CHAPTER 7

Agroforestry and tree domestication in Central Africa

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1. Introduction

Central Africa contains the second largest contiguous rainforest in the world. The Congo Basin forest plays a fundamental role in regulating the global climate and is also regarded as a biodiversity hotspot. In addition to its global importance, the forests are an important economic resource, providing direct formal employment in the timber industry, commercial agriculture and related industries, and for sustaining livelihoods for local populations including indigenous groups.

This Central Africa region also holds large rural populations which are characterized by widespread poverty, low agricultural productivity associated in part to steadily degrading natural resource bases, poor access to markets, weak rights to the forest and its products, and high climatic risks (World Bank, 2012). The rural poor are highly dependent on the forests, remnant woodlands, homestead trees, and mixed agricultural and forestry production systems for their subsistence, e.g. fuel wood, food, medicine and fodder needs (FAO, 2009).

Overall annual deforestation rates are lower in Central Africa than other regions: -0.224 % between 2000 and 2010 compared to -1.32 % in humid West Africa forests (Word Bank, 2012). The main driver of deforestation in Central Africa is the clearing of forests for agriculture, which accounts for more than 80 % of forest cover loss in Cameroon (CARPE, 2005). Similar drivers of deforestation have been documented for other Central African countries (see chapter 1). Forest clearing for agriculture includes not only slash-and-burn shifting cultivation, which has long been recognized as a key driver of deforestation in the dense forest areas (Ndoye and Kaimowitz, 2000), but also for cash cropping, most notably, cocoa (*Theobroma cacao)* (Sunderlin *et al.*, 2000). Government's promotion of cocoa as a major cash crop in Cameroon and in other Central African countries from independence until the 1980s had a considerable impact on forest integrity. In the 1990s, cocoa cultivation was less profitable as a result of declining global market prices. However, since 2005, with the current trend (increasing global market prices), cocoa planting in Cameroon has accelerated at the expense of forests (World Bank, 2008 cited by Eba'a Atyi *et al.*, 2009).

Demand for household energy, primarily fuelwood, is recognized as an increasing driver of deforestation (World Bank, 2012), especially around rapidly growing urban centers like Kinshasa, Africa's second largest city with over ten million inhabitants. The sub-region also has important forests and woodlands outside of the dense, humid forests, where higher population densities increase the demand for household energy. For instance, the eastern mountain forests in the DRC are densely populated similar to the western montane highland forest regions in Cameroon. Of the DRC's total forested area of 120 million ha, the 40 million ha of dry land forests in the North-East and South exhibit higher deforestation rates than the closed-canopy humid forests (see chapter 1).

Photo 7.1: Slash-and-burn is the first step of converting forest to crop production

Land degradation following vegetation change, especially deforestation is one of the most serious problems facing global agriculture, as it affects two billion hectares (38 % of the world's cropland). Many smallholder farmers in the Central African humid tropics are trapped in a cycle of poverty, hunger and malnutrition as a result of land degradation. As a consequence, farmers continually increase the area planted for subsistence agriculture to meet food security needs, and demands for woodfuel increase with rapid population growth. The only option to reverse this trend is to use the available land more efficiently. Therefore, this means that existing farmland has to be made more productive by either increasing the yields of existing good quality cropland or rehabilitating degraded farmland to bring it back into full production. In effect, this means either further expanding Green Revolution-like technologies (Borlaug, 2007) or seeking another solution.

In temperate countries, where there is enough capital to invest in technology, the first strategy is the more appropriate. In the tropics, although the Green Revolution has greatly improved yield potential and the quality of a number of staple crops, poor farmers have often been unable to access seeds, fertilizers and pesticides, the core Green Revolution technologies. According to Leakey (2012), adopting and implementing agroforestry technologies will help improve the productivity of staple food crops by improving soil fertility and promoting agro-ecosystem functions. In addition, the domestication of indigenous species with diverse values (food, medicine, fuelwood, income etc.), could increase trade and business opportunities for farmers that would improve their livelihoods. Together, these steps could provide a generic and adaptable model for more sustainable agriculture in the tropics, which builds on the success of and enhances the outputs of the Green Revolution (Leakey, 2012; Leakey and Asaah, 2013).

