1) a booklet with photographs portraying different calibrated portion sizes; 2) an extensive price-weight conversion list covering all foods or ingredients reported during the 24h recalls; and 3) direct measurements of estimated leftovers with a digital dietary scale with a precision of 1 g (Soehnle, Nassau, Germany) (Gibson and Ferguson 1999).

Photographs are an appropriate tool to estimate portion sizes at population level in Africa (Huybregts et al. 2008; Venter et al. 2000). Portion sizes were calculated as average small, medium and large portion sizes served in local students' and market/road restaurants. The photograph booklet was prepared from the pictures of these average portion sizes as served in local plates.

A price-weight conversion list was composed by visiting the Kisangani central market and 4 municipal markets during the survey period (July-September 2009). Edible portions were weighed using digital dietary scales with a precision of 1 g and prices recorded for all foods in the 24h recalls. Per food product in the same price category, we measured at least 10 items over different vendors per market and in different markets. Where necessary, food items were bought to identify edible portion and waste percentages. Consequently, average price-weight conversion factors for use in Kisangani were calculated. Prices in the village did not differ much from those in the city. Only for fresh leafy vegetables we needed to calculate adapted conversion factors for use in the village.

Edible portions of fruits and snacks, which come in discrete units, were estimated with the price-weight conversion list. For mixed dishes, we recorded all the ingredients of the total recipe in monetary value and converted them into edible weights by means of the price-weight conversion list. With the aid of the photobook, the total weight of the cooked dish (via an estimation of total number of plates and respective portion sizes) as well as the amount individually consumed by the interviewee were estimated. In this way, we were able to estimate the proportion from the total volume of the prepared dish consumed by the respondent and thus also the proportion of each individual ingredient. In addition, we compiled a database with average recipes for the local staple preparations *fufu* (cassava and/or maize flour and water), *lituma* (cooked and mashed plantains and/or cassava) and *chikwangue* (steamed cassava paste), and the most common mixed dishes like beans, amaranth, spinach, sweet potato leaves and cassava leaves. Per dish, 5 local recipes were collected and the average recipe calculated (Gibson and Ferguson 1999). Average recipes for mixed dishes were only used in case no individual recipe could be recorded (out of home consumption, in 8.5% of the recalls).

Species identification

Specimens have been collected and identified at the herbarium of the National Botanical Garden of Belgium (BR) during previous ethnobotanical research. For the description of species' uses and herbarium references, we refer to Termote et al. (2010b; 2011).

Socio-economic status

During the first interview with the participants, before starting the 24h recall, a number of socio-economic and demographic data were collected through a structured questionnaire with open questions. Education level was expressed as years of schooling (primary school: 1-6, secondary school: 7-12 or higher education: 13). Other parameters gathered were age, ethnicity, marital status, number of household members, dependency ratio (% of household members younger than 15 or older than 65 years; Torheim et al. 2004), estimated income, number of WEPs known and consumed, and some dichotomous (yes/no) variables such as the possession of a field or garden plot, or heads of small livestock, and whether the household sometimes gathers WEPs, insects or mushrooms, hunts wild animals or goes fishing. Women were also asked whether they were pregnant (and if yes, the semester) or lactating (and if yes, age of baby).

To estimate the household's economic status, a comprehensive index that incorporated household small livestock, household assets and housing as proxies for accumulated household wealth was developed (Lachat et al. 2009, Zeng et al. 2011). We assigned weights to small livestock, assets or house characteristics in concordance with their monetary value. An overview of the assigned weights and procedure used to calculate the household wealth index is presented in annex 3.

The variables small livestock, assets, house characteristics, accumulated household wealth and declared income were categorized into 'better-off' (highest tertile), 'normal'(middle tertile) or 'poor' (lowest tertile). Categorization was done separately for the 3 samples (Kisangani, Turumbu city and Turumbu village).

Food composition table

Apart from a very old, preliminary table (Degroote 1965), no recent food composition table is available for DRC. To convert ingredients into their respective nutrient levels, the food

composition table for Tanzania (Lukmanji et al. 2008) was used as basis and completed for lacking food items using the USDA nutrient database (www.nal.usda.gov/fnic/foodcomp/ search). For a number of rare or wild foods, other references were used (for safou (*Dacryodes edulis*) we used Kengue (2002); for palm wine Cunningham & Wehmeyer (1988); for 'fumbwa' (*Gnetum africanum*) Eyo et al. (1983) and Isong et al. (1999); for *Tetracarpidium conophorum* Enujiugha & Ayodele-Oni (2003) and Leung (1968) for other wild species). Values for nutrients which were not available from literature were replaced with data on similar foods in the food composition table. Where needed, nutrient contents of raw foods were corrected for cooking processes according to the USDA guidelines (USDA Agricultural research service 2007).

Data analysis

Food intake data from the 24h recall were entered and processed via the Lucille food analysis software (Ghent University, Gent, Belgium, www.foodintake.ugent.be) and usual food group and nutrient intake distributions were generated using the multiple source method (EFCOVAL 2010; Haubrock et al. 2011). The latter method allows eliminating the intra-person variation of the nutrient intake. The distributions generated were adjusted for 'interviewer' and 'recall day'. We omitted pregnant or lactating women in the analyses of nutrient intakes, because their energy and nutrient needs are higher to compensate for pregnancy or lactation.

Statistical analyses were performed in SPlus 8.1 (TIBCO software Inc., Palo Alto, California, USA). To compare proportions of women consuming different foods and food groups between the 3 samples, we used χ^2-tests. To compare energy contributions of food groups and nutrient intakes between the 3 samples, we used ANOVA analyses. When the latter analysis showed a significant difference ($p<0.05$), we proceeded with a Tukey post-hoc test. Comparisons of micro-nutrient intake were adjusted for total energy intake as described by Willet (1998). The percentage of non-pregnant non-lactating women with micro-nutrient intakes below the RDAs for adult women (FAO and WHO 2004) were calculated for the 3 samples. RDAs for lowest bio-availability of iron (5%) and zinc (15%) were used as the diets recorded were predominantly plant-based (Gibson and Ferguson 1999).

To assess the nutritional contribution of WEPs to the respondents' diets, the sample was split in WEP consumers (having eaten more than 10g of WEPs, the native fruit *safou* included, in

at least one of both recalls) and non-consumers. Energy contributions of food groups and usual nutrient intakes of both groups were compared in a regression model adjusted for sample design.

Finally, a logistic regression model was fitted to analyze the socio-economic and demographic parameters associated with consumption of WEPs. The initial model included variables yielding a $P < 0.25$ in bivariate analysis. A backward removal procedure was adopted using a likelihood-ratio test.
The significance level was set at 5% for all statistical tests and all tests were two-sided.

7.3. Results

Participant characteristics

Table 7.1 presents the participant characteristics for the three samples. The village sample contained significantly younger women, more lactating women, more women of a polygamous household and with a higher knowledge of WEPs. Compared to the other women, they were also more involved in activities such as agriculture, hunting, fishing and collecting WEPs, insects or mushrooms. Turumbu women in general (village or city) had a lower level of education than the overall city women sample. Women in the city (overall and Turumbu) were more involved in gardening. Total household wealth scores decreased from the overall city sample (65.4) over the Turumbu city (50.5) to the Turumbu village sample (23.5), but showed very high within sample variances.

Consumption frequency of food groups and wild foods

Cassava was the most frequently consumed staple food in the three samples (Table 7.2) (consumed in resp. 76.2, 84.3 and 98.8% of the recalls in the overall city, Turumbu city and Turumbu village samples). This basic staple is processed in different ways according to ethnic preferences. Cassava roots can either be boiled or fried (‘*molecules*’) before consumption; boiled cassava can also be pounded into a paste (*lituma,* the same name is used for the paste of boiled plantain bananas or a mixture of cassava and plantains); soaked cassava roots can be pounded into a paste which is then folded into ‘Marantaceae’-leaves and steamed for four to eight hours (*chikwangue*). Finally, the flour made from cassava can be mixed with hot water

Table 7.1: Sample characteristics of the food consumption survey[1]

Characteristics	Kisangani city *n (%)*	Turumbu city *n (%)*	Yaoseko *n (%)*	*P*[5]
Total number of subjects	241	122	129	
Age (years)[2]	35.0 ± 11.7 [a]	44.1 ± 14.8 [b]	30.5 ± 11.0 [c]	<0.001
Age categories				
<20 years	27(11.2)	9 (7.4)	27 (20.9)	
21-35 years	117(48.5)	28 (23.0)	64 (49.6)	
>35 years	99(41.1)	84 (68.9)	35 (27.1)	
(NA)	(0)	(1)	(3)	
Pregnant	18 (7.5)	5 (4.1)	13 (10.1)	0.19
Lactating	41 (17.0)	9 (7.4)	36 (27.9)	<0.001
Years of schooling[2]	8.2 ± 2.8 [a]	5.4 ± 3.9 [b]	4.8 ± 2.3 [b]	0
Number of WEPs known[2]	7.2 ± 2.6 [a]	8.0 ± 2.3 [a]	16.2 ± 5.1 [b]	0
Small livestock score[2,3]	6.0 ± 26.5	6.9 ± 22.9	4.4 ± 11.5	0.671
Assets score[2,3]	24.6 ± 53.7 [a]	13.4 ± 19.2 [b]	5.6 ± 13.5 [b]	<0.001
House score[2,3]	35.1 ± 11.5 [a]	30.0 ± 11.2 [b]	13.8 ± 4.6 [c]	0
Total household wealth score[2,3]	65.4 ± 67.4 [a]	50.5 ± 39.2 [b]	23.5 ± 24.2 [c]	<0.001
Ethnicity				
Turumbu	6 (2.5)	122 (100)	105 (81.4)	
Tshopo District	137 (56.8)	0	21 (16.3)	
Other	98 (40.7)	0	3 (2.3)	
Marital status				0
Single	16 (6.6)	12 (9.8)	2 (1.6)	
Married (1ste wife)	188 (78.0)	64 (52.5)	92 (71.3)	
Married (2^{nd} or 3^{rd} wife)	15 (6.2)	8 (6.6)	27 (20.9)	
Divorced or widow	22 (9.1)	38 (31.1)	8 (6.2)	
Household members [2]	9.0 ± 4.4	9.4 ± 5.0	8.1 ± 4.4	0.08
Field[4]	56 (23.2)	36 (29.5)	122 (94.6)	0
Garden[4]	195 (80.9)	107 (87.7)	52 (40.3)	0
Cattle raising[5]	105 (43.6)	49 (40.2)	67 (51.9)	0.15
Hunting[5]	6 (2.5)	11 (9.0)	89 (69.0)	0
Fishing[5]	16 (6.6)	15 (12.3)	99 (76.7)	0
Collecting WEPs[5]	48 (19.9)	55 (45.1)	120 (93.0)	0
Collecting insects[5]	21 (8.7)	42 (34.4)	120 (93.0)	0
Collecting mushrooms[5]	38 (15.8)	60 (49.2)	123 (95.3)	0

[1] Units presented are numbers (percentages) unless otherwise stated
[2] Mean with standard deviation
[3] For calculation of the score, see annex 3
[4] Number of women possessing a field or garden
[5] Number of women living in a household where at least one member implements this activity
[6] Calculated using χ^2-tests for factor variables; ANOVA for comparison of means, if $p < 0.05$, a Tukey *post-hoc* test was performed, different letters indicate statistically different means at 0.05 level

into a paste called '*fufu*' (whether or not mixed with maize flour). The second most important staple in the village were plantain bananas (boiled, fried or boiled and pounded into *lituma*). In the city more cereals were consumed, especially rice followed by maize (on the cob or as flour for porridge or *fufu*) and (wheat flour) bread.

Cassava leaves constituted the main side dish (more than 50% of all recalls) for women in all samples followed by sweet potato leaves, amaranth and spinach. Turumbu women in the village consumed significantly more fruits, especially the native fruit *Dacryodes edulis*, which is rich in energy (Kengue 2002). Caterpillars form an important part of the diet in all samples (resp. 19.5, 31.5 and 23.1% of the recalls for the general city, Turumbu city and Turumbu village sample). According to the respondents, our interview period corresponded with the season of highest caterpillar availability (July-October).

Only 15 WEPs (1 wild yam, 2 wild nuts, 4 wild leafy vegetable, 3 wild fruits and 5 wild spices, see table 2 for species identifications) were found in a small number of recalls in the three samples. Relatively more consumed was the native fruit safou (*Dacryodes edulis)* in 30.1% of the recalls in the village and in 19 recalls in the city (table 7.2).

Figure 7.2: Safou (*Dacryodes edulis*) tree and fruits

Table 7.2: Proportion of women who consumed food groups and food items[1]

Food groups and food items	Kisangani (n= 241) *n (%)*	Turumbu city (n= 122) *n (%)*	Turumbu village (n= 129) *n (%)*	*P* [2]	
				Kisangani - Tcity	Tcity – Tvillage
Cereals	**212.5 (88.1)**	**84 (68.8)**	**32 (24.7)**	**<0.001**	**<0.001**
Rice (*Oryza sativa* L.)	151 (62.6)	56 (45.9)	6.5 (5.1)		
Maize (*Zea mays* L.)	103 (42.7)	33 (27.2)	26.5 (20.7)		
Wheat bread (*Triticum aestivum* L.)	53 (22.0)	16.5 (13.7)	0.5 (0.4)		
Roots & tubers	**183.5 (76.2)**	**103 (84.3)**	**127.5 (98.8)**	**0.09**	**<0.001**
Cassava (*Manihot esculenta* Crantz)	173 (71.8)	97.5 (79.9)	127.5 (98.8)		
Plantain (*Musa acuminata* × *balbisiana*)	57 (23.6)	48.5 (39.8)	68 (52.7)		
*Wild yam (*Dioscorea* spp.)	0	0.5 (0.4)	0.5 (0.4)		
Nuts & pulses	**125.5 (52.1)**	**53.5 (43.9)**	**12.5 (9.7)**	**0.21**	**<0.001**
Peanuts (*Arachis hypogaea* L.)	62.5 (25.9)	38 (31.1)	10 (7.8)		
Cowpea (*Vigna unguiculata* (L.) Walp.)	7.5 (3.1)	2 (1.7)	1.5 (1.2)		
Haricot (*Phaseolus vulgaris* L.)	47.5 (19.6)	15 (12.4)	0		
Soya (*Glycine max* (L.) Merr.)	17.5 (7.3)	2.5 (2.1)	0		
Pumpkin seeds (*Cucurbita* sp.)	15.5 (6.5)	0	0		
*Wild nuts (*Tetracarpidium conophorum* (Müll.Arg.) Hutch. et Dalziel and *Panda oleosa* Pierre)	0	0	1.5 (1.2)		
Vegetables	**233.5 (96.9)**	**112.5 (92.3)**	**115.5 (89.5)**	**0.0075**	**0.45**
Cassava leaves (*Manihot esculenta* Crantz)	131.5 (54.6)	66.5 (54.5)	80.5 (62.5)		
Sweet potato leaves (*Ipomoea batatas* (L.) Lam.)	41 (17.0)	24 (19.8)	20.5 (16.0)		
Amaranth (*Amaranthus* spp.)	18.5 (7.7)	12.5 (20.1)	9 (7.0)		
Spinach (*Basella alba* L.)	11.6 (4.8)	4 (3.5)	8.5 (6.6)		
Eggplant (*Solanum melongena* L.)	52.5 (21.7)	19 (15.4)	10 (7.8)		
Welsh onion *(Allium fistulosum* L.)	165 (68.4)	73 (59.9)	44 (34.0)		
Onion (*Allium cepa* L.)	113.5 (47.0)	46 (37.7)	15.5 (12.1)		
Tomato (*Lycopersicon esculentum* Mill.)	135 (56.1)	58.5 (48.0)	50.5 (39.1)		
Tomatopaste	87 (36.0)	26.5 (21.7)	2.5 (2.0)		
Celery *(Apium graveolens* L.)	98 (40.6)	28 (23.0)	10.5 (8.2)		
*Fumbwa (*Gnetum africanum* Welw.)	0.5 (0.2)	0	0		
*Meye (*Megaphrynium macrostachyum* (Benth.) Milne-Redh.)	0.5 (0.2)	0.5 (0.4)	0		
*Gbedegbede (*Amaranthus dubius* Mart. ex Thell)	0	0.5 (0.4)	0		
*Sese (*Talinum triangulare* (Jacq.) Willd.)	0	0.5 (0.4)	6.5 (5.1)		0.0061
Fruit	**55 (23.8)**	**23 (18.8)**	**47 (36.3)**	**0.27**	**<0.001**
Avocado (*Persea americana* Mill.)	20.5 (8.6)	4.5 (3.9)	1 (0.8)		
Banana (*Musa acuminata* × *balbisiana)*	19 (8.0)	10 (8.0)	1 (0.8)		
Papaya (*Carica papaya* L.)	1.5 (0.6)	0	3.5 (2.8)		
Safou (*Dacryodes edulis* (G.Don.) H.J.Lam.)[3]	9.5 (4.0)	8 (6.4)	39 (30.1)	0.26	<0.001
*Tondolo (*Aframomum laurentii* (De Wild. Et T.Durand) K.Schum.)	0.5 (0.2)	0	0		
*Sakanu (*Cola bruneelii* De Wild.)	0	0	0.5 (0.4)		
*Bombi (*Anonidium mannii* (Oliv.) Engl. Et Diels)	0	0	4 (3.1)		
MPO*	**49.5 (20.5)**	**20.5 (16.8)**	**46 (35.5)**	**0.14**	**<0.001**
Bush meat fresh	1.5 (0.6)	1 (0.8)	6 (4.7)		
Smoked bush meat	26.5 (11.1)	13 (10.7)	36.5 (28.1)		

Food groups and food items	Kisangani (n= 241) *n (%)*	Turumbu city (n= 122) *n (%)*	Turumbu village (n= 129) *n (%)*	*P* [2]	
				Kisangani - Tcity	Tcity – Tvillage
Fish	**149.5 (62.0)**	**55.5 (45.3)**	**55 (42.6)**	**<0.001**	**0.88**
Fresh fish	16.5 (6.9)	9 (7.3)	22.5 (17.6)		
Salted fish	74 (30.8)	30.5 (24.8)	22 (17.2)		
Smoked fish	75 (30.8)	24.5 (20.1)	19.5 (15.3)		
Egg	**3.5 (1.5)**	**2.5 (2.1)**	**1 (0.8)**		
Milk & milkproducts	**38 (15.7)**	**12 (9.8)**	**2 (1.6)**	**0.051**	**<0.001**
Milk	37.5 (15.5)	12 (9.8)	2 (1.6)		
Oil & fat	**236.5 (98.1)**	**116.5 (95.6)**	**125.5 (97.3)**	**0.0486**	**0.31**
Palm oil (*Elaeis guineensis* Jacq.)	223.5 (92.7)	114.5 (94.0)	125.5 (97.3)		
Vegetal oil (different origins)	41.5 (17.2)	15.5 (12.6)	1.5 (1.2)		
Mushrooms	**7.5 (3.1)**	**3.5 (2.9)**	**12.5 (9.8)**	**0.58**	**0.0028**
Caterpillars	**47 (19.5)**	**38.5 (31.5)**	**30 (23.1)**	**0.0093**	**0.22**
Sugars	**214.5 (51.6)**	**51 (41.8)**	**49.5 (38.3)**	**0.11**	**0.50**
Sugar	117.5 (48.7)	49.5 (40.4)	46 (36.6)		
Soft drinks	11.5 (4.8)	2 (1.7)	0		
Miscellaneous	**238.5 (99.0)**	**119.5 (97.8)**	**128.5 (99.6)**		
Wild spices	2.5 (1.0)	1 (0.8)	11 (8.6)		<0.001
*Longowu (*Hua gaboni* Pierre ex De Wild.)	0	0	7 (5.5)		
*Bofili (*Scorodophloeus zenkeri* Harms)	0	0	1.5 (1.2)		
*Kalafulu (*Cinnamomum zeylanicum* Blume)	1.5 (0.6)	1 (0.8)	1 (0.8)		
*Ketchu (*Piper guineense* Schumach. et Thonn.)	1 (0.4)	0	1.5 (1.2)		
*Kelele (*Hymenocardia ulmoides* Oliv.)	0	0	0.5 (0.4)		

[*] MPO: Meat Poultry Offal food group

[1] Only food items consumed by at least 5% of a group are reported, except for WEPs. All WEPs consumed in this study are shown; they are preceded by an asterisk. For WEP herbarium references we refer to Termote et al. (2010, 2011)

[2] Turumbu living in the city were compared to the overall city sample, whereas Turumbu from the village were compared to Turumbu from the city. χ^2-tests were performed for all food groups and wild food items which were consumed by at least 10 persons over the two samples compared

[3] Safou (*Dacryodes edulis)* is native in Central Africa. This species is cultivated on a small scale around the homesteads, but so far not fully domesticated.

