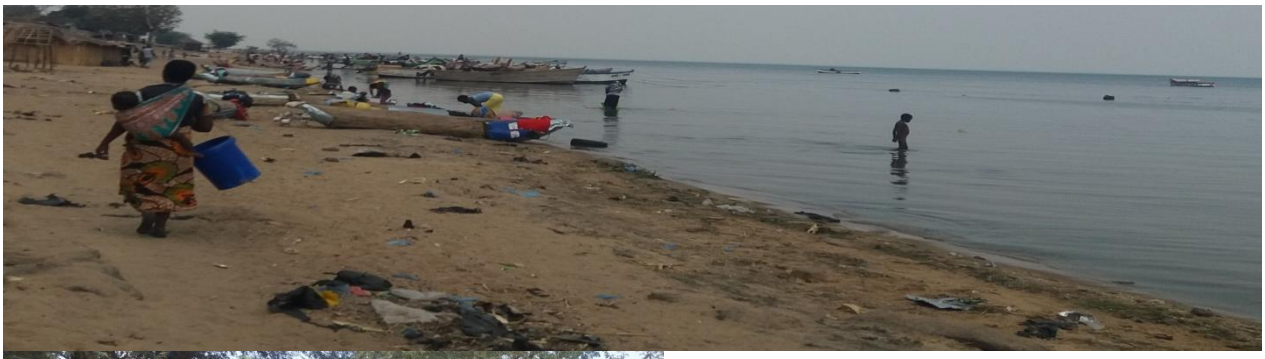
LAND USE SYSTEM ANALYSIS FOR ANNUAL CROPS AND WOODY PERENNIALS COMBINATIONS IN BAWI AND BWANJE VALLEY



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1.0 INTRODUCTION

Generally trees occur in a wide range of vegetation types, with many species only found in specific ecological regions and centre of endemism unless they are introduced exotic species. Large areas which are relatively uniformly covered by broad vegetation types such as forest, savanna, or grassland usually present one major biotic zone and are referred to as biomes. Biomes are further subdivided into smaller, homogenous ecological units or vegetation types based on dominant species, plant density and height (van Wyk and van Wyk 1997). Examples of these biomes include *Mopane* woodland; thorn bushveld; and *Miombo* woodland which reflect more localized conditions such as mean annual rainfall and the nature of soil. These biomes have been transformed greatly due to several factors which include land use change and climate change and variability.

In the tropics, as is the case in Malawi, the agro-ecosystems are complex and diversified as they respond to human resource uses. These ecosystems include, by definition, people and their institutions, as well as the agricultural biodiversity and trees in the landscape that they use and influence through their diverse range for their livelihood and well-being. Trees in the landscape represent a key element in managing the relationship between forest and agriculture that result into agricultural biodiversity in traditional forest land use management (Chirwa and Mala 2016).

All the landscapes in which the woodlands are found tend to be dominated by human settlements and therefore are exposed to different level of use for provision of different services including energy, construction materials, and a diversity of non-timber forest products. The current status of the woodlands is largely driven by the land use to which they are exposed with the main drivers of forest cover change being agricultural expansion, energy, in the form of fuelwood and charcoal, urbanization, and extractive mining (Handavu *et al.* 2018).

A growing human population has had a great influence on land use change, resource use and management in Malawi. Increasing population, accelerating deforestation, poor soil and water management, and increasing poverty and land degradation directly impact the food security and human health of millions of Malawians. Cropping systems which combine cereal crops, agroforestry and small doses of inorganic fertilizers produce food-crop yields greater than inorganic fertilizers alone on degraded soils, as well as recuperating soil nutrients over a period of years. These agroforestry practices improve the livelihoods of farm families, lower risks associated with fertilizer price increases and drought and at the same time improve biodiversity and nutrient and water cycling in the agro-ecosystem (ICRAF 2014).

While these human-nature processes for managing agricultural biodiversity have been documented in the tropics, the relationships between the management of woody perennials (trees) and the dynamics of land use systems remain poorly investigated as well as their adaptability to the traditional forest management systems (Chirwa and Mala 2016). In addition, advances made in developing sustainable forest agricultural landscape mosaics in the tropics have concentrated on the improvement of a limited number of agricultural crops and selected non timber forest products (Chirwa and Mala 2016). This study tried to understand the relationship between annual crops and woody perennials (trees) that are retained on farm within the Bwanje Valley and Bawi area in Ntcheu.