2. Agroforestry: definition and concept

Even though agroforestry is a relatively new subject of scientific study, it is a traditional practice with a long history in many parts of the tropics (King, 1968; Nair, 1989). Previously, agroforestry was defined as the set of land use practices which involve the deliberate combination of woody perennials and herbaceous crops and/or animals in some spatial arrangement or temporal sequence on the same land management unit, such that there are significant ecological and economic interactions between the woody and non-woody components (Sinclair *et al.*, 1994). What seems to be different now from the traditional approaches is the greater use of trees for the production of diverse tree products, as opposed to simply providing environmental services, which has led to the domestication of trees within the agroforestry system (Simons and Leakey, 1996; Tchoundjeu *et al.*, 2006). Accordingly, the most recent definition of agroforestry considers it, "a dynamic, ecologically-based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels" (www.icraf.cgiar.org). In essence, agroforestry combines the protective attributes of forestry with the productive characteristics of both forestry and agriculture to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems.

Photo 7.2: Cocoa beans

3. Pillars of Agroforestry

Agroforestry involves the intensive management of the interactions between intentional combinations of trees with crops and/or livestock as components of an integrated agro-ecosystem. These key characteristics are the essence of agroforestry and distinguish it from other farming or forestry practices. To be described as agroforestry, the land-use system should satisfy the following criteria:

Intentional combinations of trees, crops and/or animals, designed and managed as a whole unit, rather than as individual elements that may occur in close proximity.

Intensive management of trees, crops and/or animals within the land use system to maintain both their productive and protective functions.

Interactive management of trees, crops and/or animals within the land use system to optimize the biological and physical interactions between the different components, enhance the production of more than one harvestable component at a time, and provide environmental services, such as conservation benefits for the watershed.

Integration: The tree, crop and/or animal components are structurally and functionally combined into a single, integrated management unit. Integration may be horizontal or vertical, as well as above or below ground. Such integration utilizes more of the productive capacity of the land and helps balance economic production with resource conservation and the provision of other environmental services.

Agroforestry systems generally combine at least two of the components of trees, crops and/or animals in an optimum fashion. The components influence each other and the wider environment. The interactions could be beneficial within the system or create competition for space, water, light and nutrients. However, competition can be minimized by selecting the appropriate tree species and managing the agroforestry system so that competition is reduced (Asaah, 2012).

Agroforestry and Tree domestication technologies

Various agroforestry technologies have been developed to meet specific land-use needs. Some of these include hedgerow intercropping and/or improved fallows for soil fertility management, woodlots, windbreaks, live fencing, boundary planting, home gardens, trees on crop lands, trees on water ways and flood plains, trees in pasture and rangelands, buffer zone agroforestry, and *taungya*. The *taungya* system is in essence, the growing of annual agricultural crops along with the forestry species during the early years of establishment of the forestry plantation (Nair, 1993). In all of these cases, trees are typically added to agricultural landscapes to create desired benefits (increase soil fertility status, availability of diverse fruits, condiments, medicinal products etc.) and to restore essential ecological processes needed to sustain agriculture productivity, rather than to restore natural ecosystems.

Declining soil fertility is a major challenge within agricultural landscapes in most countries of Central Africa. Typically, individual farm sizes are quite small, from less than 2 to 5 hectares. Farming provides for household needs and seldom for producing food for sale. As a consequence, farmers do not generate sufficient cash income to purchase fertilizers and other inputs that would help to maintain good crop yields. In addition, as the forests regress, farmlands become more degraded and soil fertility declines. Similarly, there is a decline in the diversity of living organisms that are essential for the maintenance of life processes, such as nutrient and carbon cycling, food chains, pest and disease control, pollination, etc. Additionally, while modern agriculture has dramatically increased the yield potential of many staple food crops, the consumption of a diet increasingly based on starch-based foods like cassava, cocoyams and maize, as well as the reduced consumption of traditional foods, has resulted in an unbalanced diet, malnutrition and a greater susceptibility to disease in many highly populated areas (Asaah *et al.*, 2011).