Energy contribution of food groups and wild foods

Table 7.3 shows the energy contributions of 14 food groups and wild foods for the 3 samples. WEPs contributed only marginally to the energy intake in the 3 samples, except for safou in the village sample (4.8%). In the village, safou contributed more to total energy intake than the meat/poultry/offal, fish, nuts and pulses, vegetables, sugars or caterpillars food groups.

Village diets were mainly characterized by a high consumption of roots and tubers (especially cassava, 45.4%), vegetables and a high energy contribution from oils and fat (36% principally from palm oil). City diets are more composed of a mix of roots/tubers (17.5%), cereals (25%) and vegetables, and have also a high energy contribution from oils and fats (33%).

Nuts and pulses and fish and milk food groups contribute significantly more to energy intake in the city (resp. 7.7; 1.7 and 0.6%) than to that in the village (resp. 1.0; 1.1 and 0%), whereas fruits contribute significantly more to the energy intake in the village (5.1%) than to that in the city (1.7%). Although a higher percentage of women consumed meat in the village (table 7.2), the contribution of the meat/poultry/offal group to energy intake is significantly lower in the village than in the overall city sample. This can be explained by lower quantities consumed per intake. Sugar energy contribution increases significantly from the Turumbu village sample (1.6%) over the Turumbu city sample (3.1%) to the overall city sample (4.7%). The energy contribution of caterpillars is rather low in comparison with the proportion of women who consume this food group (Table 7.2) and not significantly different over the three samples.

Subsequently, we compared the energy contribution of the different food groups between women who consumed WEPs or safou and those who did not. Although our informants in *chapters 4* and *5* considered safou as cultivated, safou was included in this analysis because it is an interesting underutilized native tree from Central Africa, which apparently contributed more to the diets than any other WEP. The overall city sample counted 20 WEP consumers (safou included), the Turumbu city and Turumbu village sample resp. 18 and 72. After adjustment for the fixed effect *sample* in our model, WEP consumers consumed significantly more fruits and roots and tubers than non WEP consumers (Table 7.4).

Table 7.3: Energy contribution of food groups and wild foods per sample[1]

Food group	Kisangani city Energy (*kcal*) [3]	% total energy [4]	Turumbu city Energy (*kcal*) [3]	% total energy [4]	Turumbu village Energy (*kcal*) [3]	% total energy [4]	*P*[2]
Cereals	539.9 ± 210.9 [a]	25.0	355.2 ± 177.5 [b]	19.7	39.3 ± 81.6 [c]	2.1	0
Roots and tubers	383.4 ± 192.6 [a]	17.5	401.6 ± 168.5 [a]	22.3	847.7 ± 345 [b]	45.4	0
Wild yam			-		-		
Nuts & pulses	170.5 ± 111.8 [a]	7.8	139.5 ± 164.7 [a]	7.7	19.1 ± 70.9 [b]	1.0	0
Wild nuts	-		-		-		
Vegetables	61.2 ± 23.5 [a,b]	2.8	57.6 ± 25.4 [a]	3.1	62 ± 24.8 [b]	3.3	0.055
Wild vegetables	-		-		2.2 ± 7.5	0.1	
Fruits	39.8 ± 61.9 [a]	1.8	30 ± 49.5 [a]	1.7	95.8 ± 94.1 [b]	5.1	0.001
Wild fruits	-		-		9 ± 40.7	0.5	
Safou	12.1 ± 51 [a]	0.6	11.7 ± 36.7 [a]	0.6	89.6 ± 107.2 [b]	4.8	0
Meat/Poultry/Offal	58.5 ± 93.6 [a]	2.7	32 ± 82.7 [b]	1.8	27.9 ± 33.7 [b]	1.5	0.0004
Bush meat fresh	-		-		5.7 ± 27.6	0.3	
Smoked bush meat	17.7 ± 50.3	0.8	9.9. ± 26.2	0.6	19.9 ± 26	1.0	0.11
Fish and fish products	41.8 ± 35 [a]	1.9	30.7 ± 34.9 [b]	1.7	21 ± 23.2 [c]	1.1	<0.001
Eggs	-		-		-		
Milk/milk products	16.4 ± 40.1 [a]	0.8	11.6 ± 38.7 [a]	0.6	0.5 ± 3.8 [b]		0.0001
Oils and Fats	719.6 ± 196.1 [a]	33.0	623.8 ± 261.2 [b]	34.6	663.4 ± 236.4 [a,b]	35.5	0.0004
Sugars	101.9 ± 89.8 [a]	4.7	56.4 ± 72.7 [b]	3.1	29.4 ± 35.3 [c]	1.6	0
Miscellaneous	18.7 ± 30.6	0.9	16.9 ± 53.2	0.9	31.7 ± 84.4	1.7	0.054
Wild spices	0.2 ± 1.7	<0.1%	-		0.4 ± 2.4	<0.1%	
Mushrooms	0.4 ± 1.9 [a]	<0.1%	0.6 ± 2.8 [a,b]	<0.1%	1.4 ± 3.7 [b]	0.1	0.0034
Caterpillars	13.5 ± 27.5	0.6	16.2 ± 19.1	0.9	14.9 ± 23.6	0.8	0.59

[1]All values are usual intake means ± standard deviation, with adjustment for *recall day* and *interviewer*

[2] ANOVA comparison of means. If p <0.05, a Tukey *post-hoc* test was performed, different letters indicate statistically different means at 0.05 level

[3] 1 calorie = 4.1868 Joule

[4] Expressed as percentage of total energy intake

[5] "-" Indicates that the energy contribution from these foods was insignificant

Table 7.4: Energy contribution of food groups for WEP consumers (the native fruit safou included) and non WEP consumers[1]

Food group	WEP consumer[2] (n=110)		Non WEP consumer (n=382)		Difference of means[3]	*P*[4]
	Energy (*kcal*) [5]	% total energy [6]	Energy (*kcal*) [5]	% total energy [6]		
Cereals	165.8 ± 234.6	8.2	419.6 ±255.7	20.9	-27.3	0.21
Roots and tubers	753.6 ± 357.3	37.3	439.4 ± 257.4	21.0	106.3	<0.001
Nuts & pulses	65.9 ± 125.1	3.3	139.6 ± 132.9	7.0	-0.77	0.96
Vegetables	63.7 ± 22.3	3.1	60.6 ± 25.0	3.0	0.93	0.76
Fruits	132.9 ± 83.7	6.6	28.8 ± 51.3	1.4	97.4	<0.001
Meat/Poultry/Offal	32.0 ± 65.0	1.6	47.3 ± 84.1	2.4	-3.4	0.42
Fish and fish products	29.4 ± 33.8	1.5	34.8 ± 33.2	1.7	5.0	0.21
Eggs	-[7]		-			
Milk/milk products	3.2 ± 3.2	0.2	13.3 ± 38.3	0.7	-3.4	0.73
Oils and Fats	662.5 ± 227.5	32.8	686.4 ± 227.6	34.3	-7.8	0.78
Sugars	42.2 ± 52.5	2.1	80.0 ± 85.6	4.0	-8.1	0.38
Miscellaneous	21.3 ± 24.7	1.1	21.8 ± 61.3	1.1	-9.4	0.17
Mushrooms	1.0 ± 3.3	/	0.6 ± 2.6	/	-0.076	0.82
Caterpillars	18.1 ± 24.7	0.9	13.5 ± 24.5	0.7	5.5	0.07

[1]All values are usual intake means ± standard deviation, with adjustment for *recall day* and *interviewer*

[2] People who consumed more than 10 g of WEPs in at least one of both recalls (safou included)

[3] Model-based difference of means (WEP consumer – non WEP consumer), adjusted for the fixed effect *sample*

[4] Model-based adjusted for the fixed effect *sample*

[5] 1 calorie = 4.1868 Joule

[6] Expressed as percentage of total energy intake

[7] "-" Indicates that the energy contribution from these foods was insignificant

Usual nutrient intake of non pregnant / non lactating women

Women in the overall city sample had a significantly higher daily energy intake (2,102 kcal ± 444.2) than women in the Turumbu city (1,715 kcal ± 599.6) and Turumbu village samples (1,779.4 kcal ± 564.9) (Table 7.5). Percentage energy from protein was significantly lower in the village sample (7.6%) than in both other samples (9.2 and 9.4%, resp.). Percentage energy obtained from fat was comparable over the 3 samples.

Turumbu women in the city had significantly lower relative intakes for vitamin A, vitamin C, thiamine, niacin, vitamin B-6, folate and calcium than the women in the overall city sample and higher intakes for riboflavin. The Turumbu in the village had significantly higher intakes for vitamin C, thiamine, vitamin B-6, folate, calcium and iron, and lower intakes for niacin, vitamin B-12 and zinc than the Turumbu women in the city.

When comparing usual micro-nutrient intakes with the respective RDAs for adult non pregnant non lactating women, more than 75% of the women in all samples had intakes below the RDAs for niacin, folate, vitamin B-12, calcium, iron and zinc. However, most women in all 3 samples had vitamin A, vitamin C and riboflavin intakes above the RDAs.

Subsequently, we compared women who ate WEPs (including safou) with those who did not (Table 7.6). Corrected for energy intake, WEP consumers had significantly higher intakes of vitamins A, C and B-6, and calcium, and relatively lower intakes for riboflavin.

Socio-economic and demographic parameters related to WEP consumption

Variables age, education, small livestock, assets and house characteristics yielded a p-value higher than 0.25 in bivariate analyses with WEP consumption (or not) as dependent variable. All the above variables were entered in a stepwise backward logistic model adjusted for *sample*. Age was significantly related to the consumption of WEPs in bivariate analyses ($p = 0.008$), but once the model was corrected for the fixed effect *sample*, age was no longer significant. None of the other variables were retained in the model.

Table 7.5: Usual daily dietary intakes of non pregnant/non lactating women in Kisangani (city), Turumbu women in Kisangani (city) and Turumbu women in Yaoseko (village)[1]

Nutrient	Kisangani (n=182)	% women under RDA[2]	Turumbu city (n=108)	% women under RDA[2]	Turumbu Yaoseko (n=80)	% women under RDA[2]	*P*[3]
Weight (*g*)	1039.64 ± 275.14 [a]		872.35 ± 271.83 [b]		1062.88 ± 354.48 [a]		<0.001
Energy (*kcal*)	2102 ± 444.19[a]		1715.08 ± 599.57 [b]		1779.37 ± 564.85 [b]		<0.001
Energy density (*kcal/100g*)	205.47 ± 23.0 [a]		196.13 ± 26.21 [b]		169.34 ± 21.9 [c]		<0.001
Energy from protein (*%*)	9.24 ± 2.13 [a]		9.36 ± 2.1 [a]		7.56 ± 1.98 [b]		<0.001
Energy from lipids (*%*)	44.78 ± 5.42		46.19 ± 6.4		44.18 ± 8.06		0.0686
Total carbohydrate (*g*) [4]	260.79 ± 64.1 [a]		211.71 ± 64.82 [a]		241.62 ± 94.55 [b]		<0.001
Fibre (*g*) [4]	22.48 ± 8.73		17.59 ± 8.76		18.81 ± 7.56		0.4021
Vitamin A (*µg RE*) [4]	4240.06 ± 898.37 [a]	0	3886.47 ± 764.4 [b]	0	4301.83 ± 768.44 [b]	0	<0.001
Vitamin C (*mg*) [4]	89.39 ± 23.46 [a]	3.85	86.17 ± 29.34 [b]	5.56	165.61 ± 74.22 [c]	0	<0.001
Thiamine (*mg*) [4]	1.03 ± 0.27 [a]	63.19	0.95 ± 0.36 [b]	72.2	1.07 ± 0.41 [c]	61.25	<0.001
Riboflavin (*mg*) [4]	2.07 ± 0.73 [a]	3.85	2.55 ± 1.88 [b]	7.41	2.52 ± 2.02 [b]	13.75	<0.001
Niacin (*mg*) [4]	9.12 ± 2.87 [a]	93.4	8.08 ± 3 [b]	96.3	7.44 ± 2.76 [a]	97.5	<0.001
Vitamin B-6 (*mg*) [4]	1.73 ± 0.51[a]	24.18	1.55 ± 0.43 [b]	31.48	2.40 ± 1.1 [c]	21.25	<0.001
Folate (*µg*) [4]	219.18 ± 58.84 [a]	100	202.9 ± 65.88 [b]	100	238.08 ± 86.34 [c]	93.75	<0.001
Vitamin B-12 (*µg*) [4]	1.44 ± 0.58 [a]	93.4	1.28 ± 1.49 [a]	87.03	0.6 ± 0.57 [b]	97.5	<0.001
Calcium (*mg*) [4]	406.23 ± 104.98 [a]	100	384.87 ± 138.13 [b]	99.07	541.91 ± 245.64 [c]	95	<0.001
Iron (*mg*) [4]	11.89 ± 3.67 [a,b]	100	8.93 ± 2.89 [a]	100	10.42 ± 4.22 [b]	100	0.0154
Zinc (*mg*) [4]	6.46 ± 2.1 [a]	91.8	5.04 ± 1.8 [a]	99.07	3.89 ± 1.9 [b]	97.5	<0.001
Alcohol (*g*) [4]	0.99 ± 5.7		0.31 ± 2.32		1.37 ± 5.48		0.3143

[1] All values are usual intake means ± standard deviation, with adjustment for *recall day* and *interviewer*

[2] % of women under RDA, recommended daily allowances for adults (FAO and WHO 2004)

[3] ANOVA comparison of means; if p <0.05, a Tukey *post-hoc* test was performed; different letters indicate statistically different means at 0.05 level

[4] *P* adjusted for total energy intake in the model as described by (Willet 1998)

Table 7.6: Usual daily dietary intakes of non pregnant/non lactating WEP consumers (safou included) and non WEP consumers [1]

Nutrient	WEP consumers[2] (n=78)		Non WEP consumers (n=310)		Difference of means[3]	*P*[4]
		% women under RDA		% women under RDA		
Weight (*g*)	1099.61 ± 323.98		972.27 ± 291.16		125.4	0.0026
Energy (*kcal*)	1975.7 ± 552.48		1915.98 ± 545.52		213.6	0.0037
Energy from protein (*%*)	8.92 ± 2.44		8.93 ± 2.14		1.0	<0.001
Energy from lipids (*%*)	43.25 ± 6.81		45.5 ± 6.15		-2.3	0.0101
Total carbohydrate (*g*)[5]	262.64 ± 85.97		238.28 ± 70.52		35.6	0.18
Fibre (*g*) [5]	23.23 ± 8.26		19.65 ± 8.77		6.1	<0.001
Vitamin A (*µg RE*) [5]	4247.8 ± 802.44	0	4130.87 ± 863.32	0	63.8	<0.001
Vitamin C (*mg*) [5]	150.79 ± 72.01	0	92.49 ± 36.26	3.23	28.7	0.0025
Thiamine (*mg*) [5]	1.1 ± 0.35	56.4	1.0 ± 0.32	68.39	0.091	0.12
Riboflavin (*mg*) [5]	2.2 ± 1.5	10.26	2.32 ± 1.46	5.16	-0.36	<0.001
Niacin (*mg*) [5]	8.76 ± 2.72	93.59	8.42 ± 3.02	95.81	1.3	0.12
Vitamin B-6 (*mg*) [5]	2.37 ± 0.98	8.97	1.68 ± 0.58	27.74	0.45	<0.001
Folate (*µg*) [5]	245.07 ± 74.92	94.87	211.88 ± 64.82	99.68	28.8	0.79
Vitamin B-12 (*µg*) [5]	0.97 ± 0.76	93.59	1.29 ± 1.02	93.87	0.061	0.83
Calcium (*mg*) [5]	569.14 ± 222.91	93.59	392.82 ± 121.64	100	141.3	<0.001
Iron (*mg*) [5]	11.4 ± 3.79	100	10.6 ± 3.8	100	1.5	0.42
Zinc (*mg*) [5]	5.15 ± 2.25	94.87	5.63 ± 2.22	95.81	0.7	0.25
Alcohol (*g*) [5]	0.88 ± 4.62		0.88 ± 5.04		-0.31	

[1] All values are usual intake means ± standard deviation, with adjustment for *recall day* and *interviewer*

[2] People who consumed more than 10 g of WEPs in at least one of both recalls (safou included)

[3] Model based difference of means (WEP consumer – non WEP consumer), adjusted for the fixed effect *sample*

[4] Model-based adjusted for the fixed effect *sample*

[5] Adjusted for total energy intake in the model as described by (Willet 1998)

7.4. Discussion

Given the huge gap in knowledge on food and nutrient intake in DRC, we first discuss some generalities of the local diets before going on with the discussion on WEP contributions to energy and nutrient intake. These generalities will help to better define and set our objectives with regard to the promotion of WEP consumption and its effects on food and nutrient intake in the studied populations. Better understanding of current dietary patterns and nutrient intake is also a necessary first step in the development of locally-adapted dietary guidelines.

