Contribution of agroforestry to biodiversity and livelihoods improvement in rural communities of Southern African regions

Kanungwe Felix Kalaba[1*], Paxie Chirwa[2], Stephen Syampungani[1], and Clifford Oluyede Ajayi[3]

[1] Copperbelt University, School of Natural Resources, P.O. Box 21692, Kitwe, Zambia
[2] Stellenbosch University, Department of Forest and Wood Science, Stellenbosch 7602, South Africa
[3] World Agroforestry Centre (ICRAF), P. O. Box 30798, Lilongwe 03, Malawi

*corresponding author: K.F. Kalaba, email: kanungwe@gmail.com or kanungwekalaba@yahoo.co.uk

Abstract

It has been widely documented that the traditional farming system of shifting cultivation contributes to huge annual losses of forest cover, altering the structure and distribution of species resulting in loss of biodiversity. On the other hand, formal institutional approaches to natural forest biodiversity conservation focused on protecting the tree species in parks and reserves while neglecting their conservation in farming systems. Improved agroforestry systems (AFS) such as improved fallows that mimic shifting cultivation and other AFS provide benefits that contribute to rural livelihoods, improved socio-economic status and ecosystem functioning of land use systems. Recently, there is an increasing recognition of the contribution of agroforestry to improve ecosystem services and livelihoods especially in rural areas. Compared with subsistence agriculture, AFS provides added benefit by generating cash income from the marketing of diverse products. In southern Africa, research that aims to addressed biodiversity and socio-economic issues includes domestication of diverse priority indigenous fruit tree species; and the evaluation of soil fertility replenishing Agroforestry technologies. This paper discusses the contribution of the natural forest resource and AFS to the improvement of the socio-economic livelihoods of smallholder farmers and the promotion of the conservation of biodiversity drawing on evidence from research conducted in southern Africa over the last two decades.

T. Tscharntke et al. (eds.), *Tropical Rainforests and Agroforests under Global Change*,
Environmental Science and Engineering, 461–476, DOI 10.1007/978-3-642-00493-3_22,

Keywords: Agroforestry systems, biodiversity, ecosystem, livelihoods, socio-economic, forest resource

1 Introduction

In Southern Africa and many developing countries, there is an inextricable link between the forest resource and the livelihoods of the rural communities. More than 80% of the rural population in sub-Saharan Africa is poor and traditionally relies on forests for most of their livelihoods including fuelwood and timber as well as other non timber forest products (Brigham et al, 1996; Schreckenberg *et al.*, 2006; Ngulube, 2000). Fuelwood provides the main source of the total household energy requirements in Southern Africa with the consumption varying from country to country namely: 85% in Mozambique (Brigham et al., 1996), 76% Zambia (Chidumayo, 1997), 91% Tanzania (SADC, 1993) and 14% in South Africa (Gander, 1994). Additionally, the rural dwellers also generate a wide range of non-timber products which include beeswax, honey, edible fruits, edible insects, wild vegetable, game meat, mushrooms, traditional medicines and fibres (Brigham et al., 1996). For example, Leakey *et al.* (2005) observed that harvesting of indigenous tree fruits from the wild can boost rural annual income by US $300-US $2000 per household. The use of wild foods such as fruits is observed throughout southern Africa: Malawi (Akinnifesi et al., 2006), Zambia (Chidumayo and Siwela, 1988), Zimbabwe (Campbell, 1987), and South Africa (Shackleton et al., 1998).

On the other hand, the widespread poverty in Southern African countries due to slow rates of economic growth (Kaimowitz, 2003) has resulted in deforestation and biodiversity loss due to overexploitation, conversion to farmland, slash and burn agriculture, charcoal production, bush fires and harvesting of wood (Akinnifesi et al., 2008; Chilufya and Tengnas, 1996; Hyde and Seve, 1993). While it could be argued that conversion to agriculture with improved inputs may have resulted in increased production; the converse is true that the economic restructuring programs in most of the developing countries resulted in prohibitively increased costs of these inputs. Consequently, the rural communities have reverted back to the use of the natural resource as a source of income albeit currently being used in an unsustainable manner as a result of increased commercialization. Hence, on the whole, the natural resource has borne the main brunt of both the agricultural revolution as well as the hard economic realities.

This paper seeks to highlight the important contribution that the forest resource is making to the livelihood of rural communities in some countries in southern Africa; pointing to the importance of maintaining biodiversity; and the contribution that agroforestry as a type of land use can make to the continued conservation and maintenance of agro-biodiversity. The paper also highlights some problems encountered in promoting agroforestry for sustainable livelihoods and maintenance of biodiversity.