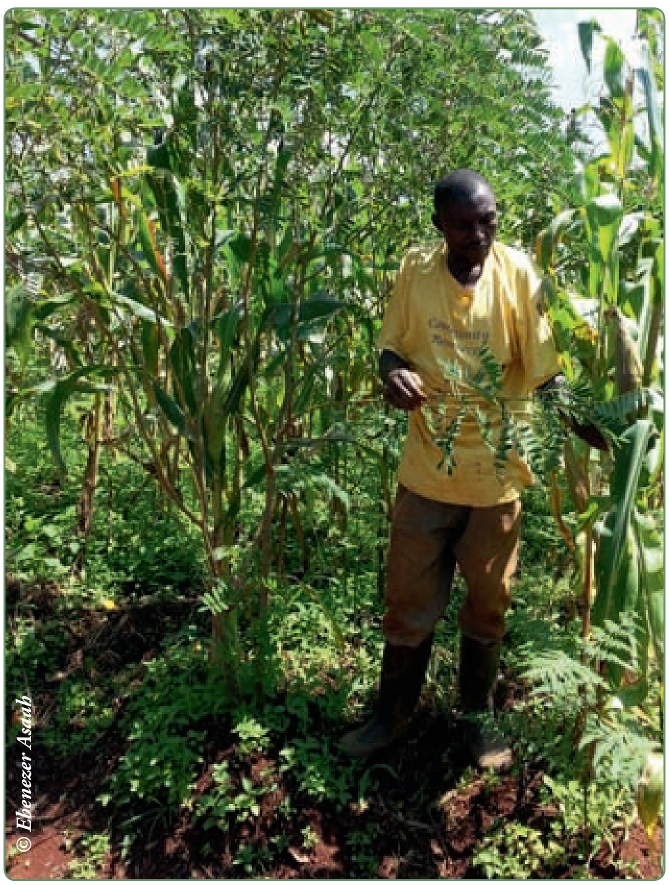

Photo 7.3: Maintaining trees on farm land generally helps maintain soil quality

Agroforestry is a delivery mechanism of multifunctional agriculture (Leakey, 2010), and it better addresses the issues of: declining soil fertility; rehabilitation of degraded land; restoration of above and below-ground biodiversity; sequestration of carbon; and, protection of soils and watersheds. Well-known, widely tested and increasingly adopted agroforestry practices like planting leguminous tree and shrub species in agricultural fallows improve soil fertility (Cooper *et al.*, 1996; Kanmegne *et al.*, 2003; Degrande *et al.*, 2007). Between 1988 and 1998, ICRAF developed two improved fallow technologies. The first technology developed was the rotational tree fallow system with *Calliandra calothyrsus.* This technology increases crop yields if farmers cut the trees back at 0.05 m above ground level and prune the trees twice during cropping (Degrande *et al.*, 2007). In addition to soil fertility improvement, *Calliandra calothyrsus* fallows manifest many additional short-term benefits such as the reduction of weeds, the provision of fuel wood and stakes, and the attraction of bees to associated apiaries, as the *Calliandra* trees flower almost all year round. However, the trees occupy the land permanently and soil fertility improvement is only observed for a number of years.

Second, to overcome a number of the constraints with tree fallows, a shrub fallow was designed, using *Cajanus cajan* in a relay cropping system. Relay cropping basically, is an option whereby different crops are planted at different times on the same farm, and both (or several) crops grow together during part of their growing cycle. An example illustrated in photo 7.3, is planting leguminous species for soil fertility enhancement into a maize crop before it is mature. According to a review by Degrande *et al.* (2007), farmers responded positively to this technology because of higher crop yields, ease of clearing the *Cajanus* fallows, and the shading out of weeds by the shrubs. The shrub fallows were particularly appreciated by women, because the shrub fallows require less labor than other fallow systems (with perennials) and because these shrubs (which are annuals) can be planted on lease land. However, wider dissemination of tree and shrub fallows was constrained by the lack of an adequate seed supply system and poor extension strategies. Nevertheless, results from a wide range of sites in Cameroon achieved maize yield increases of about 70 % on average and in some areas three or four- fold gains were possible (Degrande *et al.*, 2007).

In Burundi, the mixed rows of grass families/ legumes planted along contour lines are increasingly used as a protective measure for soil fertility management. Controlled testing in an extremely steep and erodible region (kaolisol humus-bearing clay soil of central Mumirwa) has shown interesting results. In a cassava-growing system, the mixed rows reduce water runoff, decreasing the flow by 50 % and soil loss by 96 % (Bizimana *et al.*, 1992). In Kanyosha, Burundi average flows of between 3.9 % and 6.7 % on a 45 % gradient slope (Rishirumuhirwa, 1997) were attained with bands of *Setaria* and *Calliandra* versus 12.3 % in the absence of zonal planting. According to the same author, an entire mulch of a banana tree reduces flow to 1 %, in contrast with 74-79 % on a bare plot.