Food and nutrient intake in the study population

The Turumbu samples are characterized by a rather low energy intake. The 1996 energy intake figures estimated on the basis of food availability at household level by PNUD/UNOPS (1998) for the whole Oriental Province (1,758.24 kcal/inhabitant) are comparable to the energy intakes found in our Turumbu samples. This indicates that the present food security problem not only has its causes in the 1996-2003 civil strife period (which certainly aggravated the situation) but dates back from decades of neglect and deterioration of the agricultural system under the Mobutu regime (Rossi 2006). DRC figures are in sharp contrast with energy intakes found in rural and urban Cameroon (3,947 kcal/day resp. 3,414 kcal/day for rural and urban women), a country with similar ecological and cultural characteristics (Mennen et al. 2000). The very precarious nutrition situation in rural DRC was confirmed in a more recent World Food Program (WFP) survey on vulnerability to food security (CFSVA 2008). According to the DHS-RDC study (2008), 17.3% of women in the Oriental Province have a BMI lower then 18.5 (underweight), whereas 1.1% have a BMI value higher than 30 (obese). For the whole country, these figures are 15.9 % and 20.6 % with BMI values lower than 18.5 for resp. urban and rural women and 3.9 % and 1.1 % with BMI higher than 30 (DHS-RDC 2008).

Total energy intake in the overall city sample was significantly higher than in the other 2 samples. Richer people tend to live in the Makiso municipality whereas Lubunga (at the other/left bank of the Congo river) is known to be the poorest municipality. Mean energy intakes for the 6 different municipalities ranged from 2,024.6 kcal/day in Lubunga to 2,381.6 kcal/day in Makiso, but showed no significant differences (Anova, p=0.505). Turumbu women in the city had lower energy intakes than the mean energy intakes for Lubunga. Their

socio-economic characteristics were also worse (older, less-educated, lower household wealth score, more divorced women) than those of the general city sample. However, we cannot conclude that the Turumbu are a marginalized ethnical group in the city as the sample procedure might have favoured participation of poorer women.

The variables age category, education category (primary, secondary, higher education), household income category, total wealth ranking category and marital status were significant in bivariate analyses with usual energy intake as dependent variable, with older women having less energy intakes ($p<0.001$), higher-educated women having higher energy intakes ($p<0.001$), women in better-off households having higher energy intakes ($p=0.0018$ resp. 0.0056 for income and wealth ranking category) and divorced/widowed women having significantly lower energy intakes than married women ($p<0.001$). Integrating these 5 variables into a stepwise backward linear regression model adjusted for *sample* resulted in a model where age category, education category, household income category and total wealth ranking category were withheld (model p-value =0), but which explained only 18.26 % of the variance in total energy intake.

Besides low energy intakes, we found a high contribution of fats (33 to 35.5% of total energy intake), exceeding the WHO/FAO recommendations for macronutrient intakes (15 to 30% of total energy from fats; FAO 2001) in the rural as well as urban samples. African settings show a high variation in total fat intake, going from 13.1% of total energy intake in Tanzania, to 50.7% in rural Nigeria (Elmadfa & Kornsteiner 2009). Mennen et al. (2000) found 43.8 % resp. 42.1% of total energy intake from fats for rural resp. urban Cameroonian women. In our study, but also in the Cameroonian study, red palm oil constituted the main fat source. Many side dishes contain large amounts of red palm oil, which is sometimes even drunk to finish the plate. Oil palms thus provide a cheap source of energy.

Protein intake in the village sample (7.5%) was significantly lower than in the other samples (9.1 to 9.4%) and below the WHO/FAO recommendations for all samples (10 to 15% of total energy from proteins; FAO 2001). Percentage energy from proteins in rural and urban Cameroonian women were 9.0 and 10.3%, resp. (Mennen et al. 2000) and thus in the range of what we calculated for women in our study. Farmers in rural areas typically sell their maize, legumes, peanuts and game meat to obtain some cash income and consume the less valuable, but also less nutritious cassava.

Torheim et al. (2010), in a review of 20 papers reporting on micronutrient intakes for women in resource-poor settings in Africa, found that in more than 75% of the studies mean (or median) intakes of iron, zinc, vitamin B-6, niacin and folate were below RDA values. Mean/median thiamin intakes were below the RDA in 73% of studies, whereas vitamin C was lower than standards in 55% of the studies. Mean/median vitamin A, riboflavin and vitamin B_{12} intakes were below RDA in less than 50% of the studies. Inadequate intakes of multiple micronutrients are thus common in resource-poor settings in Sub-Saharan Africa. Therefore, promoting a diversified diet is more appropriate than providing single micronutrient complements (Torheim 2010). The micronutrients of major concern in our study area are niacin, folate, vitamin B-12, iron, zinc and calcium (the latter was not evaluated in the Torheim review) with more than 75% of women having intakes below the RDA. According to the DHS-RDC study (2008), 49.2% of women in the Oriental Province were anemic (iron-deficient, blood hemoglobin < 12.0g/dl). However, for other micronutrients, no clinical data for the Kisangani region could be found to confirm (or disprove) our findings.

The high red palm oil consumption constitutes a daily source of β-carotene, precursor of vitamin A, in the 3 samples, thus preventing vitamin A deficiencies. More fruits, especially safou, were consumed in the village than in the city, providing significantly more vitamin C and calcium to the village sample than the others.

Contribution of WEPs to the diets

The main finding of this study was that WEPs were rarely consumed and do not contribute substantially to diets in this highly biodiverse region. In total, only 15 wild species figured in a small number of recalls (11 species in the village, 7 in the city), and this in the period with highest WEP availability. The most noteworthy contribution came from the native fruit *D. edulis*, reported in 30.1% of recalls and contributing 4.8% of total energy intake in the village within the safou harvest season. This is surprising as other studies have mentioned indigenous food systems where biodiversity is widely used and thus supposed to provide many essential nutrients and variety in diets (Bharucha and Pretty 2010; Grivetti and Ogle 2000; Kuhnlein et al. 2009). However, until now, only a few studies were able to calculate the complete nutrient contributions of correctly identified wild species (Peñafiel et al. 2011). In the communal areas of South Africa, Dovie et al. (2007), found that 91% of households harvested and consumed wild edible herbs, with a mean daily consumption of 0.2 kg per household. According to Ogle

et al. (2001a), more than 50 wild edible plants contributed, respectively, 81% and 63% of the daily intake of vegetables during the flood period and rainy season in the Mekong Delta in Vietnam thereby making important contributions to the intake of carotene, vitamin C, calcium and iron. On average, 3 wild vegetable species were consumed over a 7 day food frequency recall period in the Mekong Delta as well as in the Central Highland population in Vietnam (Ogle et al. 2001b). Based on this limited number of available studies and the region's high biodiversity, we expected a lot more WEPs to be regularly consumed.

The results of this study combined with the high number of WEPs known in the region and described in Termote et al. (2010b; 2011) indicate a huge gap between knowledge on and effective use of WEPs. Fifty wild vegetables, 67 wild fruits and 18 wild nuts besides condiments, tubers, tea substitutes, etc. have been inventoried in the Turumbu, Mbole and Bali communities in Tshopo District. In Yaoseko, the inhabitants described 77 WEPs, but only 11 species figured in their diets, during the period of highest WEP availability (Termote et al. 2010b; 2011). The findings of this research indicate that ethnobotanists should find ways to clearly separate knowledge from effective use of plant species. Documenting WEP knowledge before it disappears, investigating how WEPs are actually used and identifying the determinants of use is needed to develop strategies to (re)valorize their traditional uses. Our findings show that there is margin for improvement of the dietary intake in the region by consumption of WEPs and/or safou. WEP consumers ate more food and had higher intakes of energy and vitamin A, vitamin C, vitamin B-6 and calcium.

Given the mean diets' low energy and micronutrient content, one should have expected that diets are complemented by consumption of readily available WEPs, at least in the rural setting. The composition of various WEPs documented in the dietary assessment could improve dietary intake in terms of energy and micronutrients. *Gnetum africanum*, e.g. is a good source of proteins, containing all essential amino-acids and many minerals (Na, K, Ca, Mg, Fe; Eyo et al. 1983; Isong et al. 1999; Leung et al. 1968). Furthermore, wild leafy vegetables can ameliorate dietary diversity and compensate for the lack of pharmacologically-active substances - bio-active components with beneficial effects on health - which cultivated species may have lost during domestication (Leonti et al. 2006; Uusiku et al. 2010). Besides *G. africanum*, *T. triangulare*, *A. dubius*, and *S. aethiopicum*, a lot of wild vegetables inventoried in Tshopo District, but not consumed here would also merit further nutritional investigation, e.g. *Megaphrynium macrostachyum* (Benth.) Milne-Redh., *Celosia trigyna* L.,

Laccosperma secundiflorum (P.Beauv.) Kuntze, *Crassocephalum spp.*, *Cola bruneelii* De Wild., *Hilleria latifolia* (Lam.) H.Walter, *Phytolacca dodecandra* L'Hér., *Piper umbellatum* L. and different *Solanum* spp. (for an extensive list, see Termote et al. 2010; 2011).

A variety of nuts known by the Turumbu in Yaoseko (Termote 2010; 2011) such as *Panda oleosa, Treculia africana, Tetracarpidium conophorum* (Müll.Arg.) Hutch. et Dalziel, *Irvingia* spp., *Ricinodendron heudelotii* (Baill.) Heckel, etc. (which were at harvest maturity during the period of this study according to the data in table 5.2) are freely available in the wild and could provide extra energy and/or proteins to the diets. *Treculia africana* is already known to be a source of good quality protein (Bijttebier 1992; Edet et al. 1985; Lawal and Bassir 1986). In addition, the above-cited species are good sources of calcium (Leung 1968, Enujiugha and Ayodele-Oni 2003). Nuts can also provide niacin, folate and zinc, but more investigations into the nutritional composition of all interesting local wild species are needed to obtain more accurate nutritional values. Other wild nuts inventoried during ethnobotanical surveys for which no nutritional data could be found were *Anthrocaryon nannanii* De Wild., *Chytranthus macrobotrys* (Gilg) Excell et Mendonça and *Desplatsia dewevrei* (De Wild. et T. Durand) Burret (Termote 2010b; 2011).

Almost no nutritional information could be found with regard to the many wild fruit species inventoried in the region. Safou, which was fairly well-consumed in the village, is a good source of energy and proteins, but also calcium (Kengue 2002) as long as the safou season lasts (about 3 months/year). Although villagers had almost no access to milk products, their calcium intake was higher than in the city samples, mainly due to the high contributions of safou. Nutritional values of other elements such as vitamin C, vitamin A, niacin, riboflavin, thiamin, folate, etc. are not yet available for safou and urgently need more investigation. Given the yellowish colour of the fruit flesh and its consistency similar to avocado, we provisionally substituted the lacking nutritional values of safou with those for avocado in our food composition table. For *Anonidium mannii*, no nutritional values were available and these were substituted by those for ripe mango, given its very yellow colour and 'mango taste'. Other fruit species which were not consumed here, but merit further nutritional investigation are *Landolphia owariensis* P.Beauv., *Synsepalum stipulatum* (Radlk.) Engl., *Chrysophyllum lacourtianum* De Wild. and *Dacryodes osika* (Guillaumin) H.J.Lam. They are traded on the Kisangani markets and have a certain cultural value (*chapter 6*). Furthermore, in the village, a lot of smaller wild fruits will certainly also contribute to the micronutrient intake of

children, who pick them more frequently than adults along roadsides on their way to school (Redzic 2006). Examples of this are *Tristemma mauritianum* J.F.Gmel., *Passiflora foetida* L., *Sabicea johnstonii* K.Schum. ex Wernham, etc. (for an extensive list, see Termote et al. 2010b; 2011).

A possible barrier to WEP consumption may be the distance to be walked to collect certain species in primary forest or the workload to collect and prepare them. A constraint for wild nut consumption may be the high work load involved in cracking the nuts. To solve the latter problem, ICRAF designed a cracking machine for *Ricinodendron* nuts (Ogunsina et al. 2008). Furthermore, *Irvingia* and *Ricinodendron* nuts are now being successfully integrated into agroforestry systems in Cameroon which will decrease harvesting time and workload. Another barrier may be the lack of information. Many women reported that they do not know about the nutritional qualities of wild foods and they frequently expressed their eagerness to know more about nutritional benefits of their indigenous plants.

Some authors explained that the most-consumed wild edible plants are those that can be found in the immediate vicinity of the houses (Pardo de Santayana et al. 2005; Van den Eynden 2004). There are, however, some species such as *Amaranthus dubius*, *Talinum triangulare*, etc. which can be found along roadsides and around the homesteads. Why don't these species contribute more to the diets? Local populations mainly rely on conventional crops and systems as they have been introduced by colonial agricultural extension. As long as the colonial system provided every year good quality seeds and a ready market (via the Turumbu cooperative; Mbaya and Streiffeler 1986), farmers earned fair incomes and could buy supplementary food in the markets. Meanwhile, their traditional foods have been neglected (Johns and Eyzaguirre 2006).

However, the agricultural system in DRC degraded enormously during the last decades due to neglect and the 1996-2003 conflicts (CFSVA 2008). In the given situation, the promotion of WEPs alone will, of course, not suffice to tackle the nutritional problems encountered by the local populations in Tshopo District. The whole agricultural system needs urgent reorganization (CFSVA 2008). Policy makers, NGOs and local communities should grasp such reorganization to invest in agroforestry and agrobiodiversity. Integration of local fruit trees and traditional vegetables, tubers and others into agroforestry systems and home gardens for better food security, sustainability and biodiversity conservation should be promoted.

Moreover, any community development project on WEP domestication and integration into agroforestry systems should be accompanied by nutritional education and sensitization about the benefits of local foods and a diversified diet for health.

We are convinced that there is room to increase consumption of traditional foods if appropriate information is provided. Local populations were very proud to share their knowledge on WEPs during ethnobotanical surveys. They were surprised that for the first time someone came to listen to them and not came to tell them what they had or had not to do. Moreover, many respondents were concerned to know more about nutritional values of their indigenous plants.

Valorization of the extensive ethnobotanical knowledge on WEPs and the opportunity to express cultural identity through the use of WEPs, will not only have its benefits on the nutritional status of the local populations, but even more so on their cultural and social well-being (Kuhnlein 2009). Creating 'awareness' of the multiple benefits of WEPs through nutritional education, role plays, WEP fairs or recipe exchanges are some possible community interventions to promote WEP consumption (Toledo and Burlinghame 2006; Voster et al. 2007).

Study strengths and limitations

An important strength of this study is the dietary assessment method. In this study, we performed two recalls on non-consecutive days, which is appropriate to correct for intra-individual variance, calculate the usual nutrient intakes for the period with highest WEP availability, i.e. July-October, and to compare means of the three samples, and to identify the proportion at risk of inadequate intakes (Gibson and Ferguson 1999; Nyambose et al. 2002). Since potential underreporting might occur, we went to great lengths to document all WEPs consumed.

As extreme intakes are frequent and form part of the dietary habits in the study population, we did not exclude extreme intakes as over- or underreporters. Food is acquired on a day-to-day basis and only few households store food at home. In the village, households have food reserves on the field, with erratic accessibility during rains. Labour and financial revenue is unpredictable for urban dwellers as well. On the contrary, on special days, one may obtain large quantities of food from relatives or participate in several festivities, which leads to

extremely high intakes. Extreme intakes, however, are likely to be compensated for and balanced at population level. Nevertheless, to adequately estimate nutrient intakes at individual level, an increased number of recalls would be needed because of the high intra-individual variances in nutrient intake caused by those extreme intakes (Nyambose 2002).

Another constraint was the lack of an appropriate food composition table. In agreement with Baingana et al. (2004), we recommend that a food composition table is developed for DRC at least for the foods commonly eaten in the country and the most common staple preparations such as *chikwangue, fufu, lituma*, etc. In a first stage, this can be done using existing sources or FCTs while waiting for projects/initiatives that will analyze the country's own food sources in accredited laboratories. The international community (e.g. FAO, Bioversity International) also stresses the need for nutritional composition data on local varieties of crops and wild foods to tap into the potential of biodiversity for food and nutrition security (Burlingame et al. 2009).

Despite the limitations however, we are confident to provide a fair representation of the dietary contribution of WEPs on a population level in our sample. Although Yaoseko is certainly representative for the rural area in Tshopo District, integrating other ethnic groups in the region where we already inventoried WEPs, as well as other countries with other biodiversity conditions, in similar studies would contribute to the current knowledge on the role of biodiversity in diets.