2 The link of livelihood strategies of rural communities and biodiversity

Rural communities in southern Africa procure a wide variety of products from forest resources to meet their basic needs for food security, health and nutrition through collection of food, medicines, wood and pole (Shackleton and Shackleton, 2000). They are also important natural assets for rural households, providing both subsistence and market-oriented livelihood strategies. For example, in south-eastern Zimbabwe the average value of woodland goods collected was observed to be 30% of the average gross cash income per household per year (Campbell et al., 2002). The expanding commercialization of many woodland products also provides rural households with a range of market-oriented woodland livelihood opportunities. Serra and Zolho (2003) for instance, estimate that charcoal suppliers to Beira, Mozambique earn on average US$70-140 per month. The harvesting of woodland products is widely recognized as an integral component of the rural livelihoods throughout the developing world, offering goods for both household consumption and income generation (Kaimowitz, 2003).

2.1 Food security

The majority of rural communities in Southern Africa are engaged in agriculture for their livelihoods (Shackleton *et al.,* 2001). Additionally, they exploit natural resources as a means of supplementing their cash income (Brigham *et al.,* 1996). Many authors have highlighted the importance and use of woodland resource in spreading the risk associated with the availability of food over critical periods (Akinnifesi et al., 2008; Shackleton et al., 2005; Shackleton and Shackleton, 2004). Such periods include the beginning of the rainy season when food shortage is most acute as households have usually exhausted previous years harvest but the harvest for the new season has not commenced. The availability of NTFPs serves as an important gap-filler when food stocks are low (Chileshe, 2005) and also as a source of income. For example, the collection of indigenous fruits contributes between 5.5 and 6.5% to the total household income in the rural communities of Southern Africa (Akinnifesi et al., 2008). Mithoefer and Waibel (2003) estimated the returns to labour of collecting indigenous fruit tree products from communal forest areas to be equivalent to USD13.31 per day. Compared with a labour wage of less than one US dollar per day in Zimbabwe, this figure represents very high returns on investment (Akinnifesi et al., 2008). Indigenous fruit have been reported to contribute about 42% of the natural food basket in Southern Africa (Campbell et al., 1997). A survey conducted in Malawi, Zambia and Mozambique revealed that 6085% of the households lacked food during critical hunger period during the year and that these households confirmed the reduction in vulnerability by collecting fruits from woodlands (Akinnifesi et al., 2006).

Additionally, food security extends using natural woodlands for browse and fodder during drought periods (Chirwa *et al.,* 2008).

The most common edible insects are termites and caterpillars (Sileshi *et al.,* 2008). They are not only a source of food but also a source of income for the local communities surrounding the forest woodlands (Chidumayo and Mbata, 2002). According to Holden (1991), a one week collection of NTFPs can earn a person an equivalent of a months minimum wage in Zambia. Even in years of moderate abundance, edible caterpillars generate incomes of over US$60 per household that are comparable or even higher than incomes from sales of agricultural crops in the northern Zambia (Chidumayo and Mbata, 2002). In Malawi, Cunningham (1997) reported that people who participate in caterpillar collection earned an average of US$50 per person from the sale of caterpillars. Such earnings enable rural dwellers to buy goods and pay for basic services required by the household. Additionally, fruits, mushrooms, leafy vegetables, roots, bush meat and honey are important non-wood products from the woodlands.A detailed study of 36 farming households in one location in Malawi revealed that during a continuous period of 25 months a total of 37 different leafy vegetables, two root vegetables, 21 fruit and 23 mushrooms and 14 caterpillar species were collected (Lowore, 2006). The miombo ecoregion is also rich in edible mushrooms with 45 and 60 species reported in Zimbabwe and Malawi, respectively (Makonda and Gillah, 2007). Similar results were reported in Zambia (Chihongo, 1995). Honey from the woodlands of southern Africa is also an important food supplement to the rural communities; and is especially abundant under tree species such as *Isoberlinia angolensis, Julbernadia paniculata* and *Brachystegia spp.* This is especially important because of the flowering patterns of miombo species. For example, the flowering of *Brachystegia spp.* between October and December provides the farmers with food and also cash income needed to pay for agricultural inputs; while the flowering of *Julbernadia* and *Marquesia* spp. between May-June provide them with cash income without necessarily having to wait for income from the sale of agricultural crop (Jumbe *et al.,* undated).

2.2 Health and nutrition

It is estimated that more than 80% of the rural communities in sub-Saharan Africa depend on medicinal plants for most of their health needs and also for income generation (Garrity, 2004). Medicinal plants deserve special attention among the non wood products because of their importance in traditional healing and also their contribution to international trade (Syampungani *et al.,* 2008). The market in raw materials for medicinal or therapeutic plants and products of Southern Africa is readily available; between 5,000 and 10,000 tonnes are exported annually, and between 50,000 to 100,000 tonnes are consumed locally (Diederichs, 2006). The estimated market value of these products stands at US$150 million per year (Diedrichs,2006). The informal trade of medicinal plants and products in the region is dominated by four to five hundred thousand traditional healers that dispense medicines and herbal remedies to up to 100 million consumers (Diederichs, 2006). The range of plant health products has increased both within the southern African region and many parts of the world. Cunningham (1997) attributed the increase, especially in developing countries to increased urbanization and the inadequacy of conventional medicinal facilities. Local communities have exploited the leaves for treating several ailments, such as constipation, toothache, cold and cough, fever, pains, measles and Malaria (Syampungani *et al.,* 2008). There are a variety of species used in traditional healing including: A*lbizia antunesiana, Brachystegia spiciformis, Rhus chirindensis, Julbernadia paniculata, Pseudolachnostylis maprouneifolia* (see Geldenhuys *et al.,* 2006). A recent study in Zambia has shown that some indigenous fruit trees are important sources of medicine for the rural people with almost two-thirds of the households using indigenous fruit trees for medicinal purposes (Kalaba *et al.,* 2009). Plant-based traditional remedies in many sub-Saharan African countries are becoming more frequently used for the treatment of HIV/AIDS related illnesses (Kayambazhinthu *et al.* 2003).