2.0 METHODOLOGY

2.1 Study Sites

The study covered most land use types that retain trees on farm in the Bwanje Valley and Bawi area in Ntcheu. Parts of districts such as Ntcheu, Dedza, Salima, Balaka and Mangochi (Monkey-Bay) are considered as part of Bwanje Valley in this study. Specifically, the sites that were visited include; Bawi (outside Bwanje Valley), Bilira, Kasinje and Kambewa Village in Traditional Authority (T/A) Ganya in Ntcheu district; Thyolera Village in T/A Kambwiri in Salima; Mtakataka in Dedza; Namkumba area (Malembo and Sauya) in Monkey Bay (Mangochi); and Khwisa in Balaka.

Ntcheu District is located at the southern tip of Central Region of Malawi. The district lies between longitudes of 34^0 24' to 34^0 58' east and latitudes of 14^0 23' to 15^0 20' south. It borders with Mozambique to the west, Dedza to the north, Mangochi to the northeast, Balaka to the southeast and Neno to the south, (Figure 1). The area of the district is 3,424 square kilometers, representing 3.63% of the total land area of the country. Ntcheu District is situated approximately 153 and 167km from Blantyre and Lilongwe (Ntcheu SEP 2017).

Ntcheu district has two distinct terrain patterns. The eastern side runs a stretch of a valley parallel to the Kirk Range called the Bwanje Valley. The valley has alluvial soils which are rich for agricultural production. The Kirk Range lies on the western side of the district. This is an upland area that lies along the Malawi-Mozambique border and extends from Tsangano to Lizulu. The highlands consist of uplands with an altitude varying between 1200 to 2000 metres above sea level. The topography is characterized by rolling slopes to hills varying between 13-55 degrees (Ntcheu SEP 2017).

Dedza District is located in the Central Region of Malawi about 86 kilometers South of Lilongwe City, the Capital City. It borders Lilongwe district to the north, Salima district to the North East, Mangochi district to the West and Ntcheu to the South (Figure 1). It covers a total land area of 3,624 sq. Km which is about 4% of the total land surface area (94,276 sq. Km) of Malawi (Dedza SEP 2013).

Dedza district is divided into three topographic zones: the Lilongwe Plain, Dedza Highlands, and the Escarpments. The Lilongwe Plains are in the northern and western parts of the district and lie at an altitude of 1100-1300 metres above sea level. The Dedza Highlands (Kirk Range and Dzalanyama Range) occupy the western part of Dedza Escarpments. The highlands consist of uplands with an altitude varying between 1200 m to 2200 m above sea level. The topography is characterized by rolling slopes to hills varying between 13-55 degrees. The soils in the lower escarpments (600-1200 m above sea level) and upper escarpments (700-1500 m above sea level) are moderately deep and well-drained, brown to reddish brown in colour and course to fine texture (Dedza SEP 2013).

Balaka District is located in the Southern Region of the Republic of Malawi. Ntcheu borders it to the northwest, Mangochi to the north, Machinga to the east, Zomba to the southeast, Blantyre to the south, and Neno to the southwest (Figure 1). The district headquarters is 201 km from Lilongwe, and about 127 km from Blantyre. The district covers an area of 2,193km^2 representing

2.4% of the total land area of Malawi. Balaka District is located in latitude $14^0$59‘15.38“S longitude 34^0 57‘22.23“E (Balaka SEP 2017).

Balaka District is on the eastern edge of the Great Rift Valley, hence has a varied topography ranging from an elevation of about 350 to 800 metres above sea level. The topographical features in the district comprise of ridges and natural drainage systems (Balaka SEP 2017).

Mangochi District is situated in the Southern Region of Malawi (at the Southern end of Lake Malawi). It entirely surrounds the eastern tip of Lake Malawi. The district shares boundaries with the following districts: Machinga in the South-East, Balaka, Ntcheu and Dedza in the South – West, Salima in the North and shares an international boundary with Mozambique in the East and North East (Figure 1). Mangochi District has a total land area of 6,273square kilometres which is proportionately 6.7 percent of Malawi land area (94,276 square kilometres). Mangochi District is approximately 200 Kilometers from Blantyre and approximately 320Km from Lilongwe via Liwonde (Mangochi SEP 2017).