Our findings provide critical insights into a highly biodiverse context and illustrate the need to translate indigenous WEP knowledge into dietary habits. Before getting indefinitely lost, indigenous knowledge on wild edible species and their use in the diet merits further research to capture the full potential of biodiversity and ameliorate diet adequacy. Generating food composition data for WEPs and making this information available to local populations in combination with research on ecology (e.g. production calendars of interesting species, production levels, species population densities, etc.), management and (participatory) domestication of WEPs to be integrated in fields and home gardens, should be considered as a sustainable way to increase nutrition security in the area. In the context of the vast agricultural potential of DRC, food-based approaches, integrating WEPs and agrobiodiversity in dietary guidelines, are needed to address food security. Creation of added value to wild products through better conservation and processing techniques, which might increase their

‘attractiveness’, may also be considered in future. However we should keep in mind that the actual purchase power of consumers in Kisangani is very low, even for the middle class inhabitants.

7.5. Conclusion

Despite the precarious nutrition security, urban as well as rural inhabitants in a highly biodiverse region such as the Congo basin, do not valorize their knowledge on WEPs to complement their diets. Overall consumption of WEPs in the sample was too low to achieve adequate dietary intake or nutrition security. The findings of this study indicate the vast gap between agricultural potential and dietary intake in the region. In addition, potential avenues to address food security challenges in sub-Sahara Africa in a sustainable way are identified.

CHAPTER EIGHT

GENERAL CONCLUSION

This chapter recapitulates the main findings of this doctoral research and formulates some implications and recommendations for future research.

8.1. Recapitulation

Tshopo District has an enormous agricultural potential, but food security remains very precarious. Faced with the consequences of food insecurity and taking into consideration the underutilized potential of WEPs, it is imperative to valorize and promote local wild foods for better nutrition and health. Although little is known about WEPs and the indigenous knowledge on their uses in Tshopo District, we found some reports mentioning interesting species with potential to contribute to better diets and nutrition security. Moreover, there is an increasing international interest in the promotion of sustainable use and commercialization of local/wild foods for 1) improved nutrition and health; 2) increased and diversified farmers' income; and 3) sustained cultural well-being. The above-described observations lead to the initiation of our Wild Edible Plants (WEP) project in Tshopo District and, within this framework, also the definition of our PhD objectives.

The main goal of this PhD research was to contribute to the valorization of local WEPs for improved food security and livelihoods in Tshopo District, DRC. In order to reach this objective, and placing WEPs at the centre core of our research, we used a multidisciplinary approach principally encompassing the domains of ethnobotany, market analysis and nutrition. While explaining the visual representation of our research shown in figure 8.1, we present a brief recapitulation of the research objectives and main methodologies and the way in which all research performed in this thesis strategically fits together.

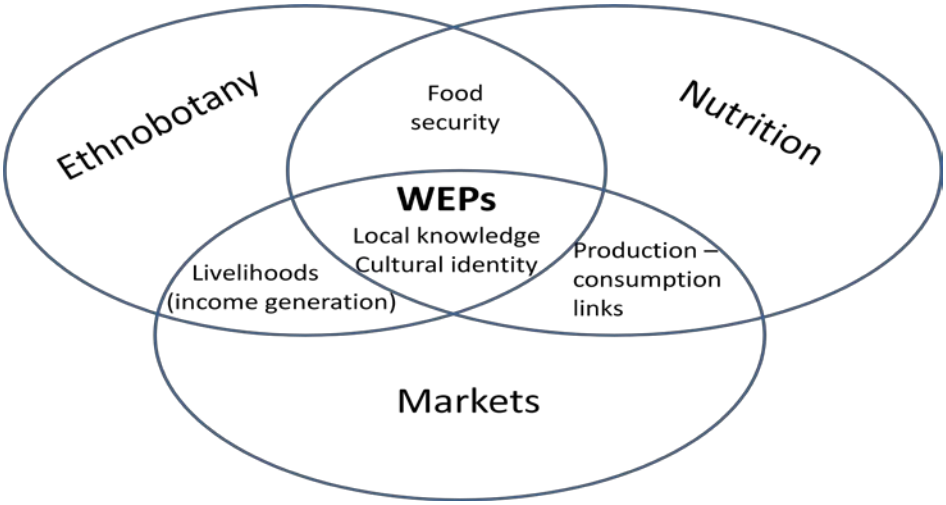

Figure 8.1: Visual representation of the multidisciplinary approach to WEP valorization used in this thesis

We started our investigations with a thorough documentation of WEPs and existing indigenous knowledge on them within the Turumbu, Mbole and Bali ethnic groups (*chapters 4* and *5*). Ethnobotanical inventories were performed within 3 villages per ethnic group, followed by ranking exercises to document local preferences for both wild fruits and vegetables (ethnobotany circle in figure 8.1).

Subsequently, we analyzed WEP markets in Kisangani in relation to number and socio-economic characteristics of sellers, WEP species and quantities offered, prices and periodicity (*chapter 6*, markets circle in fig. 8.1). The latter surveys generated valuable information which needs to be further refined and used to elaborate pro-poor strategies in WEP value chain development. Better-organized value chains should ultimately lead to higher and more diversified incomes for WEP gatherers and traders (livelihoods inner circle).

Finally, we evaluated the importance of WEPs in women's local diets, and the potential of WEPs to contribute to nutrition security (*chapter 7*). Therefore, we estimated the usual dietary intake from 2 multiple-pass 24h dietary recalls for 363 urban (Kisangani city) and 129 rural (Yaoseko village) women (nutrition circle in fig. 8.1). Additional research regarding the nutrient composition of WEPs (not presented in this work) would allow to integrate them into well-targeted food-based dietary guidelines for the region. Creating 'awareness' of the multiple benefits of WEPs through nutritional education, role plays, WEP fairs or recipe exchanges are some possible community-based interventions that could promote WEP consumption for better nutrition security (food security inner circle). Nutritional education in the city may stimulate demand for local foods, thereby reinforcing local production-consumption links and providing the necessary market incentives for farmers to cultivate/gather local foods (Johns & Eyzaguirre 2006; production-consumption links inner circle in fig. 8.1). Any project promoting the use of indigenous genetic resources should simultaneously work on the supply (sustainable production and marketing) and demand side (consumption). It makes no sense to promote WEP consumption without ensuring adequate supply. Furthermore, increasing WEP production and availability without increasing market demand will create overabundant offers and thus act as a disincentive to further production. Success of promotion programs, therefore, will depend on how these factors can be timely combined and synchronized (Chweya and Eyzaguirre 1999).

The inner core circle of figure 8.1 contains WEPs, indigenous knowledge and cultural identity. Valorization of the extensive ethnobotanical knowledge on WEPs and the opportunity to express cultural identity through the use of WEPs, will not only have its repercussions on the nutritional status of the local populations, but even more so on their cultural and social well-being (Kuhnlein 2009). In addition, the creation of added value to biodiversity by linking it up to markets and health, increases farmers' likelihood of conserving and enhancing biocultural diversity ('conservation through use' principle; Chweya and Eyzaguirre 1999, Johns and Sthapit 2004).

Because further in-depth study of *all* WEP species documented in this work is almost impossible, we also paid special attention to the prioritization of species during the whole study. However, we would like to add that food composition data on the different WEPs are needed to further refine prioritization exercises. The results of our work can then constitute the basis for further study on participatory domestication and value chain development of priority WEP species, i.e. species with both the highest nutritional and socio-economic potential, and the best cultural acceptance.

The main strength of this PhD research constitutes its multidisciplinary character providing insights into WEP knowledge and use which should contribute to a better valuation of local biodiversity for nutrition and livelihood security in Tshopo District. It is one of the first studies who combined ethnobotanical inventories of WEPs with a thorough dietary assessment method to quantitatively analyze the real contributions of WEPs to local diets. Hence, although performed in Tshopo District as a case, this study helps to expand the current knowledge base on the role of WEPs to nutrition and livelihood security, and the multiple links between biodiversity, nutrition and cultures.

8.2. Main results and limitations per objective

Document WEP knowledge within the Turumbu, Mbole and Bali ethnic groups in Tshopo District

Chapters 4 and *5* present the findings of the ethnobotanical investigations we performed in Tshopo District. Results show that there exists a vast, unexplored, spectrum of indigenous knowledge on WEPs in Tshopo District. Within the 3 ethnic groups we researched (Turumbu, Mbole and Bali), we inventoried 166 WEP species and 2 varieties in 71 plant families from which 198 plant parts are used for 228 different specific food uses. Compared to the information from the available literature, 72 species reported in our study were cited for the first time as WEP in the region. In addition, 136 of our 166 WEP species were shown also to be used for other purposes such as medicines, materials and arts, cultural uses, construction, fuels, bait, fodder or poison. Moreover, in *chapter 5*, we discussed inter- and intra-ethnic differences in WEP knowledge and found that only 21% of the species were known by all 3 ethnic groups. Hence, inventorying WEP knowledge in the other ethnic groups and territories of Tshopo District would certainly add new species and uses to our WEP list.

Although we provided a valuable contribution to the inventory of WEPs in Tshopo District (72 new species), we do not pretend to have documented *all* species known by the Turumbu, Mbole and Bali ethnic groups. The single author who performed ethnobotanical research within the *Collectivité Turumbu* found less species than we did (58 versus 85 species in our study), but 14 of his species did not figure in our inventory. The Mbole and Bali have never been studied before with regard to WEP knowledge.

The methodology used in this study (focus group discussions) did not permit to study differences in WEP knowledge relating to gender, age, education level, etc. In addition, women were rather underrepresented during our focus group discussions due to multiple occupations not permitting them to fully assist. However, we don't think this had much influence on the number of species known to be used as food. We lived in each village for two weeks and WEPs became the topic of discussion in the whole village. In the evening after work, people (men or women) sometimes came to add plants to our list, which we then discussed in the next focus group session. Although women were not always physically present in the discussions, they provided some information through their husbands or upon

request if we needed some clarification. More difficult was the registration of preparation methods for vegetables, because men did not always know. However, if needed, we asked supplementary information to the women. Nonetheless, for the preference ranking exercises (see objective 2), we took care to work with a separate women group. Extra sensitization was done to gather them at least for this (shorter) exercise.

With regard to the inter- and intra-ethnic differences found in this study, we should remind that our sample size (3 villages per ethnic group and 3 ethnic groups) was rather small to generalize findings. Furthermore, due to the lack of background information on ethnic groups and local vegetations, we were not able to explain the interethnic differences found or to attribute them to mere cultural or biological differences or historical links between the ethnic groups. Most likely, it is a combination of both. However, the main purpose of our study was to detect if there are any differences in biocultural knowledge and preferences on WEPs that we should take into account for future WEP promotion in the district and to obtain some indications whether studying other ethnic groups would add new species and uses to our WEP list. We can further remark that, e.g., *Ricinodendron heudelotii*, which is a species occurring throughout (and beyond) the Congo basin forest, was only known to be used as food by the Bali (east), while it has been collected on several places throughout Tshopo District (Lubutu (south), Basoko (west), Batikayafi (Kisangani), etc. (http://data.gbif.org)). Still, we did not perform local vegetation inventories in our study villages to be able to state with certainty that this species is present in the forest surrounding all of our sampled villages. Another interesting observation is that a lot of the common species (e.g. *Dioscorea praehensilis*, *Cola urceolata*, *Anonidium mannii*) have different names in the different languages (Turumbu, Mbole, Bali), indicating that these plants are integrated into their language culture by having own names and that they are not merely taken over from common names such as for *Passiflora edulis* (ma(n)ve(n)ve), which according to our Bali informants only recently invaded their environment. From the vernacular names we further observe that, e.g. the Turumbu under-differentiate certain *Cola* species, while the Mbole do not. Further investigation is thus needed.

Document preferences for wild fruits and wild vegetables by the Turumbu, Mbole and Bali men and women

Preferences in taste and commercial, nutritional and cultural values of both wild fruits and wild vegetables were discussed during participatory ranking exercises (*Chapters 4* and *5*).

Results show that for all ethnic groups considered together, overall liking was highest for *Anonidium mannii*, followed by *Landolphia owariensis* and *Tetracarpidium conophorum* in the wild fruits category, and *Megaphrynium macrostachyum* in the wild vegetables category. We did not perform any separate preference ranking exercises neither for spices nor for stimulant nuts. However, the ethnobotanical inventories showed that the wild spices *Piper guineense* and *Scorodophloeus zenkeri* together with the stimulant nuts *Cola acuminata* and *Garcinia kola* are used in all three ethnic groups for a great number of purposes and they are highly embedded in traditional culture. Hence, according to us, they should be added to the list of most-preferred species with regional importance.

Besides displaying differences in cultural habits and preferences for WEPs, we also observed that the various ethnic groups in Tshopo District are confronted with different opportunities and constraints such as market access. Consequently we should keep this in mind when constructing species priority lists for domestication (and/or conservation). A difference should be made between species with overall regional importance (as, e.g. for Tshopo District) and ethnospecific ones (species important to one or more ethnic groups).

There is room to refine/improve the preference ranking exercises used in this research for further study. Instead of using 4 predefined characteristics of WEPs based on literature (taste, commercial, nutritional and cultural value), one can, e.g., elicit the characteristics which are important from a local point of view ('*emic*' approach). In addition, as stated above, by performing preference ranking exercises for fruits and vegetables only, we lost valuable information on tubers, spices and stimulant nuts. Hence, the development of an overall preference ranking exercise with user-defined criteria should be considered in future.

Analyze WEP markets in Kisangani with regard to number and socio-economic characteristics of sellers, WEP species and quantities offered, prices and periodicity

C*hapter 6* describes WEP markets in Kisangani. From the 166 WEP species known by the Turumbu, Mbole and Bali ethnic groups in Tshopo District, only 15 WEPs were seen to be sold on Kisangani markets by a small number of 'ad hoc' traders, who often switch to other products when they become available. Until now, most WEPs are harvested for autoconsumption so that WEP markets in the region remain underdeveloped. Nevertheless, a certain form of organization was found in the *Gnetum africanum* trade with destination Kinshasa. In general, traders mentioned lack of transport and market infrastructure, lack of

storage space, (il)legal taxes, lack of credit facilities, insufficiency of WEPs to purchase and low purchasing power of consumers, as the main constraints in WEP trade.

Subsequently, in *chapter 6*, we were able to identify 4 main types of WEP traders which could be matched with the typology of NTFP gatherers as presented in Ruiz-Pérez et al. (2004). This typology provides valuable insights for further market chain organization and development, especially because selling particular WEPs seems to be linked to particular socio-economic trader characteristics such as gender, age, education level, marital status, residence, number of income generating activities, and yearly added values and net incomes generated. Participatory intervention strategies can thus be stratified and developed according to product and should take into account the respective traders' characteristics.

International, national as well as local markets exist for *Gnetum africanum*, *Piper guineense*, *Cola acuminata* and *Garcinia kola*. The species which has the highest demand and also the most dynamic traders is undoubtedly *G. africanum*. However, in order to guarantee long-term sustainability of successful NTFP commercialization, (participatory) domestication and integration of *G. africanum* into agroforestry systems is urgently needed. Wild spices (*P. guineense, C. acuminata* and *G. kola*), on the other hand, are so far only locally sold, mainly in micro-quantities by extremely poor, elderly widows. Organizing the wild spices market chains for more efficiency will also attract more dynamic traders who are able to specialize (Sunderlin et al. 2005). Thus, notwithstanding the potential of these products for local as well as international commercialization, special strategies should be developed to protect the elderly (widow) women; otherwise, they will probably not be able to survive in a more competitive market environment.

From the market study, it further follows that *Landolphia owariensis* and *Tetracarpidium conophorum* are priority wild fruits for *local* market development. They are both easier to transport and less perishable than the very big *Anondium mannii* fruits, whereas they are also sold by a relatively higher number of traders. Although the latter fruit obtained the highest score in the preference ranking exercises performed during our ethnobotanical investigations, better transport, processing and/or conservation of *A. mannii* will be necessary for its market to expand. Local market development for wild vegetables will require additional nutritional education and sensitization about the many advantages of diversified diets and wild vegetables for good health, in order to stimulate demand side.

One of the limitations with regard to this market study is the fact that we could not be present every day of the year on every targeted market. Due to time and budget constraints we had to cover seasonality by repeating our exercise 4 times spread over one year. This means that it is still possible that some traders 'escaped' from our study. However the finding that WEP trade is far from developed in Kisangani would not change with a few additional traders in our database. In addition, the fact that traders had to recall the buying and selling of WEPs over the year preceding the interview, could provide a source of error. Nevertheless, we tried to help our respondents to remember as accurate as possible their WEP trade activities by splitting the main question into many sub-questions (such as estimating mean quantities bought/sold per day or per week, number of days per week, number of weeks per month, which months of the year, etc.). Another remark we can make here is the fact that we could not cover the more 'informal' trade/exchange outside the markets. Some consumers explained us that *by chance*, they can buy *Megaphrynium macrostachyum* very early in the morning from a passer-by. However, studying markets, being the main places for exchange of goods, remains very valuable to obtain information on WEP trade.

Evaluate the importance of WEPs in local diets and nutrition security of women in Kisangani and Yaoseko, a rural Turumbu village

In the study of local diets (*chapter 7*) we decided to work with women because women are responsible for cooking and are the decision makers when it comes to nutritional choices in the households in DRC. Men often do not know into detail all the ingredients used to prepare the dishes. Yaoseko (a Turumbu village) was selected because this was the village where we had registered the highest number of WEPs during ethnobotanical inventories.

In contrast with our expectations, we found in *chapter 7* that the wealth of available WEPs is almost not used in the diets of neither urban nor rural women in Tshopo District. Only 15 WEPs were found to occur in a marginal number of 24h-recalls in the city of Kisangani and in Yaoseko, a rural Turumbu village, and this in the period with highest WEP availability. The most noteworthy contribution came from the semi-wild safou fruit (*Dacryodes edulis)*, reported in 30.1% of the recalls and contributing 4.8% of total energy intake in Yaoseko village, during the safou season (about 3 months/year). We further found that total energy intake of the interviewed women was rather low, with a high percentage energy coming from fats. The micronutrients of major concern were niacin, folate, vitamin B-12, iron, zinc and calcium with more than 75% of women having intakes below the recommended dietary

allowances. Despite the precarious nutrition security, urban as well as rural inhabitants in this highly biodiverse region do not valorize their knowledge on WEPs to complement their diets. Overall consumption of WEPs in the sample was too low to achieve adequate dietary intake or nutrition security. So, it is wrong to assume that biodiverse-rich environments automatically lead to better diets. However, this does nót mean that WEPs and agrobiodiversity, in general, could not contribute to better nutrition security. As described in *chapter 7*, a lot of WEPs with proven nutritional qualities, such as *Gnetum africanum* and *Treculia africana* (and others of which nutritional qualities are not yet known by science), are present in the region.