2.3 Energy and forest resource use and implications on biodiversity

Fuelwood is one of the major uses of miombo woodlands and it dominates the national energy budgets for most southern African countries (Coote *et al.* 1995; Campbell *et al.,* 2008) because it is the single most important energy source for cooking, heating and brick burning throughout Southern Africa (Geist, 1999). It accounts for high percentages of the total household energy requirements (Syampungani et al., 2009);85% in Mozambique (Brigham et al., 1996);91% in Tanzania (SADC,1993);76% in Zambia (Chidumayo, 1997) and 14% in South Africa (Gander,1994)Most of miombo woodland species are suitable to be used as fuelwoods. The preference for certain species and small dimensions (Chidumayo *et al.,* 1996) may have implications on the sustainability of supply and future availability of those particular species. Woodlands are also an important source for construction material such as poles and bark ropes. *Brachystegia* and *Bauhinia* species have been reported to be important due to their strong fibre that is also easy to peel. Rural dwellers make domestic implements used in households from the woodlands. This is because most *miombo* species used have certain attributes such as strength and resistance to splitting (Chidumayo *et al.,* 1996).

2.4 Impact of livelihoods strategies on biodiversity

The impacts of livelihoods strategies on the woodlands and individual species well-being varies. For example, the high levels of wood energy in the national energy budgets for most southern African countries make fuelwood consumption a major local and regional environmental issue (Chambwera, 2004). Neither natural nor artificial regeneration has been able to keep pace with the rate of harvesting (Syampungani et al., 2009). Fuelwood consumption together with slash and burn agriculture has accelerated forest degradation in the region (FAO, 2000). Biodiversity and nutrient losses have been cited as the major concern in the Southern African woodlands (Sileshi *et al.,* 2007). About 191 tree species are endangered while a number of animal species and small plants are threatened due to forest conversion (FAO, 2000). Conversion of woodlands due to agriculture and charcoal production deplete terrestrial carbon by drastically reducing carbon density as well as soil organic carbon (Sileshi *et al.,* 2007).

Harvesting of bark of trees for various products such as medicines, rope fibre and for making beehives can be highly destructive and lead to increased tree mortality (Chidumayo *et al.,* 1996). Beekeeping has always been considered detrimental to forestry in Miombo from time immemorial, because of the large number of trees used in hive construction, and the indiscriminate burning that was sometimes caused by honey-hunters. However, a number of methods for reducing the negative impact of bark harvesting have been proposed and tested for obtaining bark from woody material that has already been cut for other purposes and also substitution such as use of leaves for medicine (Shackleton & Clarke, 2007); improved harvesting methods (Geldenhuys *et al.,* 2006) that prevent ring barking and reduce fungal infection. Unsustainable methods for harvesting edible caterpillars have contributed to deforestation in southern Africa woodlands. Local extinction of some species due to the loss of their natural habitat and host plants, and eradication of some considered pests has been a major constraint to their sustainable utilization and harvesting (Chidumayo and Mbata, 2002; Munthali and Mughogho, 1992).

3 Agroforestry technologies and biodiversity management

The services provided by agroforestry practices to rural livelihoods and conservation of biodiversity have attracted wide attention among agroforestry and conservation scientists (Mcneely and Schroth 2006). Agroforestry technologies (AF) focus on the role of trees on farms and agricultural landscapes to meet economic, social and ecological needs (Garrity, 2006). Traditional agroforestry practices have a huge potential in supporting biodiversity conservation.

The use of agroforestry technologies mitigate biodiversity loss and provide opportunities for improving diversification and range of livelihood options for rural households (Akinnifesi *et al.* 2008).

In southern Africa, farmers have from time immemorial maintained and included trees in their landscapes. Traditionally farmers grow crops under scattered trees of different species (Akinnifesi *et al.* 2007). Some of the agroforestry technologies that are being implemented by the rural communities in southern Africa include: improved fallows, rotational woodlots and indigenous fruit trees in the parklands system.