Mangochi largely lies in the rift valley of the southern end of Lake Malawi. The land is punctuated by highlands and hills. The topography of Mangochi forms two distinct categories: the rift valley/coastal plains and the hilly-forested areas which rise above the plains. The hilly areas are found in the North-East running southwards which include Namizimu Forest Reserve and Mangochi hills while the western part consists of the Chilipa Plateau and Phirilongwe hills. In the eastern part of the district where Namwera is situated, the hilly areas rise above the undulating to flat plains where estates dominate the flat terrain. The western side is dominated by the flat plains but punctuated by isolated and a chain of hills (Mangochi SEP 2017).

Salima district is located in the Central Region of Malawi, 103 kilometres east of Lilongwe. The district covers total land area of 2,196 km², which represents 2.3% of Malawi’s total land area. It shares boundaries with Nkhota-kota to the north, Dowa and Ntchisi to the north-west, Lilongwe to the west, and Dedza and Mangochi to the south (Figure 1). The entire eastern part of the district borders Lake Malawi (Salima SEP 2017).

Figure 1. Map of Malawi showing Districts under study

2.2 Data Collection

Apart from using relevant published literature, documents, reports on sustainable land management covering the study area, the study employed field visitation, field observation, and key informant interviews within the study area. The key informants consisted of local leaders, Lead farmers and agricultural extension agents. Focus group discussion which were supposed to be part of the data collection method, were not done due to Covid 19 pandemic.

Field visitation was undertaken for field data collection after preparing clear protocols and guidelines for each component of data collection. The main components of field data collection in this case were instrument design and enumerator coaching. Each of these components was carried out based on best practices in field data collection. The research team therefore established clear channels for regular communication among entire data collection team to effectively collect quality data.

Observation is a data collection method by which knowledge of the researched phenomenon is gathered through making observations of the phenomena, as and when it occurs. Observation is way of gathering data by watching behavior, events, or noting physical characteristics in their natural setting. Observation is used in the social sciences as a method for collecting data about people, processes, and cultures. For a study of this nature, observation method was found to be suitable as it enabled good capture of the various landscape configurations. To provoke open discussion during Key Informant Interviews, overt observation was applied in this study as opposed to covert.

Key Informant Interviews are qualitative in-depth interviews with people who know what is going on in the community and their surroundings. Within the context of research on woody perennials – annual crop combinations, key informant refers to the person with whom an interview about a particular practice is conducted. The purpose of Key Informant Interviews was to collect information from a wide range of people including community leaders, professionals, or key players who have firsthand knowledge about the community practice. Key Informant Interviews in this study involved interviewing local leaders, lead farmers and extension agents as these were regarded as having a particularly informed perspective on woody perennials – annual crop combinations that were being evaluated within the Bwanje area and beyond. Key informant interviews were conducted as one-on-one assessments that allowed the data collection team to gain insight about the said landuse practice and the motivation behind the practice.

2.3 Data Analysis

Data analysis was heavily dependent on the researcher's analytic and integrative skills and personal knowledge of the social context where the data was collected. The emphasis was "sense making" or understanding a phenomenon, rather than predicting or explaining. As such, content and thematic analysis was applied to the collected qualitative data to generate sense or understand the phenomenon (Schilling 2006).

Content analysis is one of the most common methods to analyze qualitative data and in this study it was used to analyze gathered information from interviewees. Content analysis was used to

analyze content systematically on who said what, to whom, why, and to what extent and with what effect in a qualitative manner (Schilling 2006).

Thematic analysis involved working out the concept, thought, opinion or belief that was expressed by respondents. Thematic analysis is used in qualitative research and focuses on examining themes or patterns of meaning within data. This method emphasizes both organization and rich description of the data set and theoretically informed interpretation of meaning (Schilling 2006).

3.0 RESULTS AND DISCUSSION

3.1 Agro-ecosystems of the study area

The ecosystem in the study area has been influenced by both natural and anthropogenic factors such as fire, cultivation practices and charcoal production. These factors have had an impact on biodiversity and its occurrence in the area. Additionally, the anthropogenic influences have had an impact on the distribution of the woodland ecosystems in the area. For example, the current distribution of woody perennials in the area is a function of fire regimes and anthropogenic practices. Agricultural land takes up more of the land surface in the area than any other type of land use.