An important strength of this study is the dietary assessment method. We performed two recalls on non-consecutive days, which is appropriate to correct for intra-individual variance, to calculate the usual nutrient intakes for the period with highest WEP availability, i.e. July-October; to compare means of the three samples; and to identify the proportion at risk of inadequate intakes. In addition, since potential underreporting might occur, we went to great lengths to document all WEPs consumed.

The main limitation in this study was the non-existence of a food composition table for use in DRC. Consequently, we had to compose our own table based on different tables from neighbouring countries (each with their own specificities). Another limitation is the sampling procedure we had to follow to find the Turumbu women in the city of Kisangani. Despite we repeatedly explained the goals of our study and the expectations with regard to the participants, it might be that our informant systematically indicated the poorer women in the hope that they would benefit from some kind of assistance.

Despite the limitations however, we are confident to provide a fair representation of the dietary contribution of WEPs on a population level in our samples. Although Yaoseko is certainly representative for the rural area in Tshopo District, integrating more villages from different ethnic groups in the region would enlarge the current knowledge base on the role of biodiversity in local diets for Tshopo District. It would also permit to study inter-cultural differences in effective WEP-use.

8.3. General conclusion and recommendations

Eventually, the major conclusions from this PhD research can be summarized as:

1) there exists a lot of indigenous knowledge on WEPs in this highly biodiverse region; but
2) this knowledge is not translated into structural use, nor into local diets, nor are WEPs used for commercialization or income generation.

Revisiting the species which appeared in the different chapters as preferred, traded or consumed, we observed that the wild fruit species which were present on the markets fairly well correspond with the most preferred species from the preference ranking exercises (*Tetracarpidium conophorum, Landolphia owariensis, Anonidium mannii*). The leafy vegetable *Gnetum africanum* was present on the markets, but does not belong to the original food cultures of the ethnic groups living in Tshopo District. Only the Turumbu preferred *G. africanum* for its economic value, because they have (the best) access to Kisangani markets. We were not able to detect *Megaphrynium macrotstachyum* on Kisangani markets, although it was the most preferred wild vegetable by all 3 ethnic groups. This vegetable is probably more exchanged by informal trade. Some informants mentioned us: ‘‘Passer-by’ traders never reach the market with this vegetable; it is always sold before arriving at the market place’. Both *Solanum* species present on Kisangani markets are species which are more widely distributed throughout Africa. The spice *Piper guineense* and stimulant nuts *Cola acuminata* and *Garcinia kola* were present on the markets, but were omitted in the preference rankings because of the methodology used.

For the WEPs consumed during our food consumption study, it is more difficult to trace (dis-) similarities in use patterns and preferences because their consumption is very marginal. However, we noticed that 2 women in the city consumed *Megaphrynium macrostachyum*, although it was not ‘visible’ in the market places (see above). *Amaranthus dubius* and *Talinum triangulare* were both consumed in 1 recall from 1 Turumbu woman in the city. Both species are easily found in backyards and along roadsides, even in the city. *Talinum triangulare* was furthermore the most consumed wild edible plant species in the village (besides the native fruit safou which was considered as cultivated in this study). This confirms its position as one of the most preferred wild vegetables in the Turumbu preference ranking

exercises. The stimulant nuts *Cola acuminata* and *Garcinia kola* were not consumed by the women in our dietary assessment study. Some informants stated that only men consume them, but as many informants deny this statement.

Why are WEPs not valorised in Tshopo District?

With the data and results from our study, we were not able to provide answers to the question, 'why WEPs are actually not valorised in Tshopo District?' This question will need additional investigation. Some of the most frequently cited reasons for the decline in use of indigenous food species that have been reported from regions all over the world are: declining availability of wild foods due to overharvesting and land clearing for agriculture; difficulties in access to land and land tenure; local populations' perceptions about wild foods as being 'food for the poor'; loss of traditional knowledge; high work load to collect, process and prepare traditional foods; integration in market economies and globalization, etc. (Kuhnlein et al. 2009; Bharucha & Pretty 2010). For the case of Tshopo District, until now, access to land and land tenure do not constitute major constraints. The hypothesis of globalization is, until now, also less relevant for the region, given the recent history of war, insecurity, isolation, etc. Both situations may, however, rapidly change in future. Furthermore, there are certainly species, such as *Ricinodendron heudelotii*, which are hard to collect, process and/or prepare, but there are other species, readily available in the vicinity of the houses (e.g. *Amaranthus dubius*, *Talinum triangulare*), which are also not 'valorised'. When we asked women during our dietary assessments whether WEPs are seen as 'food for the poor', they did not confirmed this statement (nor disconfirmed). Instead they answered that they do not know if consuming this kind of plants is good for health.

Johns and Eyzaguirre (2006) argued that the neglect of indigenous foods in Africa started from decades of European colonialization. Western agricultural models, solely concentrating on the cultivation of conventional crops, were exported to the tropics and modified to comply with the local conditions. More specifically, in Tshopo District, an experimental alley cropping agricultural system was introduced in 1944 by the Belgian colonialists and called '*paysannat*' (Besombi 1947). Agricultural production significantly increased and was permanently supported by agricultural research at the INERA Yangambi station. However, today, due to difficulties in the agricultural extension and commercialization system, hardly anything is left from this productive period (Mbaya and Streiffeler 1986; Miasuekama Nkusu

1974; Russell 2011), and the recent wars (1996 – 2003) have destroyed much of the remaining socio-economic tissue (*Ministère du Plan* 2005).

In the given situation, it is clear that WEP promotion alone will not solve all underlying causes of nutrition insecurity and poverty in the region, but WEPs could at least provide a better contribution to local diets and incomes then they currently do. Given the right actions are undertaken, we think that the enormous indigenous knowledge on WEPs in Tshopo District can be (re)valorized in order to stimulate sustainable and healthy diets. Below, we briefly explain why we think there is potential to promote WEPs and reflect on some recommendations with regard to their promotion. Because the latter recommendations should be sustained by scientific research, we give some brief indications here to complete the idea. Nonetheless, section 8.5 will further discuss issues for future research in more detail.

There is potential for WEP promotion in Tshopo District

The pride demonstrated by local people when talking about 'their' WEPs; the fact that many WEPs also have a number of alternative uses, sometimes strongly linked with culture and identity (e.g. bathing the new born in a decoction of certain plant species for improved health; the use of certain species to obtain ancestral benediction; use as luck charms or to chase bad spirits, etc.); the fact that many women showed their eagerness to know more about the nutritional qualities of WEPs, together with declarations of participants during focus group discussions such as '*It is one of the most delicious dishes* (about melelu, *Talinum triangulare*)', '*Nobody told us before that consuming these plants is good for health*', etc. support our conviction that there is room to improve WEP use for better food security and livelihoods in Tshopo District. In addition, although we are conscious of the fact that words and actual behaviour sometimes differ, we can mention that many respondents interviewed are interested to participate in a project that would focus on WEP domestication and valorization. They motivated their interests as '*our fruits will be more accessible*', '*learning more about our traditional plants*', '*learning about domestication techniques*', '*gaining money through the commercialization of our fruits*', etc.

Promotion of WEPs should be integrated into strategies for sustainable rural development in Tshopo District. The region has an enormous agricultural potential and harbours many local, underutilized species with a lot of nutritional potential. In line with this, we could e.g. consider the promotion of home gardens, which in many other tropical countries mimic the

natural forest and in which local populations grow and/or manage wild plants next to domesticated ones for food, fodder, medicines, fuelwood, etc., in the vicinity of their homesteads (FAO 1999; Van den Eynden 2004). According to Frison et al. (2011), home gardens are some of the most diverse production systems in the world and also some of the most productive per unit area; they are also more resilient in the face of perturbations and can thus enhance food security (Frison et al. 2011; Galluzi et al. 2010). In addition, it are culturally constructed spaces in which the cultivation (and/or toleration) of indigenous fruits, vegetables, tubers, spices, etc. can be promoted and through which ethnobotanical knowledge on how to manage the natural environment can be preserved (Galluzi et al. 2010).
Participatory domestication of indigenous fruit (and medicinal) trees and integration of these trees into agroforestry systems belongs to the core activities of ICRAF's work in West and Central Africa. Since 2009, ICRAF extended its activities into Tshopo District, but further research is necessary to assess the socio-economic environment of production and the way in which home gardens and agroforestry can be promoted in Tshopo District. Research into agroforestry and agrobiodiversity starting from local needs and indigenous knowledge, and backed up by sound scientific research principles will be indispensable to create innovative, resilient agricultural models able to produce healthy foods in a sustainable way while at the same time conserving biodiversity for future generations.

Another recommendation that we would like to make here stems from the observation that knowledge on biodiversity is strongly linked with cultural identity. Even though nowadays WEPs are neither widely traded nor used in Tshopo District, the indigenous knowledge on them is still present and bioculturally well-defined. Hence, it should be possible to identify, embrace and build upon local socio-cultural values which are likely to enhance WEP consumption and trade. Nutritional education activities to promote WEP consumption for good nutrition and health should thus, on the one hand, be based on sound scientific knowledge of WEP nutritional values and, on the other hand, be able to stimulate local positive behaviours towards WEPs (Kuhnlein 2009). It is not enough to know what is good for health, positive behaviours should be stimulated. Research into cultural and social values relying on food choices and wild plants, and a better understanding of local culture are hereby essential. Moreover, generating and making available nutritional and health information on WEPs will also help to validate the existing local knowledge on WEPs. This seems all the more necessary as the local population itself – being told for decades that only conventional crops are good for health - is requesting this kind of information and would most benefit from

it. Through the recognition and valorization of their own knowledge, local populations can reach a sustainable way of living in conjunction with the modern context (Gradé 2008).

8.4. Major implications of our research findings

The results of this research are of interest to **NGOs, farmers and policy makers** as we documented knowledge on local WEP uses, values and potentials. The potential of NTFPs to alleviate poverty has been acknowledged in the country's Poverty Reduction Strategy Papers (DSCRP 2006, 2011), even though the latter documents recognize the huge knowledge gap at this level. Furthermore, besides providing information for better use and valuation of WEPs as such, policy makers, NGOs and local communities can find in this thesis a stimulus to engage in agroforestry and agrobiodiversity activities. The latter activities can easily be combined with valuation of local (wild) plant resources and indigenous knowledge on biodiversity. At present, the merits of supporting small peasant farming enterprises combining staple crops with indigenous fruit and medicinal trees in complex agroforestry systems are more and more recognised in terms of improved livelihoods, as well as in terms of on-farm biodiversity conservation and thus long-term sustainability (Asaah 2011).

Traders of WEPs in Tshopo District will find in *chapter 6* of this work some valuable information concerning the commercialization potential of specific WEP species, the main production centers, production seasons, etc. in addition to some suggestions on how to improve the value chains. According to us, the creation and empowerment of official traders' organizations as well as gatherers' organizations will be a necessary first step to develop WEP markets successfully for the benefit of the poor. Building linkages as well as creating some essential trust among actors in the value chain should be key components in any strategic action plan aiming at developing NTFP value chains (De Caluwé 2011). NGOs interested in the empowerment of WEP traders and/or gatherers may be particularly interested in the discussion about the traders' typology. Selling specific WEPs seems to be linked to distinct socio-economic trader characteristics. This means that intervention strategies to further develop and organize value chains can be targeted according to product and trader's characteristics.

Nutritionists and health workers often do not know about the existence of most WEPs even though these may have excellent characteristics that could be used to ameliorate nutrition security and health. Although many issues still need to be addressed, not in the least the nutritional properties of most of the plants, this work helps to make them aware of the possibilities of freely available WEPs for nutrition and health promotion. Once they have been informed, nutritionists and health workers can sensitize local populations about the benefits of diversified diets and the integration of WEPs into their dietary habits. In addition, *chapter 7* of this work provides an overview of dietary patterns in the city of Kisangani and in Yaoseko village. According to our knowledge, no other studies have ever analyzed diets and nutrient intakes in Tshopo District in such detail as we did. Our results can also form a first step in the elaboration of food-based dietary guidelines based on local foods.

Conservationists can use the results of this work to acquire more information about plant uses and the importance of specific species to local populations. Information about trade and consumption may help them to set priorities for conservation in the region. Besides conservation in strictly protected areas, article 22 of DRC's Forestry Code (August 2002) also provides for the creation of community concessions aiming at developing permanent forests. Discussions on the management of these forests are underway, but so far there are no examples of effective development of community concessions apart from some preliminary thinking being done through a FAO project aiming at developing and implementing community forestry in DRC (Eba'a Atyi and Bayol 2008). More research into the best practices to implement such community forests, and on how to empower forest communities with regard to the sustainable exploitation and management of their forest resources should help to address the double goal of poverty alleviation and biodiversity conservation. Conservation activities have more chances to succeed if they acknowledge existing indigenous knowledge on ecosystems and biodiversity, and when they seek to empower local populations regarding the sustainable management of their own natural resources. One should not only preserve nature, but also the cultural diversity and positive influence of people on the environment (Van den Eynden 2004). If biodiversity is to be maintained in forest ecosystems, it is necessary to recognize that these forests are there because of the actions of people who live in and around them (Mutenje et al. 2011; Russell 2011). There is considerable evidence that local people can – and do indeed – protect forests and ecosystems services of local value (Scherr et al. 2002).

Finally, we also refer to our collaboration with the University of Kisangani (UNIKIS, Faculty of Sciences) and IFA-Yangambi, mutually reinforcing research capacity and experiences. We are very grateful to our local collaborators for the many things we learned from them about tropical plants, differences between ethnic groups, interpretations of plant uses, etc. On the other hand, since the beginning of our investigations, we regularly organized workshops on ethnobotany and participatory research methodologies. Subsequently, we performed all field work for this thesis in collaboration with the local researchers. Hence, the insights obtained during workshops could directly be consolidated in the field. The main rationale behind this research was to elicit and valorize local knowledge. Meanwhile, local researchers found out how to combine local indigenous knowledge with formal scientific research principles to find locally adapted solutions for local problems.

8.5. Recommendations for future research

Until now, very little was known about WEP uses, their trade or consumption in Tshopo District. We may say that we worked on a topic that remains quite under-studied for the region. This implied, on the one hand, a very challenging and interesting research environment for which we could generate valuable basic information on WEPs. On the other hand, we think this research generated more questions than it actually could solve. Below, some topics for further research into the subject of WEP valorization are put forward.

Ethnobotany of WEPs

Apart from the 14 major ethnic groups studied during our WEP project, there are also smaller groups living in Tshopo District, such as the Barumbi, Wagenia, etc. As we kept on mapping new edible species and uses with each additional group interviewed, we think it is worthwhile to study these other groups and to continue to investigate inter- and intra-ethnic differences in WEP knowledge.

Methodologically, there is a need to develop clear and simple (less time-consuming) ways to differentiate between WEP knowledge and effective use of plant resources. Methods to assess the *real* value of species for local populations and procedures to compare these values between species and ethnic groups also need to be further developed (see *chapter 5*).

Furthermore, as was seen in *chapter 4* of this work, one-to-one relationships between common names and scientific names of plants do not always exist. The way in which local populations classify their plants (folk classification) does not always exactly correspond to the way science classifies species and genera (scientific classification). Studying and comparing folk classifications of plants within the different ethnic groups in Tshopo District, would help to obtain better insights into how local populations perceive their natural world. Likewise, research into the ways in which plants are named can tell us a lot about how plants are viewed in a given culture (Van Den Eynden 2004). Amongst others, a plant's name may be based on its cultural or utilitarian meaning, on its morphological characteristics or on its ecology (Berlin 1973). During our focus group discussions in Bafwabula, for instance, people were constantly giggling when pronouncing certain plant names in their Bali language. When later on, we showed these plant names to linguists at the Royal Museum of Central Africa in Tervuren, they translated e.g. '*odikimombolobi*' as '*he came by himself*', which teach us something about the history of this plant in their culture/environment.

The science of ethnobotany encompasses two main components, namely people and plants. In these two domains - upon which ethnobotanists heavily rely – a lot of work remains to be done also in Tshopo District. At the start of our WEP project, we experienced quite some difficulties to identify and localize the different ethnic groups in the District. The dilapidated state of the roads, the recent wars and insecurity situation lead to the isolation of many of these groups which seriously hampered any field work in the region. Some general geographical and administrative indications on ethnic groups from DRC are presented in the work of de Saint Moulin and Kalombo (2005), but more up-to-date ethnographic research is needed in order to better identify and localize the different ethnic groups in the region, and to study their origins, migration routes and history, their language, their culture etc. Almost nothing is known about the majority of these groups.

There is also a need to continue vegetation studies in Tshopo District. The region around Yangambi (where the INERA research station is located) has been quite well-studied, but no detailed vegetation data were found for the other areas around Kisangani (Opala, Bafwasende, Ubundu, Lubutu, etc.); they are in urgent need of further exploration and collection (Bamps in Kendrick 1989). In addition, DRC's flora volumes are still not complete and many of our identifications had to be done on the basis of comparisons with voucher specimens in the National Herbarium of Belgium in Meise. We probably found one new Rubiaceae species

(personal communication with Rubiaceae specialists in Meise), but unfortunately could not access the flowers of the species to confirm this.

WEP commercialization

According to Marshall et al. (2003), it is difficult to generalize factors of success in NTFP trade, since social and economic situations and NTFP products highly differ from case to case. Hence, highly detailed, site-specific value chain studies are the way forward.

Because WEP markets in Kisangani are still underdeveloped, further research into WEP commercialization should primarily focus on domestic market development, except for *Gnetum africanum* trade with Kinshasa. Research activities necessary to sustain promotion of WEP commercialization in Kisangani are, amongst others:

- value chain analysis of priority species and stakeholder analysis of all chain participants ideally leading to the identification of locally adapted pro-poor strategies for successful WEP market development;
- development of adequate conservation and processing techniques, easily adoptable by the poor, to increase shelf life and added value of the priority species;
- analysis of consumer behaviour, perceptions, motivations and barriers to WEP consumption;
- study of current legislation on WEPs (NTFPs in general) and ways through which legislation can enhance (or hinder) WEP commercialization; and
- assessment of current ecology (production calendars, populations densities, regeneration issues, genetic variability, etc.) and production levels of priority species, sustainable harvest levels and techniques that will guarantee resource maintenance, domestication and integration into agroforestry systems of the most interesting species; etc.