3.1 Rotational woodlots

Rotational woodlot is an agroforestry practice whose primary goal is to increase fuelwood production. Woodlots are stands of trees planted on farms, communal land or degraded lands to provide products and services. Trees grown in rotational woodlots or scattered on crop land provide large quantities of fuel wood. Woodlots are one of the agroforestry options with the capacity to arrest deforestation and shortage of wood fuel energy in southern Africa (Akinnifesi et al., 2008). The establishment of woodlots reduces the pressure on indigenous forest by alternatively providing both wood and non-wood products to the rural communities; and so maintain the biodiversity in the natural forests. Woodlots contribute significantly to the reduction of deforestation and conserving biodiversity. The trees have the potential to increase the soil fertility and improve soil structure through nutrients contributed via the decomposition of biomass or leaf residues. The fast-growing trees provide products services such as provision of vegetative cover to reduce soil erosion.

3.2 Improved fallows

It has been widely documented that the traditional farming system of shifting cultivation contributes to huge annual losses of forest cover, altering the structure and distribution of species resulting in loss of biodiversity (Chidumayo and Mbata, 2002; Chidumayo *et al.,* 1996). On the other hand, formal institutional approaches to natural forest biodiversity conservation focused on protecting the tree species in parks and reserves while neglecting their conservation in farming systems. "Improved fallow" involves the planting of fast growing nitrogen-fixing tree species for one to two years followed by two years of cropping (Sanchez, 1999). The practice builds on the knowledge that nitrogen is the most limiting macro nutrient in the soil, but it is highly abundant in the atmosphere. Improved fallows mimic shifting cultivation but they are an improvement as they replenish the soil fertility system in a shorter period thereby contributing to the rural livelihoods and ecosystem functioning of land use systems. This can be attributed to the careful choices of species, management of tree density and accompanying silvicultural practices that distinguish improved fallows from natural fallows. Several agroforestry technologies have subsequently been developed with the aim of addressing the soil fertility improvement including alley cropping, improved fallows, coppicing fallows (see Matthews *et al.* 1992 in Akinnifesi *et al.* 2008) and using *Leucaena leucocephalla and Gliricidia sepium* to increase the yield of associated crops (Sileshi *et al.,* 2005; Matthews *et al.* 1992 in Akinnifesi *et al.* 2008). Various tree species have been utilized in improved fallows to improve yields especially by mixing species with compatible and complementary rooting or shoot-growth patterns in fallow systems and thereby diversifying the system and maximizing growth and resource utilization above and below ground (see Akinnifesi *et al.* 2008).

3.3 Indigenous fruit trees parklands system

The inclusion of indigenous fruit trees (IFTs) on agricultural land in southern Africa has been highlighted by various authors (Ngulube *et al.* 2006; Kalaba *et al.* 2008) In Zambia, Kalaba *et al.* (2009) reported that rural households intentionally retain fruit trees on their fields, by leaving trees standing in agricultural land. In Malawi, Ngulube *et al.,* (2006) highlighted the prevalence of cultural-religious restrictions governing the use and exploitation of indigenous fruit trees. For example, during woodland clearing prior to cultivation or settlement, important fruit trees such as *Parinari curatellifolia*, *Strychnos cocculoides* and *Uapaca kirkiana*, are customarily left uncut and scattered around homesteads or crop fields. Packham (1993) has reported similar cases for Tanzania, Zambia and Zimbabwe where *Parinari curatellifolia* and *Uapaca kirkiana* are left deliberately in cultivated fields. The integration of IFTs in agricultural production systems has been reported to reduce the risks inherent to monocultures of staple food crops, such as susceptibility to pests and diseases, soil nutrient depletion (Hughes and Haq, 2003). This also improves the landscape mosaic which ultimately reduces the risks of monocrops while increasing agro biodiversity in the landscape.

4 Socio-economic conditions that affect the adoption of agroforestry

Rural communities in southern Africa are faced with high poverty levels. In Zambia, Kalaba *et al.* (2009) revealed that over 90% of rural households experience regular hunger periods during the rainy season between November and April. Similar findings have been reported for Malawi, Zambia and Mozambique (Akinnifesi *et al.,* 2004). This implies that most households suffer from food insecurity, offering enough evidence of the high prevalence of rural poverty. Rural households are characterized by low literacy and lack inadequate skills and training, such as production and marketing skills. Given the profitability of agroforestry technologies (Franzel et al., 2002; Ajayi et al., 2007) and the impact that they have on households and the environment (Ajayi et al., 2004; Kwesiga et al., 2005), efforts are being made to scale up the adoption of the technology and enhance its acceptability among many more potential farmers who could benefit from the technology. Results of studies conducted in the southern African region show that farmers do appreciate agroforestry and its potential linkage to food security and household welfare indicators, but they face some challenges to the widespread uptake of agroforestry including land constraints, property rights, availability of seeds, knowledge-intensive nature of the technology. Farmer acceptability and improved adoption of the technology will be influenced by the extent to which efforts are taken to meet these challenges (Ajayi, 2007). The process of adoption of agroforestry technologies is more complicated than those for annual crops and modern agricultural development packages based on chemical inputs (Mercer 2004; Scherr and Müller 1991) because of the multi-components and the multi-years through which testing, modification and "adoption" of agroforestry takes place (Ajayi et al., 2003). A synthesis of the studies on the adoption of agroforestry in Zambia (Ajayi et al., 2003) revealed that the adoption of agroforestry is not a direct relationship based on the technological advantages of an agroforestry practice alone, but is influenced by several factors. The broad category of the factors are technology-specific (e.g. soil type, management regime), household-specific factors (e.g. farmer perceptions, resource endowment, household size), policy and institutions context within which agroforestry technologies is disseminated (input and output prices, land tenure and property rights), and geo-spatial such as tree species performance across bio-physical conditions, location of village (Ajayi et al., 2007). One way to enhance the adoption of agroforestry technologies is to target them to their biophysical and social niches, facilitate appropriate policy and institutional context for the dissemination of the technologies, understanding the broader context and dynamics of the adoption process (Ajayi et al., 2007).