4. Participatory tree domestication

The World Agroforestry Centre (ICRAF) and its partners began a program for the domestication of underutilized and indigenous trees in the mid-1990s. This program sought to improve the quality and yield of products from traditionally important species. In addition to meeting the everyday needs of local people, these products are widely traded in local and regional markets. As a result of domestication, underutilized crops have the potential to become new cash crops for income generation. They also have the potential to counter malnutrition and disease by diversifying the diet and energy sources of local people and by increasing the dietary intake of micro-nutrients, which are known to boost the human immune system among other health benefits (Ajibesin, 2011). These indigenous tree species also play an important role in enhancing agro-ecological functions, and can mitigate climate change by increasing carbon sequestration (Asaah, 2012).

Domestication is a complex process akin to evolution in which human use of plant and animal species leads to morphological and physiological changes that create a distinction between domesticated taxa and their wild ancestors (Purugganan and Fuller, 2009). Interestingly, domestication of food and tree crops has occurred for more than 13 000 years (i.e., since the last ice age), and it arose independently in several regions (Gepts, 2002). In spite of the geographic and climatic diversity in the different regions, there is a remarkable similarity in the set of traits which were selected for in completely unrelated types of crops.

In perennial crops, individuals that exhibit a more compact growth habit (fewer, shorter branches, as opposed to the tall, single-stem, wild variety) are generally selected for through the process of domestication. Selecting for a more compact growth habit is reported to have a positive impact on the harvest index (ratio of harvested part to overall aboveground biomass) and the size of the fruit or grain (Donald, 1968 cited by Gepts, 2004). There have also been many changes to the reproduction systems of the trees through domestication (Elias and Mckey, 2000 ; Gepts, 2004). In general, domestication has increased the number of species that reproduce via self-fertilization, also known as “selfing”, or resulted in the replacement of sexual reproduction by vegetative propagation in order to maintain the trueness in type of cultivated individuals when faced with the possibility of outcrossing with wild relatives.

A tree is normally considered “wild” when it grows spontaneously in self-maintaining populations in a natural or semi-natural ecosystem and when it can exist independently of direct human action (FAO, 1999). In contrast, it is considered to be domesticated when it has undergone purposeful selection for specific genetic characteristics, and when it is propagated and cultivated in managed agro-ecosystems (Leakey and Newton, 1994). For example, fruits of *Dacryodes edulis* under domestication on farms in most of Central Africa, where reported by Waruhiu *et al.* (2004) to be 66 % larger than those obtained from trees in the wild in Cameroon and Nigeria. Crop domestication has been limited to less than 0.05 % of all plant species and about 0.5 % of edible species (Leakey and Tomich, 1999). According to FAOStat (2010), out of a total of 400 000 flowering plants species, less than 200 have been domesticated as food and feed plants, and just 12 species provide 75 % of the food eaten.

Interestingly, some innovative farmers have reacted to deforestation and the decrease in the supply of traditional tree products by selecting and growing these trees within their farms. This farmer-driven domestication, in which species are brought into a managed environment through planting or retention, demonstrates that farmers will spontaneously invest in indigenous fruit species. Asaah *et al.* (2003) and Leakey *et al.* (2004) reported that farmers were selecting and multiplying *Irvingia wombolu* and *Irvingia gabonensis* (bush mango) trees, in Cameroon and Nigeria respectively, that have 44 % larger kernels over other, similar trees of the same species (particularly in south-eastern Nigeria). Farmers in southern Cameroon have also been reported to select particular trees of *Irvingia* species for their large fruit size as well as other characteristics such as taste and yield (Schreckenberg *et al.*, 2006). Finally, the selective planting by farmers in Cameroon and Nigeria, as reported by Waruhiu *et al.* (2004), has resulted in *Dacryodes edulis* fruits from trees on farms being 66 % larger than those obtained from trees in the wild.

Photo 7.4 : Banana and cassava cultivation on a former charcoal processing site, Bateke plateau – Mampu, DRC

Farmers have developed these strategies to become self-sufficient in food, micro-nutrients, medicines and many other daily needs (Tchoundjeu *et al.*, 2008). The actions by farmers to retain natural seedlings on their farms and in their home gardens, to eliminate trees with products (fruits/nuts) with less desirable attributes, and to sow and/or disperse the seeds of the more desirable fruit trees close to their homesteads, are thought to be a form of "commensal" domestication (Leakey and Asaah, 2013). This commensal approach to domestication constitutes one of the building blocks of the pathway to participatory tree domestication. Participatory tree domestication combines agricultural science and technology with traditional knowledge as an integrated package (Tchoundjeu *et al.*, 2006). The domestication of agroforestry trees could therefore be considered a necessary step in promoting sustainable agriculture because domestication helps to diversify the species which generate income in local and distant markets, improve diets and health, meet domestic needs, and restore functional agro-ecosystems, as well as empowering local communities (Leakey, 2012).