Most communities do practice the land use system of combining annual crops and woody perennial either by choice or by chance. The main annual crop in all districts visited was maize followed by groundnuts, rice, soya, tobacco, pigeon peas and cotton. Maize and cotton are managed by applying inorganic fertilizers, and pesticides and insecticides respectively and general farm weeding. Farming systems in the area has largely remained subsistence on ever-decreasing plots of lands with declining soil fertility. As a result of this retrogressive trend, frustration has set in amongst farmers as the system can no longer support farmers' diverse needs since these farming systems have become inadequate to cope with population growth that is experienced in the area. It has been argued that due to lack of investment in the farming systems, there are changes in agricultural production systems that are shifting from diversified cropping systems towards ecologically more simple cereal based systems. This shift is already contributing to poor diet and crop diversity (Khumalo *et al*. 2012).

The general agro-ecosystems/farming systems in Bwanje Valley and Bawi have largely remained the maize mixed farming and the rice-tree crop farming system to some extent especially in the Bwanje Valley. This system comprises of scattered small holder farms within the homesteads with mixed cereal-livestock systems including scattered indigenous and exotics tree species managed alongside the maize and other annual crops. In addition, maize mixed farming and agro-pastoral farming systems were observed to be practiced in the area. The livestock which are mostly on a free range type of grazing are allowed to graze on crop residues (maize stalks, rice husks and groundnuts residues) left on farm after harvest and woody perennials retained on farm.

3.2 Woody Perennials Retained on Farm in the Bwanje Valley

Woody perennials retained on farm in the Bwanje Valley are presented in Table 1. These woody perennials are retained on farm deliberately for different purposes in what can be described as traditional agroforestry system. As such the interaction between the woody perennials and annual crops is either neutral or positive. The woody perennials are managed alongside the annual crops to ensure that they don't compete with the annual crops thereby mitigating any likely negative interaction. In most cases these wood perennial are randomly distributed in the fields which is an indication that they have grown naturally in the farms where farmers, realizing their importance, have taken over management of them in association with annual crops grown. This is a common feature under traditional agroforestry system where spatial arrangement of woody perennial is not well defined. However, farmers have imposed certain management regimes on this system by

removing some trees growing on farm to create space for annual crops; and through farmer managed natural regeneration, to reduce competition and shading on annual crops.

Vegetation in Bwanje Valley is generally part of the Zambezian Phytoregion. The area falls within the tropical summer-rainfall zone with a single rainy season (November-April) and two dry seasons, a cool season from May to August and a hot season from September to November (Geldenhuys and Golding 2008). Annual rainfall ranges from 500-1500 mm, and is highly variable from season to season. Based on variation in rainfall and soils, three distinct forest types are observed in the Bwanje Valley. These vegetation types are important because of their floristic and substrate differences, namely; *Miombo* woodland, undifferentiated woodland and *Mopane* woodland (Geldenhuys and Golding 2008).

The traditional management systems in the tropics are a continuum of forestry agriculture in different forms; and these systems have been managed for millennia using existing traditional institutional frameworks that also take cognizance of the attitudes and local knowledge of the communities (Nair 1989). As such, it is argued that this is the reason why many governments in the tropics have adopted policies that promote community management of natural resources (Roe *et al.* 2009). However, governments have not considered the differences in people's attitudes in policies that promote agroforestry which has affected adoption rate despite the practice being around for ages. Agroforestry adoption will only improve once strategies to involve people in natural resources management recognize both positive and negative attitudes since communities are not homogeneous. Thus, the more strategies are developed to reflect local conditions and needs, the more agroforestry adoption will improve in most agro-ecosystems.

The most demanded tree species in all district sites within Bwanje Valley include *Faidherbia albida*, *Khaya anthotheca* and *Acacia polyacantha*. This is the case considering the uses of these species in agro-ecosystems as presented in Table 1. Nonetheless, positive and negative attitudes surround the sustainability of these species in these agro-ecosystems due to perceived gaps in the supply chain. There are perceived gaps in terms of seed regeneration for the wood perennials retained on farm. The demanded species may be regenerated either through seed of natural regeneration. Considering the mode of regeneration, it came out clear that supply of tree seed for these species is either low or nonexistent especially in those areas where the species are sought after.