Given the strong influence of the policy and institutional context within which agroforestry technologies are disseminated to potential users, it is important that efforts to scale up agroforestry should complement farmer training at the farm level with active engagement of policy makers and shapers (advocates) to facilitate policy incentives and regulations that are conducive to and encourage smallholder farmers to adopt agroforestry technologies (Ajayi et al., 2007).

4.1 Adoption of agroforestry

Farmers show their appreciation of diversity by retaining and managing trees on their farmlands. It is worth noting that farmers will only be involved in conservation of biodiversity if there is a perceived benefit. The World Agroforestry Centre (ICRAF) reports that over 480, 000 smallholder farmers in southern Africa are practicing agroforestry (ICRAF 2007). The successive adoption rate has been attributed to the adoption criteria which has been participatory in nature. Akinnifesi *et al.* (2008) reported an increase in demand in the adoption of agroforestry by farmers. The impact of agroforestry adoption on livelihoods of farmers in Malawi, Mozambique and Zambia includes increase in crop yields, increase in income, increased savings resulting in change of wealth and soil improvement. Qualitative assessments of the impact of agroforestry adoption on livelihoods of farmers in Malawi, Mozambique and Zambia are presented in Table 1.

Table 1. Qualitative assessments of impact of agroforestry adoption on livelihoods of farmers in Malawi, Mozambique and Zambia

Impact indicator	Malawi (n=31)	Zambia (n=184)	Mozambique (n=57)	Regional range
		% of respondents		
1. Increase in area under agroforestry	55	87	65	83-100
2. Yield increase (> quarter to triple)	70	90	71	83-100
3. Significant food security (> 2 months of hunger reduction)	94	84	54	66-100
4. Increase in income	58	68	53	33-83
5. Firewood availability	90	nd*	59	nd*
6. Increased savings	87	94	71	nd*
7. Change in wealth	77	84	77	77-100
8. Strong reduction in *Striga spp*	90	93	88	71-100
9. Soil improvement	84	82	59	71-100
10. Other benefits	65	nd*	24	nd*

nd* Not determined
Adapted from Akinnifesi *et al.* 2008

There are a number of factors that influence the adoption of species. Among them are household or community preferences, land tenure and inheritance rights and the availability of germplasm.

Germplasm accessibility is a critical factor that affects the adoption of agroforestry technologies. In the absence of the germplasm, rural people are left with no option but to abandon the technologies despite their superiority which can be established scientifically. For example, in Malawi, the number of farmers using *Gliricidia*-maize intercropping is relatively low as compared to those using *Tephrosia spp., Sesbania sesban and Cajanus cajan* (Akinnifesi *et al.* 2008). They cited the lack of availability of germplasm for *Gliricidia* as a factor retarding its adoption whereas the seeds of Tephrosia spp are easily accessible to farmers at minimal costs. Land tenure and inheritance rights also significantly affect adoption of AF technologies. Tree based agroforestry technologies are more negatively affected by land and tree tenure arrangements (Akinnifesi *et al.* 2008). According to Ajayi (2007), the extent to which land tenure affects adoption of agroforestry technologies varies by geographical location, type of culture and whether the technologies is tree-based or annual shrub based.

4.2 Policy and governance

The types of institutions and legislation and sectors governing the management of natural resources in Southern Africa include government ministries, para-state agencies, international conventions and religious or faith-based institutions (Oduol *et al.,* 2008). The institutions have been changing according to the changing state and administrative frameworks from colonial to post-colonial times (see Kowero, 2003). These changes have undermined the traditional institutions and organisations responsible for the management of woodland resources (Matose and Wily, 1996) and therefore have resulted in the exclusion of the local communities in managing the resources. Additionally, there is lack of clear and appropriate policies that support the development of important agroforestry products such as non wood forest products with economic potential (Oduol *et al.,* 2008). The available policies and laws governing forest exploitation are restrictive in nature, through control for protection (Kayambazinthu *et al.,* 2003). They put emphasis on non-consumptive utilization of protected resource (Munthali and Mughogo, 1992). Policies conducive to the promotion of agroforestry are lacking in Southern Africa (Syampungani *et al.,* 2008). It is therefore important that policies that promote agroforestry are put in place.