Work to domesticate agroforestry species in order to improve the yield and product started in Cameroon in 1997 with a focus on the priority species identified by farmers (*Irvingia gabonensis*, *Dacryodes edulis*, *Ricinodendron heudelotii*, *Garcinia kola*, *Cola spp*, *Pausinystalia johimbe,* and *Prunus africana*). The techniques and strategies employed ; vegetative propagation, characterization of genetic variation, tree selection, and cultivar development have been extensively reported elsewhere (see reviews by Tchoundjeu *et al.*, 1998 ; 2006 ; Leakey *et al.*, 2005 ; 2008). Uniquely, Cameroon researchers worked directly with local communities to identify and promote the use of local knowledge (Tchoundjeu *et al.*, 2006 ; 2010). This approach successfully developed techniques and strategies for participatory tree domestication that empower local communities, promote food self-sufficiency, generate income and employment, and enhance nutritional benefits (Asaah *et al.*, 2011). Furthermore, evidence that agroforestry can help rural communities become self-sufficient on an area of less than 5 ha (Schreckenberg *et al.*, 2006 ; Degrande *et al.*, 2006) is growing. Consequently, the domestication of indigenous fruit and nut trees, which is increasingly recognized as an important component of agroforestry, is impacting rural development, contributing to the alleviation of poverty, malnutrition and hunger (Asaah *et al.*, 2011 ; Tchoundjeu *et al.*, 2010). Agroforestry has recaptured and utilized farmers' knowledge about trees, seeds, crops, soil and livestock to establish more integrated, diverse, productive, profitable, healthy and sustainable land-use systems.