In addition to the priority species mentioned in this study, we also recommend studying the value chain of safou (*Dacryodes edulis*). This globally underutilized, but locally important species was considered as being cultivated by the focus group participants in all 9 villages participating in our ethnobotanical studies. Therefore, safou does not appear on our list of WEPs. However, during our nutritional investigations we found that safou was more consumed than any other wild species. Yet, safou is a tree native to Central Africa for which little formal research into domestication has been done apart from the work of ICRAF West and Central Africa. Nevertheless, in recent years, various national research institutions in Cameroon, Nigeria, Congo Brazzaville and DRC showed some interest and started research on safou (Asaah E, personal communication).

WEPs and biodiversity in nutrition

One of the most interesting aspects of WEPs is that they can provide a range of rare nutrients and pharmacologically active substances. In addition, they bring variation in and complement local diets, especially with vitamins and minerals. Undoubtedly, we urgently need more data on nutritional values of priority species. According to Burlingame (2009), food composition analysis is a useful vehicle to explore synergies between biodiversity and nutrition. Making food composition data available will help to further prioritize local WEP species and to discover those species with particular nutritional qualities able to contribute to better diets.

Furthermore, we saw in this study that WEPs may be available and known by local populations, without, however, being widely used. More is thus needed. More research into the actual and potential contributions of biodiversity to diets and health within other ethnic groups in the region and in other ecological settings should contribute to a better understanding of the links between biodiversity, nutrition and culture. These *strategic linkages between health, culture, environment and agriculture and nutrition to combat hunger and micronutrient deficiencies* have also been described as *'food systems'* (Burchi 2011).

Until now, however, large-scale food and nutrition system approaches that promote sustainable agriculture aiming at improving diet diversity and livelihoods have been limited in their development and implementation (Burchi 2011). For too long, agricultural, nutrition and health policies have been conceived and implemented independently. Frison et al. (2006) explain this by the fact that there is both a lack of political commitment and a lack of direct scientific evidence for the effectiveness of dietary diversification strategies to make a convincing case in support of large-scale implementation programs. Indeed, a recent review on the effectiveness of agricultural interventions that aim to improve nutritional status of children confirmed that '*little evidence exists of an effect of agricultural interventions on the nutritional status of children*'. However, the authors of the review attributed this result to the lack of power of the studies reviewed rather than to the lack of effectiveness of the intervention themselves (Masset et al. 2012). They further add that this is a consequence of the complexity of the environment rather than of a lack of skills or rigour of researchers. Many confounding factors such as the circumstances under which people participate in these interventions, their health and sanitation environment, cultural practices, etc., interfere with the implementation and outcomes of programs which aim at promoting agrobiodiversity for better nutrition and health. More investigations are thus needed to construct a clear conceptual

framework which will help us, not only to evaluate the large-scale effectiveness of food system approaches/interventions, but also to rigorously analyze the effects on intermediate outcomes in order to identify the underlying factors of success (or failure). Population-based studies combining clinical data and measures of access and consumption of biological diversity are key to demonstrate the important relationships between biodiversity, dietary diversity and health outcomes, and thus to construct a stronger evidence base than currently exists.

Successful interventions to support the use of biodiversity for health objectives are likely to be multi-sectoral, multidisciplinary, community-based and problem-focused. The challenge is to address a problem for which the causes and consequences span culture, health, agriculture, markets and environment (Johns and Eyzaguirre 2006).

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ANNEXES

Annex 1 : Non-food uses of WEPs documented within the Turumbu, Mbole and Bali ethnic groups, Tshopo District, DRC

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
Acanthaceae	*Justicia insularis* T.Anderson	ophole (l)	cultural	prepared leaves: applying on body while citing ancestors to remove a curse (l), eating ophole with ripe plantains planted after circumcision to confirm manliness (l)
Achariaceae	*Caloncoba subtomentosa* Gilg	lisende (o) lisakele, liphephele (f) lisene, liphephele (l)	medicinal	bark powder on breast to improve respiration (f), inhaling young crumbled leaves against head ache (f), roots: dental caries (l), bark and leaves: splenomegaly (swollen liver after badly treated malaria) (l); fruit: constipation (f)
			tech & mat	poles for traps (f) bark: meat conservation, against maggots (f,l)
			fuels	firewood (l)
			construction	branches: building poles (o,f, l), wood: boards (l)
			bait	fruit pulp: bait on fish-lines (l)
			fodder	host tree for edible caterpillars (o,f, l)
Amaranthaceae	*Amaranthus dubius* Mart. ex Thell.	ngbelengbele (o), lonenge (w,o) odikimombolobi (a,v,m)	cultural	leaves: chasing bad spirits/witches (o,w), ancestral benediction (o)
			fodder	pig feed (o)
Anacardiaceae	*Antrocaryon nannanii* De Wild.	bokongo, kongo (u,w,o) okongo (k) utiongo (a,v, m)	medicinal	bark: enema to calm pain from hernia (k), tuberculosis (a)
			tech & mat	fruit: chasing mice (v)
			cultural	bark: treating *Iyambe* (cultural disease concerning conflicts, showing abscesses) (k)
			fuels	firewood (w)
			construction	wood for construction (v)
	Pseudospondias microcarpa Engl.	agombe (m)	fuels	firewood (m)
			construction	building poles (m)
			fodder	host tree for edible caterpillars (m)
	Trichocypha acuminata Engl.	naola (l)	medicinal	bark: cough (l)
			construction	trunk: building poles (l)
Annonaceae	*Anonidium mannii* (Oliv.) Engl. & Diels	anguto (u,w,o) ombi (k, f) oomi (l) upombi (a,v,m)	medicinal	bark: snake bite (o,u), eye injury (o), foot wounds (o,u), post-partum pain and bleeding (w,u,v), lumbago (u), abscess (k), bellyache (k), diarrhea (f), burning wounds (f), menstruation pain (a), rheumatism (a,m), calming pain from hernia (m), haemorrhoids (m)
			tech & mat	leaves: packing material (l) bark: temporary bed in the forest (a,v), intimidate wasps during honey extraction (v)
			cultural	bark: ancestral judgement of guilt (u), treating *Iyambe* (cultural disease concerning conflicts, showing a swollen, bloated belly) (f), chasing bad spirits (l), bathing the newborn for good health (a,v,m), young shoot: to let grow the fungi in the forest (v) fruit: throwing the fruit to provoke malediction (curse) (v)
			fuels	firewood (l)
			construction	bark: roof thatching (l), branches: building poles (l)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
	Artabotrys thomsonii Oliv.	liyomomi (l) dandi (v)	medicinal tech & mat	liana: tuberculosis (v) liana: traps (v)
	Isolona hexaloba Engl. & Diels	unkosakosa (a)	medicinal cultural	bark: lumbar pain (a), joint inflammation (a), impotence (a) branches: catching edible termites (a)
	Monodora myristica (Gaertn.) Dunal	ophaningo (f)	medicinal tech & mat cultural	bark decoction: malaria (f) branches: long chairs (f) fruit: with leaves ifofoyange treats *Iyambe* (cultural disease concerning conflicts, showing a swollen, bloated belly) (f)
Apocynaceae	*Clitandra cymulosa* Benth.	inono (u,w,o) linono (k), lilolo (f) mbado (a,v,m)	tech & mat medicinal bait	latex: making balls (o,w,u,k), ngong handles (o,k), repair flat tyres (o,w,u) latex: intestinal worms (o,k), lumbar pain (v, m), malaria (m) fruit: bait for apes (u)
	Landolphia foretiana (Pierre ex Jum.) Pichon	lingbotoma (o) mandolo (a), angolo (a), maligbo, nambedumbedu (m)	tech & mat	latex: making balls (o), repair flat tyres (o)
	Landolphia mannii Dyer	mesisi (v)	tech & mat	latex: making clothes (v), balls for children (v), repair flat tyres (v) liana: traps (v), spears (v)
	Landolphia owariensis P.Beauv.	lilolo (u), liyo (w,o) liyo (k,l), liyo, itophe (f) nekala (v,m), nekala, lisisa (a)	medicinal tech & mat bait	leaves: cough (l), latex: eye injuries (l), intestinal worms (a), malnutrition (a) latex: making balls (o,w,u,l,a,v,m), ngong handles (o,w,f,l), repair flat tyres (o,w,u,l,a,v,m), repair sandals (l), caoutchoux (f), local pitcher or calabash (a), making clothes (a,v,m) liane: traps (a,v), spears (v,m) fruit: bait for apes (u)
	Landolphia robustior (K.Schum.) J.G.M.Pers.	angolo (a, v, m)	medicinal tech & mat cultural	latex: intestinal worms (a), malnutrition (a), uterine fibroid/fibroma (m) latex: local pitcher or calabash (a), making clothes (a,v,m), balls for children (a,v,m), repair flat tyres (a,v,m) liana: traps (a,v), spears (v) liana: amulet against miscarriage (a)
	Landolphia villosa J.G.M.Pers.	libii (u), lilombo (w) inono (w) lisenda, limbi (f), limbi (k), liphi (l) maligbo (a,v,m)	medicinal tech & mat bait	latex: eye injuries (l), intestinal worms (a), malnutrition (a), malaria (v,m), lumbar pain (m) latex: making balls (u,l,a), ngong handles (l), repair flat tyres (u,l,a), repair sandals (l), local pitcher or calabash (a), making clothes (a) liana: traps (a) fruit: bait for apes (u)
	Landolphia sp1	ngilaseka (u,w)	tech & mat bait	latex: making balls (w), repair flat tyres (w) fruit: bait for apes (u)
	Picralima nitida (Stapf) T.Durand & H.Durand	agbodu (v)	medicinal tech & mat	bark: hernia (v) leaf: shooter of bows to direct arrows (v)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
	Saba comorensis (Bojer ex A.DC.) Pichon	lilombo (u,o), libii (w) ambedumbedu (a)	medicinal	roots: gonorrhoea (o) fruit juice: haemorrhoids (o)
Araceae	*Anchomanes giganteus* Engl.	likondoyaolimo (o) libugudebezili (a)	cultural	leaves: luck charm for hunting (a)
	Lasimorpha senegalensis Schott	owaka (l)	tech & mat	branches for fire activation (blacksmith) (l) leaves: chasing head-lice (l), hat or umbrella (l)
Arecaceae	*Elaeis guineensis* Jacq.	atchichi (f), loombo (f) balia, libala (a,v,m)	tech & mat construction fodder	Branches: traps (f), beds (f), brooms (f,v,m) male inflorescence sap: laundry soap (f,m) spine: pins (v) leaves: roofs of paillotes/hangars (v) host tree for edible larvae (*mpose*) (v,m)
	Laccosperma secundiflorum (P.Beauv.) Kuntze	likawu (u,o) okawu (k,f,l) ukawu, ongonga (a), unkawu (v,m)	medicinal tech & mat construction	leaves: snake bite (o) leaf button: intestinal worms, ascaris (k,l,v,m), menstruation pain (l), calms pain from hernia (a) young tuber: enema to calm pain from hernia (k) sap: snake bites (f,l), earache (f) liana: baskets and mats (o,u, a,v,m), chairs and beds (u, k,f,l, a,v,m), baskets and fish fykes (traps) (o,k,f,l), ladders or cords for climbing trees (k,l,m), bows and arrows (l,v), pushing fish into nets (l), hook to take bird nids (l) leaves: roof thatching (u) liana: transverse laths (k,f, l)
	Raphia gilletii Becc.	balia, lisingo (v)	medicinal construction tech & mat	roots: malaria (v), intestinal worms (v) leaves: roof thatching (v) branches: chairs, beds (v), baskets (v), traps (v), arrows (v), *pieko* (=traditional cloth) (v)
	Raphia sese De Wild.	ikolo, fande (u) ikolo (k,f)	construction tech & mat fodder	palm leaves: roof thatching (u, k,f) branches: doors (k) palm leaves/branches: brooms (u), temporary beds (u, k,f), child toy (k), arrows (k,f), basketry (f) host tree for edible larvae *(mpose, makokolo*) (u, k,f)
Asteraceae	*Bidens pilosa* L.	mbelembele (v)	medicinal	leaves: anemia (v), bruises (v)
	Crassocephalum crepidioides (Benth.) S.Moore	limbiti (u,w,o) lisahuka (l)	cultural	*'bolenge'* reduce female domination (love charm) (u)
	Crassocephalum montuosum (S.Moore) Milne-Redh.	agili (a,v,m)	medicinal cultural	stem: tuberculosis (m) leaves: chasing bad spirits (v)
Begoniaceae	*Begonia eminii* Warb.	likaliyokoko (l)	medicinal	leaves: scabies (l)
Burseraceae	*Canarium schweinfurthii* Engl.	bobele, ibele (u,w,o)	medicinal	bark: back ache (o), intestinal worms (k,f), measles (k), haemorrhoids (k), hernia (f), post-partum

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
		oyele, shele (k,l), owele, tchwele (f) mbele, limbini (a,v), kasuku (m)	 tech & mat	pain (l), impotence (l), cysts (m) resin: smoke against haemorrhoids (f) fruit: constipation (v) resin: varnish (w), candles chase mosquitos (k), mastic to repair roofs or canoes (f), ameliorates organoleptic quality of drinking water (f) trunk: canoes (f,l) young shoot: traps (a) husks: children's toy (a)
			cultural	resin: smoke to chase bad spirits (u,k,f,l,a,v,m)
			fuels	resin: candles for light (o,w,u,k,f,l,a,v,m), firewood (l,v,m)
			fodder	host tree for edible caterpillars (*itombe*) (f)
	Dacryodes osika (Guillaumin) H.J.Lam.	ibele sawu, isawusawu (u,w,o) okololo (k), osukukelele (f,l) ugbagba, ngiangia, usowu (v)	medicinal tech & mat fuels	bark: fever (k), post-partum pain (l), constipation (l) fruit: constipations (v) trunk: canoes (l), mortars (l) firewood (w,u,l)
Celastraceae	*Loeseneriella africana* (Willd) R.Wilczek ex N. Hallé	namamili (a,v,m)	medicinal	bark: calms pain from hernia (a, v,m), menstruation pain (a), impotence (a,v,m), intestinal worms (v,m), lumbago (v), uterine fibroid/fibroma (m)
Clusiaceae	*Garcinia epunctata* Stapf	oluho/londuho (k), otchuwo (f) undandi (a,v,m)	medicinal construction bait	bark: intestinal worms (f), calms pain from hernia (a), impotence (a) yellow latex: *bokukwo* (= Kibali; pian = yaws, polypapilloma tropicum = tropical infection of skin, bones and joints) (a), intestinal worms (k, m), lumbar pain (m), impotence (m) building poles (v) fruit: bait for squirrels (v)
	Garcinia kola Heckel	oyale (k), onale (l) agambo (a), mbongo (v), akbatuwé, umbongo (m)	medicinal tech & mat cultural fuels construction	bark: calms pain from hernia (k,a,m), intestinal worms, ascaris (k,l), general pain (k), impotence (k,a,m), fever (a), menstruation pain (a), uterine fibroid/fibroma (m) seeds: asthma (v) trunk: pestle & mortars (k,l) bark: in palm wine (l) firewood (l) trunk: building poles (k,l,m)
	Mammea africana Sabine	boliti (o) b'huliti (v,m)	medicinal cultural construction fuels	fruit: intestinal worms (v) stimulate children to start to walk (o) trunk: construction wood (v,m) branches: building poles (v,m) firewood (m)
Connaraceae	*Manotes expansa* Sol. ex Planch.	tokayikayi (f)	medicinal	leaves: to calm pain from rheumatism (f), post-partum pain (f)
Costaceae	*Costus lucanusianus* J.Braun & K.Schum.	bokako (bobaye) (u,w,o) okako (k,f,l) makakokako (a,v,m)	medicinal	stem sap: measles (o,w,k,a,v); injuries (w), syrup to add to other medicinal products (u), painly menstruation (k,a), snake bites (a), lumbago (v,m), malaria (v,m), cough (v,m) stem: dental infection/ caries (f,l), constipation (f), gonorrhea (f), stomacache (l), cough (l) leaves: post-partum pain (f), fever (a,v), lombar flu (a), fruit: malaria (f)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
				young plant: antidote(o)
				leaf sap: amoeba (o)
			tech & mat	bark: ropes for transporting firewood (w), small mats (k)
				sap: cleaning hands (l)
			cultural	stem: chasing bad spirits (l)
				eating young leaves: problem solving (o)
			fodder	seed: poultry feed (l)
	Costus phyllocephalus K.Schum.	tulukako (l)	medicinal	stem: dental caries (l), stomacache (l), cough (l)
			tech & mat	sap: cleaning hands (l)
			fodder	seed: poultry feed (l)
Cucurbitaceae	*Momordica foetida* Schumach.	ngoza (a,v,m)	medicinal	leaves and fruits: intestinal worms (v,m)
				roots: hernia (m)
			tech & mat	leaves: chasing wasps (a)
Dichapetalaceae	*Dichapetalum mombuttense* Engl.	ekpalanganga (u,o), lisungulingba/lisunguliteti (w,o)	medicinal	fruit juice: back ache (u)
			tech & mat	branches: traps (w)
Dilleniaceae	*Tetracera alnifolia* Willd.	mbembi (m)	medicinal	liana: intestinal worms (m)
			tech & mat	liana: traps (m)
			construction	liana: to tie up, lash in construction (m)
	Tetracera potatoria Afzel. ex G.Don	mbembi (a,v)	tech & mat	liana: traps (a)
Dioscoreaceae	*Dioscorea burkilliana* Miège	liphe, ipheli (l), epheli, yuphe (k)	medicinal	liana: headache (l)
			cultural	liana: stimulating dogs for hunting (k), protecting house from bad spirits (k)
			tech & mat	liana: traps (l)
	Dioscorea minutiflora Engl.	Ikeke (u,w,o) opheyipheyi, lepheyi (f), lewa (l)	medicinal	tuber: diarrhea (f)
				liana: impotence (f)
	Dioscorea praehensilis Benth.	bosondi (u,w,o) lilungu (l), ikuse (k) kpegu (a,v), begpegu (m)	medicinal	liana: diagnose vaginal spots (genital herpes or syfilis) (l)
				leaves: treatment vaginal spots (genital herpes or syfilis) (l)
Euphorbiaceae	*Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg.	liondje (u,w,o) lionje (k,l), liyotche (f) kopata (v,m)	medicinal	leaves: anaemia (u,l,v,m), dental caries (o, k,f), diarrhea (f,l), malaria (v,m)
				fruits: malaria (v)
				roots and leaves: measles (m)
			tech & mat	roots: holding hot materials by blacksmith (l)
				leaves and grains: black markers (f), to color fish nets black (f)
			cultural	leaves: wound healing after circumcision (u)
			fuels	firewood (l,v)
			bait	fruits: bait/poison for fish (w,u,f,l), bait in bird traps (u,k,f,l)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
	Erythrococca atrovirens (Pax) Prain var. *flaccida* (Pax) Radcl.-Sm.	likile (w,o) mbileteke (k), mbeteke (f), meteke (l) ponyonyo (m)	medicinal cultural	leaves: bruises (o), eye injuries (w) leave sap: dizziness (k) bark: eye injuries (w) leave in pockets to dominate (luck charm) (f)
	Euphorbia hirta L.	ngotoindika (o)	medicinal	whole plant: amoeba (o), intestinal worms (o)
	Ricinodendron heudelotii (Baill.) Heckel	agele, ngoza (a), agele, ungozo (v,m)	medicinal tech & mat cultural fuels fodder	young leaves: intestinal worms (a), calms pain from hernia (a) bark: anaemia (m) canoes (m) bark: bathing newborn for good health and strength (v) firewood (m) host tree edible caterpillars (*bafoyo*, *bokpolo*) (a,v,m)
	Tetracarpidium conophorum (Müll.Arg.) Hutch. & Dalziel	botito, tito (u,w,o) tito (k,l), lokaso (f) ngezi (a,v,m)	medicinal cultural	young leaves: cough (k) liana: broken bones (a), hernia (m) children put nut peel on forehead to play/for beauty (u,k,f) leaves and liana: burn in field to avoid bird attack (v,m), chasing elephants (m)
Fabaceae (Caesalpinioideae)	*Gilbertiodendron dewevrei* (De Wild.) J.Léonard	mbolu, lofete (u,w,o) mbele, omongo (k) akiengie, umbolu, ambalakata (a,v,m)	medicinal tech & mat cultural fuels construction	bark: back ache (u) sap: abcess (a) bark: 'sombotiti' local (temporary) mortar (w, o,v) trunk: mortar (o) seeds: childrens' toy: diabolo (u,v) bark of young plants: rope for transporting goods (v,m) bark: for good health and smooth skin of newborn (o) young shoot: amulet to let fungi grow (a) firewood (w,v), charcoal (v) wood: boards (w,o,u), red wood (a,v,m) leaves: roof thatching (o,u, a,v,m) branches: building poles (a,v,m) bark: rope for construction (m)
	Normandiodendron romii (De Wild.) J.Leonard	ikumbo (k,f), shofa (k), yopha (l)	medicinal tech & mat cultural fuels construction	young leaves: wound healing (f) branch: handles for axes, machetes and hoes (l) leaves on handle axe gives courage to continue to cut big trees (f) firewood (k,l) building poles (k,l)
	Scorodophloeus zenkeri Harms	bofili (u,w,o) ophili (k,f,l) bioli, adolombi (a), afe (v,m)	medicinal tech & mat cultural fuels construction poison	bark: hernia (u), filariasis (u, k,f,a), intestinal worms, ascaris (= roundworm infection) (u,l), eye injuries (k), malnutrition (l), measles (f), bloody diarrhea (f) branch: handles for axes (l) bark to treat *Iyambe* (cultural disease concerning conflicts, showing a swollen, bloated belly) (f) leaves: dogs become better hunters (m) firewood (l) building poles (l) fish poison (o)