5 Conclusion

The natural forest resource continues to play a major role in improving the livelihood of rural communities in Southern Africa, and this it does, because of the rich biodiversity in forests. Thus, natural forests are able to provide for energy, food and nutrition and health. However, the current levels of deforestation which cause land degradation, soil nutrient depletion, loss of natural habitats and therefore change in structure and composition of the natural woodlands pose a threat to the contribution of the southern woodlands to rural livelihoods. Improved agroforestry systems have the potential to contribute to the maintenance of biodiversity in natural systems due to the reduction in overreliance of rural communities on natural forest resources; as they are able to maintain their production systems through improved AFS. AFS have inadvertently resulted in improved agro-biodiversity because of the multiple components involved; and through mimicking traditional systems in some cases, the so called new AF technologies have easily been adopted. However, there is still a strong need to promote AFS through increased dissemination of germplasm and advocacy to policy makers.

References

Ajayi OC, Akinnifesi FK, Sileshi G, Chakeredza G (2008) Comparative Evaluation of Labor Use and Profitability of Renewable Soil Fertility Replenishment Technologies in Southern Africa. Proceedings of the Tropentag Conference Competition for Resources in a Changing World: New Drive for Rural Development, October 7-9, University of Hohenheim, Germany. http://www.tropentag.de/abstracts/full/708.pdf

Ajayi OC, Place F, Kwesiga F, Mafongoya P (2007) Impacts of Improved Tree Fallow Technology in Zambia. In: Waibel H, Zilberman D (eds.) International Research on Natural Resource Management: Advances in Impact Assessment. CABI Wallingford, UK and Science Council/CGIAR, Rome pp.147-168 ISBN: 976-1-84593-283-1

Ajayi OC, Franzel S, Kuntashula E, Kwesiga F (2003) Adoption of improved fallow soil fertility management practices in Zambia: synthesis and emerging issues. Agroforestry systems 59 (3): 317-326

Ajayi OC , Akinnifesi FK, Gudeta S, Chakeredza S (2007) Adoption of Renewable Soil Fertility Replenishment Technologies in Southern African Region: Lessons Learnt and the Way Forward. Natural Resource Forum 31 (4): 306-317

Akinnifesi FK, Sileshi G, Ajayi OC, Chirwa PW, Mngomba S, Chakeredza S, Nyoka BI (2008) Domestication and conservation of indigenous Miombo fruit trees for improving rural livelihoods in Southern Africa. Tropical Conservancy 72-74

Akinnifesi FK, Sileshi G, Ajayi OC, Chirwa PW, Kwesiga F, Harawa R (2008) Contributions of agroforestry research and development to livelihood of smallholder farmers in Southern Africa: 2. Fruit, medicinal, fuelwood and fodder tree systems. Agricultural Journal 3 (1): 76-88

Akinnifesi FK, Kwesiga FR, Mhango J, Chilanga T, Mkonda A, Kadu CAC, Kadzere I, Mithofer D, Saka JDK, Sileshi G, Ramadhani T, Dhliwayo P (2006) Towards the developmentof Miombo fruit trees as commercial tree crops in southern Africa. Forests, Trees and Livelihoods 16: 103121

Brigham T, Chihongo A, Chidumayo E (1996) Trade in woodland products from the miombo region. In: Campbell B (ed.), The Miombo in Transition: Woodland and Welfare in Africa. Centre for International Forestry Research (CIFOR), Bogor,pp. 136-174

Campbell BM (1987) The use of wild fruits in Zimbabwe. Economic Botany 41 :375-385

Campbell B, Jeffrey S, Kozanayi W, Luckert M (2002) Household Livelihoods in Semi-Arid Regions: Options + Constraints. Jakarta, Indonesia, Center for International Forestry Research (CIFOR)

Chambwera M (2004) Economic Analysis of Urban Fuelwood Demand: The case of Harare in Zimbabwe. PhD Thesis, Wageningen University, The Netherlands

Chidumayo EN, Gambiza J, Grundy I (1996) Managing miombo woodlands. In: Campbell BM (ed.), The Miombo in Transition: Woodlands Welfare in Africa. Centre for International Forestry Research, Bogor, pp.175-193

Chidumayo EN (1997) Miombo ecology and management: an introduction. Stockholm Environment Institute, Stockholm, Sweden

Chidumayo EN, Mbata KJ (2002) Shifting cultivation, edible caterpillars and livelihoods in the Kopa area of northern Zambia. Forests, Trees and Livelihoods 12: 175-193

Chihongo AW (1995) Tanzanian perspective towards non wood products from Africa. A resource paper prepared for the African Academy of Sciences round table discussion on non wood forest products. Pretoria, South Africa, 21-23 November, 1995

Chikamai B, Tchatat M (undated) Forest Management For Non-wood Products and Services in Africa. A report prepared for the project lessons on Sustainable Forest Management in Africa. AFORNET/FAO/KSLA. http://www.ksla.se/sv/retrieve_file.asp. Date visited: 19/07/2008