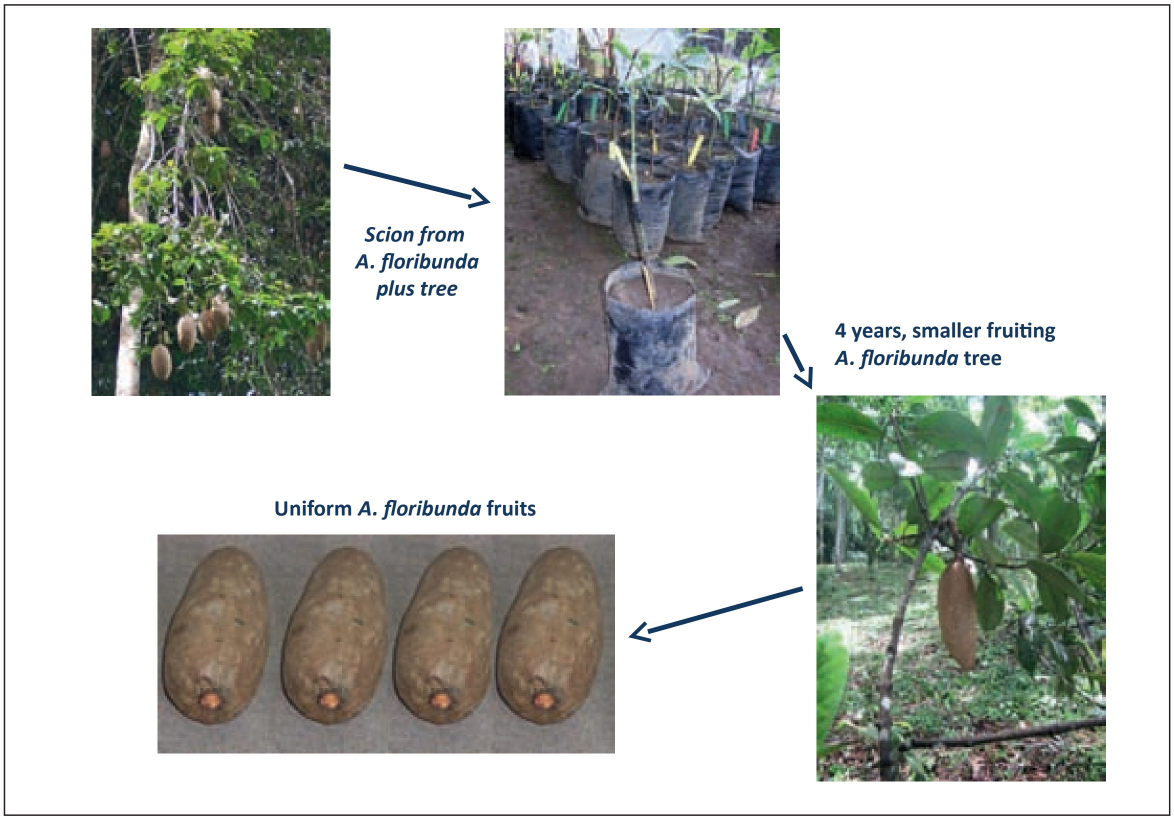

Figure 7.1 : Shortened juvenile phase to fruiting ; 4 years via grafting down from 12 years in Allanblackia floribunda, Cameroon

Source : Ebenezer Asaah

5. Outcomes of Agroforestry and Tree domestication

5.1 Biological and Environmental outcomes/impacts

The planting, promotion and adoption of "fertilizer trees", such as *Calliandra calothyrsus*, *Acacia angustissima, Sesbania sesban, Tephrosia vogelli,* and *Cajanus cajan* that fix atmospheric nitrogen and restore soil fertility is one of the main environmental outcomes of agroforestry. However, more farmers adopted the practice in higher-populated, less-forested savanna ecosystems than in the dense, humid forest (Degrande *et al.*, 2007). In the western highlands of Cameroon for instance, Rural Resource Centers (RRC) promote the planting of over 52 500 fertilizer trees annually (Asaah *et al.*, 2011) for soil fertility management, apiculture, fodder banks and woodfuel. RRCs are knowledge and demonstration centers (hubs) that act as an interface between research institutions and farmers for the promotion and diffusion of technological innovations within a target area. Between 2007 and 2008 in one of the RRCs, the RIBA Agroforestry Resource Center (RARC), the number of farmers planting fertilizer trees rose from 208 to 360 (Asaah *et al.*, 2011). These improved fallows have now become a well-accepted technology in most of the communities and farmers are reporting that their crop yields have doubled or tripled. This

Photo 7.5: Banana plantation after clearing, Gabon

significant increase in staple food crop productivity is a great contribution towards reversing observed tends of food insecurity in some rural areas in Cameroon. This increased yield could allow farmers to plant smaller areas of food crops while at the same time making space available for other types of crops in order to meet other needs. Leguminous trees and shrubs also attract bees, and many communities have adopted apiculture, providing more access to honey, a better substitute for refined sugars. The RARC is located on a 7 hectare plot that was completely bare and degraded, and had been abandoned by farmers. Today, the soils have been rehabilitated through agroforestry and the yields of wheat, maize, beans and potatoes have doubled. Furthermore the site now has a diverse range of tree species serving different purposes such as: woodfuel, windbreakers, fodder production for livestock and forage for bees. Moreover, increased tree cover, arranged along the contours of the hillsides, also protects the soil and reduces the risks of soil erosion while protecting watersheds.

In Burundi, one of the main environmental advantages of agroforestry is erosion reduction. For example, progressive terraces on the Kiyange hill in the village of Makebuko where agroforestry was initiated by the FAO in 1997 are still being maintained by farmers. Bugomora hill farmers have reduced the silting up of the Nyamaso swamp in Muyinga (Anonymous, 2011) with anti-erosive mixed rows. Agroforestry also enhances the beauty of the scenery, especially where diverse tree species are dispersed within fields or planted along contour lines at large scale. Other, less noticeable effects, could relate to the reduction of climatic changes and improvement of the local micro-climate.

The environmental outcomes of tree domestication in Central Africa include the development of new tree crop types (cutting, marcots, grafts) and new cultivars of indigenous fruit/nuts species with improved product quality and greater market demand. Tree domestication is occurring in many countries in Central Africa (Cameroon, Equatorial Guinea, Republic of Congo, and the DRC) and with several dozens of species. However, participatory tree domestication is most advanced in Cameroon, where improved cultivars have been developed through vegetative propagation techniques by local farmers for cultivation aimed at meeting their household needs. It is hoped that the development and integration of improved cultivars will increase the supply of these products in coming years, because the demand for tree products like bush mango kernels (*Irvingia* spp) and Eru/Okok leaves (*Gnetum africanum*) currently exceeds the quantities that can sustainably be obtained from the wild. According to Tchoundjeu *et al.* (2010), Asaah *et al.* (2011) and Leakey (2012), the tree products will be sold – at first locally and then more widely – both regionally within the Central Africa countries and in Europe and America.