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Fabaceae (Mimosoideae)	*Entada gigas* (L.) Fawc. & Rendle	lute (l)	medicinal	sap: stimulating maternal milk production (l)
	Pentaclethra macrophylla Benth.	owala (k) ukelede (a,m)	medicinal	bark: to calm pain from hernia (k, a,m), dental caries (k,m), impotence (a,m), uterine fibroid/fibroma (m), tuberculosis (m)
			tech & mat	fruit peel: boy's sandals (k)
			cultural	fruit peel: chasing bad spirits (k), against bolt of lightning (k)
			construction	building poles (k)
			bait	husks: bait for fish in fykes (m)
Fabaceae (Papilionoideae)	*Desmodium setigerum* (E.Mey.) Benth. ex Harv.	ikpesaamuku (o)	cultural	root: luck charm for winning e.g. foot match (o)
Gnetaceae	*Gnetum africanum* Welw.	fumbwa (u,w,o)	medicinal	leaves: cholera (o) leaves/liana: diarrhea (o)
Huaceae	*Afrostyrax* sp.	longoho (k)	medicinal	leaves: intestinal worms (k)
			tech & mat	small branch: fishhook (k)
			construction	building poles (k)
	Hua gabonii Pierre ex De Wild.	lofiongi (u,w), longowu (w,o) longoho (k), oyenge (f,l)	medicinal	fruit juice: amoeba (o) leaves: cataract (u), intestinal worms (k) roots: headache (l)
			tech & mat	small branch: fishhook (k)
			cultural	leaves: stimulating dogs for good hunting (u)
			construction	building poles (k)
			poison	fruit/bark: fish poison (o)
Icacinaceae	*Alsodeiopsis rowlandii* Engl.	lokembya (k), lokeya (f)	medicinal	impotence (k)
Irvingiaceae	*Irvingia excelsa* Mildbr.	abele aselele (v,m)	fuels	firewood (m)
			construction	building poles (m)
	Irvingia grandifolia (Engl.) Engl.	alube (a,v,m)	medicinal	leaves: skin mucosa (a), dysentery (v)
			cultural	leaves: preventing the night to fall to continue march (a); fruit: malediction (curse) (v)
			construction	building poles (v), wood for construction (v)
			bait	bait for pigs, antelope (v)
	Irvingia robur Mildbr.	otchili (f), ondili (k) abele akabula (a,v,m)	medicinal	bark: to close fontanel of newborns (a)
			cultural	bark: luck charm to avoid rebels coming in the village (a), fruit: malediction (curse) (v)
			fuels	firewood (v,m)
			construction	building poles (m)
	Irvingia smithii Hook.f.	bosombo (w,o)	medicinal	root: strenghtener (o) bark: back ache (o), intestinal worms (w)
Loganiaceae	*Strychnos* cfr. *aculeata* Soler.	agbodu (m)	medicinal	bark: calms pain from hernia (m), uterine fibroid/fibroma (m), intestinal worms (m), impotence

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
				(m)
Malvaceae	*Cola acuminata* (P. Beauv.) Schott. & Endl.	angbongbo(lia) (u,w,o) liyelu (k,f) ligo (a,v,m)	medicinal	seeds: impotence (o,u, k,v), calms pain from hernia (o, f, a,v), intestinal worms (k), malaria (k), hypo-tension (a), gastro-intestinal problems (a), backache (v), thoraxache (m) bark: anaemia (v), amoeba, intestinal worms (m), uterine fibroid/fibroma (m)
			cultural fuels	seeds: luck charm (o,w,u, a), solving problems (u), blessing (a) firewood (m)
	Cola bruneelii De Wild.	losakanu, sakanu (u,w,o), limbabaliyekondo (w,o) alembe, okowa (k) alembe, litaphala (f, l)	medicinal	roots: joint problems, rheumatism (o,u) leaves: stimulating maternal milk production (o) young leaves: stimulates appetite of pregnant women or sick persons (f), to remove pus out of swollen wounds (f)
			tech & mat	branch: children's toy (gun) (o,k), rat traps (k,l), baskets (l), beds (l), spears (l)
	Cola ballayi Cornu ex Heckel	likapu (a,v,m)	medicinal cultural fuels	seeds: convulsions (a), dental caries (v), lumbar pain (m), impotence (m) fruit: to harden/strenghten the child (a,v), to become wicked (m) firewood (m)
	Cola congolana De Wild. & T.Durand	losakanu, sakanu (u,w,o), limbabaliyekondo (w,o) ongando oïtchi (f) tongombo (k)	medicinal	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o, k,f)
			tech & mat	branch: children's toy (gun) (o)
	Cola marsupium K.Schum.	losakanu, sakanu (u,w,o) limbabaliyekondo (w,o) koloko (k)	medicinal	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o)
			tech & mat	branch: children's toy (gun) (o)
	Cola urceolata K.Schum.	losakanu, sakanu (u,w,o), limbabaliyekondo (w,o) tongombo (k), ongando oïtchi (f) nzanzalinza (a,v,m)	medicinal	roots: joint problems, rheumatism (o,u) leaves: removing fish bone in throat (o), stimulating maternal milk production (o,k,f, a), to calm rheumatism (v), eye injuries (m)
			tech & mat	branch: children's toy (gun) (o) leaves: chasing wild animals attacking dogs (m), intimidate wasps during honey extraction (v,m)
	Grewia louisii R.Wilczek	iphimbo, ndolo (k,f)	medicinal	fruit: intestinal worms (f) fruit sap: anaemia (f)
			tech & mat	bark: fire-making (k), rope for transporting goods (f), belts (f)
	Grewia pinnatifida Mast.	iphimbo (k)	tech & mat	bark: fire-making (k)
	Hibiscus acetosella Welw. ex Hiern	damudamu (u) iyawo (f,l)	medicinal cultural	leaves: anaemia (u), stimulating appetite when sick (f), fever (l) leaves: red decoction water serves as symbol of Christ's blood in church (u), appealing someone who is lost in the forest (l)
	Hibiscus sabdariffa L.	lokeke (l)	cultural	leaves: to narrow the vagina (l)
Marantaceae	*Megaphrynium macrostachyum* (Benth.) Milne-Redh.	likongo, beye (u,w,o) oheye, likongo (k,f), meye,	medicinal tech & mat	leaf button: removing tickle or fish bone in throat (l), otitis (v) leaves: packing material, plates (o,w,u,k,f,l,a,v,m), burn the condiments inside the leaves (k),

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
		okongoto (l)		dustpan (f), hat or umbrella (f), shoes (f)
		angule, ungoli (a,v,m)		stems: mats, beds, baskets (o,w,u, k,f,l,a,v,m), hats (k,l), oil press (k), pipes (f), traps (f), palm wine extraction (a), fishfykes (a)
			cultural	fruits: domination, problem solving (f)
			construction	leaves: roof tatching (o,w,u,k,f,l,a,v,m)
				liana: construction of small huts in the forest (k)
	*Thaumatococcus danielii (*Benn.) Benth. & Hook.f.	nzilizili (a,v,m)	medicinal	seeds: snake bites (v)
				fruit pulp: child weaning (m)
				roots and fruits: distocia (slow or difficult labor of childbirth) (a)
			tech & mat	leaves: packing material (a, v)
				stem: mats, baskets (a,v)
			construction	leaves: roof thatching (a,m)
	Trachyphrynium braunianum (K. Schum.) Baker	ikokombeshalia, bolikabwalima (w), ikokombeibaye (o)	tech & mat	leaves: packing the bait (o)
			cultural	stems: good luck for fishermen (w)
Melastomataceae	*Tristemma mauritianum* J.F.Gmel.	lituma lilokonda (u,w, o)	medicinal	leaves: intestinal worms (o), vaginal mucosa (a)
		etele (k,f), okama (l)		ripe fruit: anti-poison, to diminish pain (k)
		ekba (a,m), limbodidi (v)	tech & mat	whole plant: ameliorate taste during palm wine extraction (a)
			cultural	fruit: avoiding snake bites (o, u)
				whole plant: treatment of traditional diseases as *Oté* (f)
				leaves: luck charm (a)
Menispermaceae	*Penianthus longifolius* Miers	lokumbo (o)	medicinal	root: back ache (o,v), impotence (o,f,a,m), stimulating maternal milk production (k,f), gonorrhea
		lokumbo (k,f)		(k,a), wound healing (k,f,a), calms pain from hernia (a), broken bones (v), bellyache (v),
		kosombo (a,v,m)		intestinal worms (v), malaria (v)
			tech & mat	leaves: shooter of bows to direct arrows (o,a,k,f,v,m)
			cultural	branch: protection against storm (a), for good growth of plantain suckers (v)
Moraceae	*Musanga cecropioides* R.Br. ex Tedlie	bokombo (o)	medicinal	sap: stimulating maternal milk production (k)
		litumbe (k)	tech & mat	trunk/wood: beds (o,k), canoe or rafts (o,k), banks, coffins (k), ngong (k)
				roots: chairs (k), funnels (k)
	Treculia africana Decne. ssp. *africana* var. *africana*	bombimbo, limbimbo (u,w,o)	medicinal	bark: as ergomethrine, redress ovaria and uterus after childbirth (a)
		oimbo (k,f), oimo (l)	tech & mat	branch: handles for axes, hoes, machete (k,l,v), chairs (l)
		opiso (a,v,m)	cultural	belief: a pregnant woman may not eat the nuts of oimbo, if she did and the fetus is still not moving at 6 months, the bark of oimbo is used to test whether the fetus is still alive (f)
			fuels	firewood (l,m)
			construction	trunk: house pilar (k)
			bait	bait for porcupine (v)
	Trilepisium madagascariensis DC.	indoli, anziga (v)	medicinal	fruit sap: internal measles (v)
			construction	building poles (v)
			fuel	firewood (v)
Pandaceae	*Panda oleosa* Pierre	bakale (u,w,o)	medicinal	fruit: eye injury (o)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
		lopha (k), leteko (f,l) angele (a,v,m)		bark: buboes (= inflammation of lymph nodes due to an STI (sexually transmitted infection) or bubonic plague) (u), to calm pain from hernia (f), splenomegaly (l), snake bites (a)
			tech & mat fuels	seed oil: body lotion (k) nut shells: charcoal (f) firewood (l,m)
Passifloraceae	*Passiflora foetida* L.	maveve (u,w,o) maveve (k,l) maveve (a,v,m)	medicinal tech & mat	measles (o) stem: skipping-rope (v) leaves and stem: traditional soap (v,m)
Pentadiplandraceae	*Pentadiplandra brazzeana* Baill.	etekele, amelalokulu (u,w,o) tophanda (k,f), ophana (l) dingabi (m)	medicinal	root: back ache, lumbago (o,w,u,l,m) malaria (o,k,f,m), shingles (o), warm abscess (o), gonorrhea (u), dental caries (u), measles (u), scabies of dogs (u), scabies (f), cough (f), impotence (l), fever (l)
			poison	bark: fish poison (o,u)
Phyllantaceae	*Bridelia stenocarpa* Müll.Arg.	olanga (f)	medicinal fodder	bark: cough (f), post-partum pain (f), enema against STI (sexually transmitted infection (f) host tree for edible caterpillars (f)
	Hymenocardia ulmoides Oliv.	bokelele (w,o) okelia (k), okele (f), yonga (l)	medicinal	bark: snake bite (o) leaf decoction: stimulating maternal milk production (o), cough (f), anaemia (f)
			construction fuels	branches: building poles and fence posts (o,w,k,l) firewood (w,f,l), charcoal (w)
	Maesobotrya longipes (Pax) Hutch.	ndako ya hongo (k), okokolongo (f), salasala (l)	medicinal cultural fuels	bark: cough (l) leaves and roots: chasing bad spirits (l) firewood (l)
	Phyllanthus polyanthus Pax	okolo (k,f)	medicinal cultural	leaves: headache (f) whole plant: ancestral blessing after disagreement (k), permits menstruating women to treat their child with enema (k)
Phytolaccaceae	*Hilleria latifolia* (Lam.) H.Walter	lokobo (u,w,o) lokowo (k), loko (l)	medicinal	leaves: asthma (o), swellings (o), felon (u) young leaves: bronchitis (k), abscess (k), dizziness (l)
	Phytolacca dodecandra L'Hér.	lisingo (u,w,o) lisasingo (k), lisilingo (f,l)	medicinal	stem: dental caries (u) leaves: abscess (k), wound healing (k)
Piperaceae	*Piper guineense* Schumach. & Thonn.	iketu (u,w,o) toketu, ohaya (k), lokoloko, toketchu (f), toketu, oleleko (l) mbikondi (a,v,m)	medicinal	leaves: back ache (o,w), cough (o), menstruation pain (f), lumbar pain (l), fever (l) roots: general pain (w), impotence (k), chestache (k), fruits: cough (w,v), lumbago (f), haemorrhoids (f), headache (l), strengthen body after childbirth (l), thoraxache (v), bellyache (v), liana: hernia (k), impotence (f,m), roots and leaves: malaria (v), backache (v), impotence (v) liana/fruits: back and thorax ache (u), lumbar pain (m) fruits or leaves: lumbago (a), flu (a), cough (m)
			cultural	fruits: to narrow the vagina (l) liana: for good growth of plantain suckers (v)