Chileshe RA (2005) Land tenure and rural livelihoods in Zambia: A case studies of Kamena and St. Joseph. PhD Thesis. Faculty of Arts, University of The Western Cape, South Africa

Chilufya H, Tengnäs B (1996) Agroforestry extension manual for northern Zambia. Regional Soil Conservation Unit (RSU), Technical Handbook Series 11, p.124

Chirwa TS, Mafongoya PL, Chintu R (2003) Mixed planted-fallows using coppicing and non-coppicing tree species for degraded Acrisols in eastern Zambia. Agroforest. Systems. 59: 243-251

Chirwa PW, Akinnifesi FK, Sileshi G, Syampungani S, Kalaba FK, Ajayi OC (2008) Opportunity for conserving and utilizing agrobiodiversity through agroforestry in Southern Africa. Biodiversity 9 (1&2) 45-48

Cunningham AB (1997) An Africa-wide overview of medicinal plant harvesting, conservation and healthcare. Medicinal plants for forest conservation and healthcare. Non wood forest products 11, FAO, Rome, Italy

Diederichs N (ed., 2006) Commercialising Medicinal Plants: A Southern African Guide. Sun Press, Stellenbosch

Franzel S, . Phiri D, Kwesiga F (2002) Assessing the adoption potential of improved fallows in eastern Zambia. In: Franzel S, Scherr SJ (eds.) Trees on the Farm: Assessing the Adoption Potential of Agroforestry Practices in Africa. CAB International, Wallingford, UK, pp 37-64

Food and Agriculture Organization (FAO, 2000a) Global Forest Resources Assessment Available at http://www.fao.org/docrep/004/Y1997E/y1997elr.htm bm63. Last accessed: July 22, 2008

Food and Agriculture Organization (FAO, 2000) The elimination of food insecurity in the Horn of Africa, A strategy for concerted government and UN agency action. FAO, Rome.
Available at http://www.fao.org/docrep/003/x8406e/X8406e00.HTM

Gander M (1994) Domestic Energy used by Farm workers Living on Farmland in Natal and Transvaal. Report to the Department of Mineral and Energy Affairs, South Africa

Garrity DP (2004) Agroforestry and achievement of the Millennium Development Goals. Agroforestry Systems 61: 5-17

Geist JH (1999) Global assessment of deforestation related to tobacco farming. Tobacco Control 8: 18-28

Geldenhuys CJ, Syampungani S, Meke G, Vermeulen WJ (2006) Response of different species on bark harvesting for traditional medicine in South Africa. In: Beste JJ, Seydack AWH, Vorster T, van der Merwe IJ, Dzivhani S (eds.) Multiple use management of natural forests and woodlands: Policy refinement and scientific progress. Natural Forests and Savanna woodlands Symposium IV Port Elizabeth, South Africa, 15-18 May 2006

Holden S (1991) Edible caterpillars - A potential agroforestry resource? Food Insects Newsletter 4 (3): 3-4

Hyde WF, Seve JE (1993) The economic role of wood products in tropical deforestation: The severe example of Malawi. Forest Ecology and Management 57: 283-300

Hughes A, Haq N (2003) Promotion of indigenous fruit trees through improved processing and marketing in Asia. International Forestry Review 5 (2 special issue: NTFPs revisited): 176-181

Jumbe BL, Bwalya SM, Husselman M (Undated) Contribution of dry forests to rural livelihoods and the national economy in Zambia. http://www.cifor.cgiar.org/miombo/doc. Dated visited: 19/09/2008

Kalaba FK, Chirwa PW, Prozesky H, Ham C (2009) The role of indigenous fruit trees in rural livelihoods: the case of communities around the Mwekera area, Copperbelt province, Zambia. In: Jaenicke H, Ganry J, Hoschle-Zeledon I, Kahane R (eds.) Underutilized plants for food, Nutrition, Income and Sustainable Development. Proceedings of International Symposium held in Arusha, Tanzania 3-7 March, 2008. Acta Horticulturae 806. International Society for Horticultural Science. Leuven, Belgium 739pp

Kaimowitz D (2003) Not by bread alone: forests and rural livelihoods in sub-Saharan Africa. In: Oksanen T, Pajari T, Tuomasjukka T (eds.) Forests in Poverty Reduction Strategies: Capturing the Potential. EFI: joensuu 65-86

Kayambazinthu D, Matose F, Kajembe G, Nemarundwe N (2003) Institutional arrangements governing natural resource management of the miombo woodland. In: Kowero G, Campbell BM, Sumaila UR (eds.) Policies and Governance Structures in Woodlands of Southern Africa. CIFOR, Bogor, Indonesia, p 45-64

Kowero G (2003) The challenges to natural forest management in sub-Saharan Africa rural development: experiences from the miombo woodlands of southern Africa. In: Kowero G, Campbell BM, Sumaila UR (eds.) Policies and Governance Structures in Woodlands of Southern Africa. CIFOR, Bogor, Indonesia, p 1-8