The integration of these potential new cash crops into diverse farming systems has also resulted in more stable and healthier agro-ecosystems. Diverse systems, of either mixed crops or land use mosaics, are thought to improve the general agro-ecosystem functions and could reduce the incidence of pest and diseases (Schroth *et al.*, 2004). According to McNeely and Schroth (2006), agroforestry systems are more supportive of biodiversity than mono-crop systems, although the maintenance of high levels of biodiversity may often depend on the presence of natural habitats in close proximity. In a recent study, Asaah (2012) and Asaah *et al.* (2010; 2012), reported that trees of vegetative origins allocated their biomass differently, with less fine roots and more primary roots and shoots, suggesting that clonal cultivars

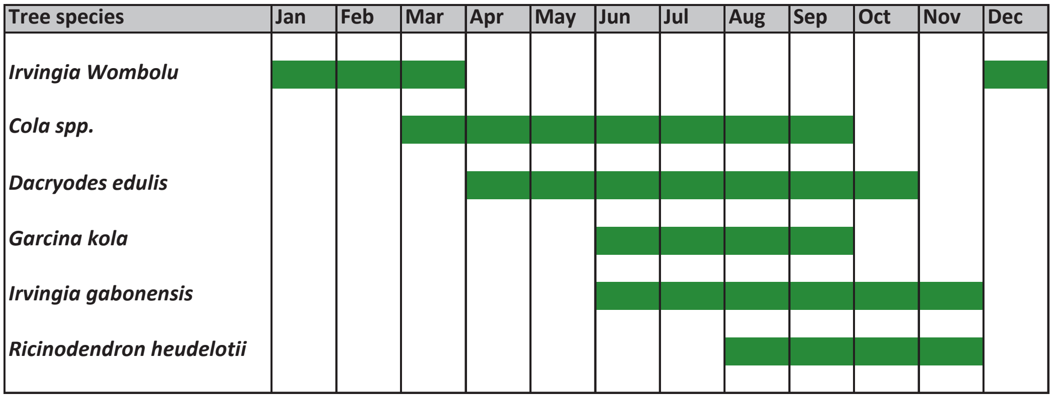

Figure 7.2 : Year-round harvest of some key agroforestry trees in Central Africa
Source : Kehlenbeck et al., 2013

are less likely to be competitive with annual crops. Perennial trees are biological sinks of carbon, with the additional benefit of climate change mitigation. Available evidence suggests that cultivars which have been produced using vegetative propagation could store double the amount of carbon in their shoots and primary roots than trees propagated by seeds, an unexpected benefit of tree domestication (Asaah, 2012).

5.2 Commercial and social outcomes/impacts

There are several social and commercial outcomes of agroforestry and tree domestication leading to greater environmental sustainability, and better livelihood options to both women and youths as they're are increasingly important actors in the production, management, harvesting/ post harvesting, value addition and marketing of agroforestry products. According to Asaah *et al.* (2011) and Degrande *et al.* (2012), rural resource centers (RRC) are now delivering both education and training in agroforestry and tree domestication, as well as in business management, so that farmers can earn money from the sale of plants and their tree products.

One impressive outcome of tree domestication is the development of tree nurseries and the potential of income generation from the sale of desired cultivars of indigenous fruit trees. In north-west Cameroon, Tantoh Mixed Farming Common Initiative Group (MIFACIG), one of the RRCs that adopted agroforestry and tree domestication over 10 years ago, along with its satellite network of nurseries, sold over $ 21 000 of plants in 2009. About 35 % of that income, i.e. $ 7 350, went to the satellite nurseries owned by farmer groups. Additionally, GIC PROAGRO, another RRC in western Cameroon that adopted agroforestry and tree domestication five years ago, had a plant-derived income from the sales of soil fertilizer species that was estimated at around $ 1 750 in 2007. Starting in 2008, this RRC focused on producing and selling improved cultivars of indigenous fruit trees like Kola (*Cola* spp), Safou (*Dacryodes edulis*) and other adapted exotic fruits like Avocado (*Persea americana*), and their income rose to about $ 40 000 in 2009 (Asaah *et al.*, 2011). This suggests that cultivars derived from superior trees of diverse species could be among the biggest source of income in the nurseries developed by farmers. Furthermore, it is hoped that all of these communities will also be

Photo 7.6: Tree savanna in Akagera National Park, Rwanda

able to further increase their income by selling fruits from the cultivars already integrated into their agricultural landscape.