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			bait	seeds: bird traps (v)
	Piper umbellatum L.	bogolo (a,v,m)	medicinal	leaves: tropical abscess (a,v,m), sputum (a), tuberculosis (v,m), haemorrhoids (m), eye injuries (m), antidote(m), uterine fibroid/fibroma (m)
			cultural	leaves: chasing bad luck (m), exorcize witchcraft (m)
Plantaginaceae	*Bacopa* sp.	ingawungawu (w) liseli (f)	medicinal	leaves: constipation (f), gastritis (f), lumbar pain (f), calms pain from intestinal worms (f)
Polygalaceae	*Carpolobia alba* G.Don	lokembia (w,o) liyambaliyekondo (k), isekya (k,l), iseke (l) lindiko (a,v,m)	medicinal	bark: malaria (k) roots: malaria (f), impotence (o,l,m), gonorrhea (l), deafness (l), headache (l), backache (a)
			tech & mat	trunk: traps (l), branches: arrows (l) young trees: squirrel traps (v)
			cultural	leaves: chasing bad spirits (m) bark: purification of hunter (k)
Portulacaceae	*Talinum triangulare* (Jacq.) Willd.	melelu (u), sese (w,o) ambioko (k), alengalenga (f,l) ngolu (a), neputu konkolo (v)	medicinal fodder	leaves: thorns in feet (o), abscess (k), gastritis (f), correcting menstruation cycle (a) pig feed (u)
Rubiaceae	*Aidia micrantha* (K.Schum.) Bullock ex F.White var. M*icrantha*	okenia (f)	medicinal	fruit: impotence (f)
	Csplenomegalyrispermum schweinfurthii Hiern	umbatana (a)	medicinal	bark: impotence (a)
	Heinsia/Mussaenda sp.	liakookenge, ayakpwokenge (k)	medicinal	roots: impotence (k) bark: splenomegaly (k), headache (k), dental caries (k)
	Morinda morindoides (Baker) Milne-Redh.	kumbololo (f)	medicinal	leaves: malaria (f), post-partum pain(f) roots: stimulating maternal milk production (f), snake bites (f)
	Mussaenda elegans Schumach. & Thonn.	kombeyekongo (k)	medicinal	flower: anaemia (k), antidote(k)
	Sabicea johnstonii K.Schum. ex Wernham	damudamu (o)	medicinal	fruit: anaemia (o)
	Sherbournia bignoniiflora (Welw.) Hua	losabola (u,w,o) losawola, yekayesenga (k), ayamaysene (l) moyomememi (a)	medicinal cultural	roots: cough (u) leaves: gastritis (u) leaves: antidote snake bites (k) leaves: reduce female domination (love charm) (o)
Rutaceae	*Zanthoxylum macrophyllum* Nutt. var *preussii* Engl.	bolongo (o)	medicinal	bark decoction: back ache (o), malaria (o), cough (o), general weakness (o)
Sapindaceae	*Chytranthus carneus* Radlk.	okene (l)	fuels	firewood (l)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
			construction	wood: doors, windows, furniture (l)
	Chytranthus macrobotrys (Gilg) Exell & Mendonça	botokolo, tokolo (u,w,o) okene (k,l) gesumba (a,v,m)	medicinal	bark: abscess (a) leaves: buboes (= inflammation of lymph nodes due to an STI (sexually transmitted infection) or bubonic plague) (m)
			fuels	firewood (l)
			construction	wood: doors, windows, furniture (l)
	Pancovia harmsiana Gilg	mangiamangia, undilinga (a,v,m)	medicinal	bark: treating broken bones (a)
			tech & mat	branches: handles for axes, pestles (a,v,m), traps (v) trunk: mortars (v)
			cultural	bark: blocking factor, e.g. putting a diamond with the bark of mangiamangia in the quarry and it will not produce any diamond anymore (a), prediction of events (a)
			construction	trunk: house piles (a)
	Pancovia laurentii (De Wild.) Gilg ex De Wild.	botende, ntende (u,w,o) ntende (k,f)	tech & mat fuels	latex: making balls for children (o) firewood (w)
Sapotaceae	*Chrysophyllum lacourtianum* De Wild.	bolinda, lilinda (u,w,o) lilinda (k), ohambu (f), ohamu (l) ubombi (a,v,m)	medicinal	bark: stimulating maternal milk production (u) latex of fruit: intestinal worms (v)
			fuels	firewood (w, l,m)
			construction	trunk: house piles(w,l,m) wood: doors, windows (l,v,)
	Synsepalum brevipes (Baker) T.D.Penn.	bokokolo, ikokolo (w,o)	medicinal	bark: back ache (o)
	Synsepalum stipulatum (Radlk.) Engl.	bonga, tonga (u,w,o)	fuels	firewood (w)
Smilacaceae	*Smilax anceps* Willd.	likako (u,w,o) akpu, masesa (a), iko, masesa (v), liko, masesa (m)	tech & mat cultural	liana: field fences against thiefs (m) liana around house protects against nightmares (o), ancestral appeal for persons far away (a), anti-lightning (a), anti-miscarriage (a)
Solanaceae	*Capsicum frutescens* L.	mbase ikukunde (w,o)	medicinal	leaves: abscess (o), felon (whitlow) (o), otitis (o) fruit: constipation (o), post-partum pain (w)
	Solanum aethiopicum L. "gilo group"	losuke (w,o)	medicinal	fruit: antidote(o) roots: to close fontanel of newborns (o)
	Solanum aethiopicum L. 'Shum group'	azoko (v,m)	medicinal	leaves: conjonctivitis (m)
	*Solanum distichum** Schumach. & Thonn.	ikalu (w,o) ngbaku (k) anzuwe (a), atanga (v,m)	medicinal bait	fruits: filarisosis (v), calms pain from hernia (v), body strengthener (v), thoraxache (m) fruit: bait in bird traps (k)
Tiliaceae	*Desplatsia dewevrei* (De Wild. & T.Durand) Burret	bokomba, likamba (u), lisuli (w,o)	cultural	fruit: protect fishermen (w), drive away hippopotamus (u), chasing mosquitoes (o), permits pregnant women to enter the tomato fields (o)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
			tech & mat	bark: basketry (u)
Urticaceae	*Myrianthus arboreus* P.Beauv.	bongunguna (u), bohuma (w,o) ohuma (k,f,l) unkawa (a,v,m)	medicinal	leaves: antidote(o), gastritis (f), burning wounds (l) fruit: dental caries (k) bark: bellyache (l), diarrhea (a), diabetes (a), vomiting (v) seeds: post-partum pain (v)
			cultural	bark: anti-domination product (o)
			fuels	firewood (w,f,l,v,m)
	Myrianthus preussii Engl.	bohuma bolukund (w), bohuma petit (o) obukiengie (a,v,m)	tech & mat fuels	poles for traps (m) firewood (m)
Verbenaceae	*Lippia multiflora* Moldenke	liyangalombo (f)	medicinal	leaves: dizziness (f), intestinal worms (f)
	Vitex congolensis De Wild. & T.Durand	ebite (o)	medicinal construction	leaves: tuberculosis (o) building poles and post fences (o)
Vitaceae	*Cissus dinklagei* Gilg & M.Brandt	wese (o) limiambia (k,f), lahola (l) aliga (a,v), nambodo (m)	medicinal	sap: snake bites (f) latex: calms pain from hernia (a)
			tech & mat	liana: traps (v) liana/bark: washcloth (k,f,l,v)
			cultural	liana: cache-sexe (a) sap: courage to work (l), courage to tease a woman (l) stem: chasing bad spirits (l)
	Cyphostemma adenocaule (Steud. ex A.Rich.) Desc. ex Wild & R.B.Drumm.	bombeye (o) ombeye (k), awuliakongo (l) mendengele (m)	medicinal	leaves: head ache (o), stimulating maternal milk production (m) roots: abscess (o), calms pain from hernia (k), treats swollen breasts after childbirth to ameliorate suckling (l), enema for pregnant women against pain (m)
			cultural	leaves: protects the wises against bad spirits (l)
Zingiberaceae	*Aframomum laurentii* (De Wild. & T.Durand) K.Schum.	bongongoo, soso (u,w,o) lososo, lihoho (k,l), osomboko, loole (f) limbalu, lidulu (a,v,m)	medicinal	fruit: filariasis (o,f), syrup to add to other medicinal substances (u,o,f), cough, cold (k,f,l,a,v), scabies (k,f), test of broken bones (k), eye injuries (k), stimulates maternal milk production (k,f,l), red ants swellings (f), wound healing (l), skin mucosa (l), removing tickle or fish bone in throat (l), general pain (w), flu (a), measles massages (a) an enema (a), eye injuries (v,m) leaves: cough (v), wound healing (m), lumbago (m), otitis (m), syrup to add other medicinal substances (a)
			tech & mat	leaves: packing food to cook for aroma (k), umbrella (k) stem: palm wine extraction (k), washing very dirty cooking pots (k), sandpaper (k), straws (k), child toy: vehicles (k), pipe (k), protection roof against wind (v) fruit pulp: chasing wasps (l) fruit peel: young girls play to have breasts (k)
			cultural bait	fruit: wound healing during circumcision (a,v) bait in traps for apes (v)
	Aframomum sp. 4	ndala, lidulu (v)	tech & mat	stem: protection roof against wind (v) fruit: child toy: ring or bracelet (v)

Botanical family	Scientific name	Vernacular name[1]	Use category	Specific use[2]
			bait	bait in traps for apes (v)
	Aframomum sp.2	onongo (k,f,l)	medicinal cultural	fruit: impotence (k), wound healing (f, l), headache (l) fruit: circumcision (l)
	Aframomum subsericeum K.Schum.	nadeye, lidulu (v,m)	tech & mat	stem: protection roof against wind (v)
	Aframomum verrucosum Lock	kobasa, lidulu (v)	tech & mat bait	stem: protection roof against wind (v) bait in traps for apes (v)
	Indéterminé	wodho (a,v,m)	medicinal	leaves: constipation (v)
Pteridophyta				
Cyatheaceae	*Cyathea manniana* Hook.	oyaele (l)	medicinal	leaves: menstruation pain (l)
Dennsteadtiaceae	*Blotiella glabra* (Bory) R.M.Tryon	asaha (k), oheyi yasi (f), oheyi (l)	medicinal tech & mat	leaves: menstruation pain (l) leaves: soap (k), fish drying (k)
	Pteridium aquilinum (L.) Kuhn	lilele (o) isili (f)	medicinal tech & mat	young leaves: eye injuries (o) young buds: remove thorns in feet (o) whole plant: conservation of fish (o)
Dryopteridaceae	*Diplazium sammatii* (Kuhn) C.Chr.	andole (f), aneke (l)	medicinal	roots: menstruation pain (f)
Lomariopsidaceae	*Lomariopsis* sp.	asaha (k)	tech & mat	leaves: soap (k), fish drying (k)
Nephrolepidaceae	*Nephrolepis biserrata* (Sw.) Schott	asaha (k), likekele (l)	medicinal tech & mat	leaves: thorns in body (l) leaves: soap (k), fish drying (k)

[1] (u), (w), (o), (k) , (f), (l), (a), (v) and (m) vernacular name(s) under which the plant species is known and used in Yalungu, Yasekwe ,Yaoseko, Yaleko Village, Olife, Lefundelo, Bafwabula, Bavoy and Bafwambalu, respectively

[2] (u), (w), (o), (k) , (f), (l), (a), (v) and (m) other use registrated in Yalungu, Yasekwe, Yaoseko, Yaleko Village, Olife, Lefundelo, Bafwabula, Bavoy and Bafwambalu, respectively

Annexe 2: Number of times a particular origin has been cited by the traders interviewed for the different WEPs on Kisangani markets

Direction and distance	*Gnetum africanum*	*Solanum americanum*	*Solanum distichum*	*Aframomum spp.*	*Anonidium mannii*	*C. lacourtianum*	*Dacryodes osika*	*Landolphia spp.*	*Myrianthus arboreus*	*Synsepalum stipulatum*	*Cola acuminata*	*Garcinia kola*	*T. conophorum*	*Capsicum frutescens*	*Piper guineense*
Kisangani city	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**5**	**1**	**0**	**0**	**0**	**0**
Buta	**0**	**0**	**2**	**6**	**2**	**5**	**0**	**6**	**0**	**1**	**15**	**5**	**6**	**3**	**19**
0-30 km	0	0	2	6	1	2	0	4	0	1	9	5	3	2	10
31-60 km	0	0	0	0	1	3	0	2	0	0	6	0	3	1	8
61-100 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>100 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Airport	**3**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**0**	**1**	**4**
Ituri	**0**	**0**	**1**	**1**	**3**	**1**	**0**	**5**	**1**	**1**	**2**	**1**	**2**	**1**	**4**
0-30 km	0	0	1	1	3	1	0	2	1	1	1	1	1	1	4
31-60 km	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0
61-100 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>100 km	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Lubutu	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**1**	**1**	**0**	**1**	**3**	**1**	**4**
0-30 km	0	0	0	1	0	0	0	1	1	1	0	1	1	0	3
31-60 km	0	0	0	0	0	0	0	2	0	0	0	0	2	1	1
61-100 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
>100 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ubundu	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**2**	**4**	**2**	**6**
0-30 km	0	0	4	0	0	0	0	0	0	0	3	2	2	2	3
31-60 km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61-100 km	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
>100 km	0	0	0	0	0	0	0	0	0	1	4	0	1	0	2
Opala	**1**	**6**	**10**	**1**	**4**	**3**	**0**	**2**	**3**	**3**	**3**	**5**	**4**	**10**	**7**
0-30 km	0	6	10	1	4	3	0	2	2	1	0	3	3	9	5
31-60 km	1	0	0	0	0	0	0	0	1	1	0	1	1	1	1
61-100 km	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
>100 km	0	0	0	0	0	0	0	0	0	1	3	1	0	0	1
Left bank	**7**	**0**	**1**	**2**	**2**	**3**	**3**	**21**	**0**	**1**	**1**	**2**	**5**	**8**	**5**
0-30 km	0	0	0	1	0	0	1	1	0	0	2	2	2	6	1
31-60 km	6	0	0	1	1	2	1	12	0	0	0	0	1	2	2
61-100 km	1	0	0	0	0	0	0	2	0	0	0	0	1	0	0
>100 km	0	0	1	0	1	1	1	6	0	1	0	0	1	0	2
Yangambi	**11**	**0**	**0**	**1**	**2**	**2**	**1**	**4**	**0**	**0**	**1**	**0**	**1**	**4**	**1**
0-30 km	2	0	0	1	1	0	0	1	0	0	0	0	0	3	0
31-60 km	6	0	0	0	0	1	1	0	0	0	0	0	1	0	0
61-100 km	2	0	0	0	1	1	0	2	0	0	0	0	0	0	0
>100 km	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Total citations	**22**	**6**	**18**	**14**	**14**	**14**	**4**	**41**	**7**	**14**	**32**	**17**	**25**	**30**	**50**

The sum per plant does not reflect total numbers of persons selling the respective WEP due to missing values and respondents could also indicate more than one origin per WEP.

Annex 3: Calculation of the household wealth index

Livestock	Poultry	0.5 x number of poultry = X_1
	Goat	5 x number of goat = X_2
	Sheep	5 x number of sheep = X_3
	Porc	5 x number of pigs = X_4
	Bovine	50 x number of bovine = X_5
	Others	1 x number of other animals = X_6
		CATTLE SCORE = $\sum_i^6 X_i$
Assets	Bicycle	5 x number of bicycles = Y_1
	Motorcycle	30 x number of motorcycles = Y_2
	Car	150 x number of cars = Y_3
	Canoe	25 x number of canoes = Y_4
	Pushcart	2 x number of carts = Y_5
	Radio	0.5 x number of radios = Y_6
	TV	5 x number of TVs = Y_7
	Electricity generator	5 x number of generators = Y_8
	Solar panel	15 x number of solar panels = Y_9
	Computer	25 x number of computers = Y_{10}
	Others	2 x number of other assets = Y_{11}
		ASSETS SCORE = $\sum_i^{11} Y_i$
House	Water	If not connected to the public water pipe $Z_1 = 0$
		If group connection to the public water pipe $Z_1 = 5$
		If private connection to the public water pipe $Z_1 = 10$
	Electricity	If not connected $Z_2 = 0$
		If connected $Z_2 = 5$
	Ownership	If renter $Z_3 = 0$
		If owner $Z_3 = 10$
	Roof	If roof made from straw or leaves $Z_4 = 0$
		If roof made from corrugated iron or roof tiles $Z_4 = 10$
	Walls	If walls made from loam $Z_5 = 0$
		If walls made from bricks or concrete $Z_5 = 10$
	Door	If door made from bamboo or bark $Z_6 = 0$
		If door made from wood $Z_6 = 2.5$
		If door made from steel $Z_6 = 5$
	Windows	If windows made from bamboo or bark $Z_7 = 0$
		If windows made from wood $Z_7 = 2.5$
		If windows made from steel $Z_7 = 5$
		HOUSE SCORE = $\sum_i^7 Z_i$
		TOTAL HOUSEHOLD WEALTH SCORE = CATTLE SCORE + ASSETS SCORE + HOUSE SCORE

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Education

2006 - present:	PhD candidate, Faculty of Bioscience Engineering, Ghent University, Belgium
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1998 – 2003:	Master in Applied Biological Sciences, Agronomy, Ghent University, Belgium
1992 – 1998:	Secondary school, Sint-Jozefsinstituut, Torhout, Belgium

Professional training

February – May 2007	Academic English: writing skills, University Language Centre, Ghent University, Belgium
August 2004	Training on Gender, REFED, Mbuji Mayi, DRCongo
March 2004	Training on ADOP methodology (*Accompagnement des Dynamiques Organisationnelles Paysannes*), INADES Formation Congo, Kinshasa, DRCongo
November 2003	Intercultural communication and conflict management, ITECO, Brussels, Belgium
October 2003	Knowledge management and capacity building, ATOL, Brussels, Belgium
October 2003	Professional training from Broederlijk Delen in preparation of the work as cooperant in DRCongo

Professional experience

October 2005 – present : Assistant at the Laboratory of Tropical and Subtropical Agriculture and Ethnobotany, Department of Plant Production, Faculty of Bioscience Engineering, University of Ghent, Coupure links 653, 9000 Gent.

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July-August 2006 / October-November 2006 / November-December 2011: member of the EurAc (*Réseau européen pour l'Afrique Centrale*) mission for International Observation of the DRCongo elections for presidency, National Assembly, and provincial legislatures in 2006; elections for presidency and National Assembly in 2011.

March 2004 – June 2005 : Development worker for Broederlijk Delen in Kabinda, Kasaï-Oriental, DRCongo, consultant on sustainable agriculture and capacity building for 2 Broederlijk Delen partners: BDD Kabinda (*Bureau Diocésain pour le Développement de Kabinda*) and UPADD (*Union Paysanne pour l'Agriculture et le Développement Durable*).

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Tutor of Master dissertations and Bachelor projects

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Awards

Laureate of the Belgian Stichting Roeping - Vocatio (stichting van openbaar nut) - Onder de Hoge Bescherming van Hare Majesteit Koningin Fabiola. Brussels, May 17, 2008. (www.vocatio.be)

Co-promotor of dissertation Sarah Haesaert: Prize of the Belgian Development Cooperation 2010 with dissertation: '*Toegepaste etnobotanie identificatie, gebruik en socio-economisch belang van wilde eetbare planten bij de Turumbu (DRCongo, District Tshopo)*'