Kwesiga F, Franzel S, Mafongoya P, Ajayi OC, Phiri D, Katanga R, Kuntashula E and Chirwa T (2005) Successes in African Agriculture: Case Study of Improved Fallows in Eastern Zambia. Environment and Production Technology Division (EPTD) Discussion Paper 130, IFPRI, Washington DC

Leakey RRB, Tchoundjeu Z, Schreckenberg K, Shackleton SE, Shackleton CM (2005) Agroforestry Tree Products (AFTPs): Targeting poverty reduction and enhanced livelihoods. International Journal of Agricultural Sustainability 3: 1-23

Lowore J (2006) Miombo woodlands and rural livelihoods in Malawi. International Forestry Research (CIFOR), Bogor, Indonesia

Makonda FBS, Gillah PR (2007) How to balance variable wood and non wood products and uses in miombo woodlands.
http://www.metla.fi/hanke/8512/esitelmat-tanzania-2007.
Date visited 17/08/08

Mithöfer D, Waibel H (2003) Income and labour productivity of collection and use of indigenous fruit tree products in Zimbabwe. Agroforestry Systems 59: 295305

Muntali SM, Mughogho DEC (1992) Economic incentives for conservation: bee-keeping and saturinid caterpillar utilization by rural communities. Biodiversity Conservation 1: 143-54

Ngulube MR, Mwabumba L, Chirwa PW (2006) Socio-economic aspects of Miombo woodlands in Malawi: The case of Non-Timber Forest Products. Natural Forests and Woodland Savanna Symposium IV, Port Elizabeth, South Africa. 15-18 May 2006

Ngulube MR (2000) The utilization and marketing of non-timber forest products from the Miombo woodlands of Malawi: a case study. In: Ngulube RM, Mwabumba L, Chirwa PW (eds.) Community-based management of Miombo woodlands in Malawi: proceedings of a national workshop, Mangochi, Malawi, 2729 September 1999. Forestry Research Institute of Malawi, Zomba. p 4469

Oduol PA, Ajayi OC, Matakala P, Akinnifesi FK (2008) The role of Institutional Arrangements and Policy on the Conservation, Utilization and Commercialization of Indigenous Fruits in Southern Africa. In: Akinnifesi FK, Leakey RRB, Ajayi OC, Sileshi G, Tchoundjeu Z, Matakala P, Kwesiga FR (eds.) Indigenous Fruit Trees in the Tropics: Domestication, Utilization and Commercialization. CABI/ICRAF, Wallingford. pp 310-321.

Packham J (1993) The value of indigenous fruit- bearing trees in miombo woodland areas of South Central Africa. Rural Development Forest Network Paper, Overseas Development Institute, London

Pattanayak SK, Sills EO (2001) Do tropical forests provide natural insurance? The microeconomics of non-timber forest product collection in the Brazilian Amazon. Land Economics 77 (4): 595-612

Peham APK (1996) NWFP development in Malawi. In: FAO (Ed.) Commonwealth Science Council: Non-Wood forest products: A regional expert consultation for English-speaking African Countries, 17-22, October 1993, Arusha, Tanzania

Schreckenberg K, Awono A, Degrande A, Mbosso C, Ndoye O, Tchoundjeu Z (2006) Domesticating indigenous fruit trees as a cntribution to poverty reduction. Forests, Trees and Livelihoods 16: 35-51

Serra A, Zolho R (2003) Inqurito Sobre a Produo e Consumo de Combustvel Lenhoso na Cidade da Beira. SAfMA Internal Report

Shackleton SE, Dzerefos CM, Shackleton CM, Mathabela FR (1998) Use and trading of wild herbs in the central lowveld savanna region, South Africa. Economic Botany 52 (3): 251-259

Shackleton CM, Shackleton SE (2000) Direct use values used in woodlands. In: Owen DL (ed.) The Southern African Forestry Handbook. Pretoria, South African Forestry Institute. pp 635-41

Shackleton CM, Shackleton SE, Cousins B (2001) The role of land-based strategies in rural livelihoods: the contirbution of arable production, animal husbandry and natural resource harvesting in communal areas in South Africa. Development Southern Africa 18 (5): 582-604

Sileshi G, Akinnifesi FK, Ajayi OC, Chakeredza S, Kaonga M, Matakala PW (2007) Contributions of agroforestry to ecosystem services in the miombo ecoregion of eastern and southern Africa. African Journal of Environmental Science and Technology 1 (4): 68-80

Southern African Development Community (SADC) (1993) Energy Statistics Year Book for 1991. Energy Sector, TAU, Luanda, Angola

Syampungani S, Chirwa PW, Akinnifesi FK, Sileshi G, Ajayi OC (2009) The miombo woodlands at the cross roads: potential threats, sustainable livelihoods, policy gaps and challenges. Natural Resources FORUM 33: 150-159