Agroforestry also increases household incomes in Burundi. Although a comprehensive study has not been carried out to estimate benefits from the various agroforestry products or services, three categories of benefits are identified, as follows:

(i) job creation from plant production in nurseries; setting out of contour lines and planting according to the approach used by the project SEW (Sustainable Energy Production Through Woodlots and Agroforestry). For example, 310 967 man – days with 39 % women participation for installing micro-afforestation's using the HIMO (High-intensity Labor) approach (IFDC, 2011);

(ii) sale of produce (wood, fodder, *Pennisetum* stalks, milk, honey, etc.);

(iii) woodwork (sawing, carpentry, carbonization, etc.).

According to Asaah *et al.* (2011), within the highlands of Cameroon some farmers were observed to be planting between 10 and 120 fruit trees on their farms. Similarly in DRC, a diversity of species produced through vegetative propagation has been integrated into the agricultural landscape by farmers (table 7.1).

Table 7.1: *Species already integrated in 2012 in farming fields, DRC*

Species	Technique used	Area
Dacryodes edulis (Safou)	Aerial stratification	12 ha
Treculia africana	Stratification by bedding	9 ha
Monguifera indica	Aerial stratification	16 ha
Citrus spp	Aerial stratification	24 ha

6. Challenges for Agroforestry and Tree Domestication Implementation in Central Africa: need for reforms on rights and tenure

In order for agroforestry to fulfil its full potential of improving livelihoods and providing environmental services, the appropriate strategies, institutions, and financial mechanisms need to be in place. To accomplish these objectives, Foundjem-Tita and Degrande (2012) made the following policy recommendations:

(i) *Put in place a comprehensive program to develop capacity, guide and implement agroforestry strategies*. Appropriate policies, policy instruments, strategies and implementation mechanisms are required to reap the full benefits of agroforestry. Furthermore, these changes require concerted action between many organizations, including all government ministries interested in tree planting. Such a program would define clear objectives and targets and would require adequate financial and sectorial affiliation.

(ii) *Develop a clear distinction between agroforestry products harvested from trees on-farm and non-timber forest products (NTFPs) collected from the wild*. Thanks to recent advances in tree domestication research, farmers will likely be able to plant most of the NTFPs with high economic value, which are currently being collected from the wild. Furthermore, development projects in the domain of climate change mitigation and adaptation (including REDD+ programs) will likely further encourage tree planting by farmers. Thus, there is a need to develop specific criteria to distinguish agricultural and agroforestry products from forestry products and NTFPs. Since it is difficult to visually differentiate tree products harvested from the wild from those harvested on farmers' fields, certificates of origin may be useful.

(iii) *Facilitate access to land and secure ownership*. The process of obtaining land certificates should be simplified to allow farmers to have secure ownership of the land and the trees they plant on that land. On the other hand, strategies are needed either to encourage land markets or to redistribute land to enterprising farmers in another manner.

(iv) *Provide additional incentives to encourage farmers to plant more trees.* Farmers have developed agroforestry as a traditional land use practice with minimal assistance from either governments or NGOs. Nevertheless, policies that provide additional incentives for farmers could accelerate the adoption of agroforestry. These include: assistance for the production and distribution of quality tree planting material; policies that add value to tree products, for example through investments in improved processing of tree products; and, policies to help disseminate appropriate tree propagation and tree management skills to farmers through vast extension programs.

Photo 7.7: Terrace crops on the Rwandan hills

7. Conclusion

It is clear from this review that agroforestry and tree domestication in Central Africa is dynamic and expanding both geographically and in species. Domesticating new tree crops based on traditionally important wild trees in Central Africa has greatly enhanced the multifunctionality of agroforestry systems. If the potentials of agroforestry and tree domestication are properly harnessed, they could rehabilitate degraded lands, restore agroecosystem function and provide a sustainable pathway to lift poor smallholder farmers out of poverty, malnutrition and hunger. There is therefore an urgent need for a political and economic recognition that agroforestry and tree domestication, can immensely contribute to national domestic food budgets, foster new social infrastructure and cultural relations, help the emergence of new businesses and thereby mainstream local economic growth and improve the well-being of both rural and urban populations in Central Africa.