Table 1. Woody Perennials Retained on Farm within Bwanje Valley and Bawi Area

Local name	Botanical name	Use	Distribution in the study area
Mango	*Mangifera indica*	Fuelwood, Food, Shade	Ntcheu, Dedza, Salima, Mangochi, Balaka
Msangu	*Faidherbia albida*	Nitrogen fixer, Fodder, Canoe making, Timber, Fuelwood, Apiculture, Medicine, Dye, Fibre, Soil biomass, Shade, Moisture retention, Crafts	Dedza, Salima, Mangochi, Balaka, Ntcheu
M'bawa	*Khaya anthotheca*	Timber, Water conservation, Fuelwood, Medicine, Moisture retention	Dedza, Ntcheu
Mthethe	*Acacia polyacantha*	Nitrogen fixer, Fodder, Fuel wood, Soil conservation, Land restoration, Timber, Medicine	Mangochi, Dedza, Salima, Balaka
Kesha wa milimo	*Senna siamea*	Nitrogen fixer, Fodder, Poles, Fuel wood, Shade	Ntcheu, Dedza, Salima, Balaka, Mangochi
Mphakasa	*Philenoptera violacea*	Soil enrichment, fuel wood, land restoration, food, Moisture retention, shade, fodder (browse)	Ntcheu, Dedza, Salima, Mangochi, Balaka
Gilisidiya	*Gliricidia sepium*	Nitrogen fixer, Fodder, Fuel wood, Poles	Ntcheu, Dedza, Salima, Balaka, Mangochi
Mthuthu	*Tephrosia vogelli*	Nitrogen fixer, Fodder, Fuel wood, Medicine	Ntcheu, Dedza, Salima, Balaka, Mangochi
Lukina	*Leucaena leucophala*	Nitrogen fixer, Land restoration, Furniture, Paper pulp,	Ntcheu, Dedza, Salima, Mangochi
Mlambe	*Adansonia digitata*	Food, Fibre, Shelter, Crafts	Ntcheu, Dedza, Salima, Balaka, Mangochi
Zinkhwambala	*Borassus aethiopicum*	Crafts, Ornamental, Food	Salima, Mangochi
Mfula	*Sclerocarya birrea*	Food, Medicine, Shade	Ntcheu, Dedza, Salima, Balaka, Mangochi
Nyeka, Nkolobwe	*Boscia salicifolia*	Fuel wood, Medicine, Poles, Soil biomass, Timber	Ntcheu

Local name	Botanical name	Use	Distribution in the study area
Neem	*Azadirachta indica*	Medicine, Fodder, Poles, Fuelwood, Shade, Timber	Ntcheu, Salima
Masawu	*Zyziphus mauritiana*	Food, Hedge, Crafts, Fuelwood	Ntcheu, Dedza, Salima, Balaka, Mangochi
Mkolong'onjo	*Combretum imberbe*	Poles, Fuelwood, Medicine, Crafts	Ntcheu, Dedza, Salima
Chitimbe	*Piliostigma thoningii*	Medicine, Fuelwood, Poles, Crafts	Salima, Dedza, Ntcheu, Mangochi, Balaka
Mtanthanyelere	*Senna petersiana*	Medicine, Fuelwood, Poles	Ntcheu, Dedza
Mtangatanga	*Albizzia lebbeck*	Poles, Medicine, Fuelwood, Crafts, Shade, Soil fertility, Fodder	Ntcheu, Dedza, Salima
Muwale	*Erythrina abbysinica*	Medicine, Shade, Moisture retention	Dedza, Ntcheu

3.2.1 Woody Perennials Regeneration

Woody species in the study area are generally naturally regenerated. Woody species have both vertically and horizontally extensive root systems, which facilitate recuperation after being cut. These extensive root systems tend to produce root suckers and coppices once the aboveground parts are removed. Natural regeneration associated with coppicing has been reported mostly in Malawi. Chirwa *et al* (2015) also reported that assisted natural regeneration is used in forest restoration in Malawi. Pollarding is also a common practice in Bawi and Bwanje Valley especially for trees on the farmland. Another approach actively promoted is farmer managed natural regeneration (FMNR). This is common in Bawi and Bwanje Valley where farmers select and protect regenerating trees of their choice and density based on their interests.

In areas where clear cutting is for permanent agriculture, tree regeneration is through roots or coppices. Subsequent management would be through selective thinning for poles and timber in the long term. The 'nicking' of the cut edge will encourage sprouting from the stump (Lowore and Abbot 1995), while deep ploughing is said to increase the stocking rate by causing root suckers to develop (Chidumayo *et al.* 1996).

3.3 The traditional tree legume-based system (*Faidherbia albida*)

Bwanje Valley as an agro-ecosystem has for centuries thrived on the versatile and resilient *Faidherbia albida*. For many years farmers have retained a low density of trees in their

farmlands or two-tiered systems in order to improve the yield of understorey crops (Akinnifesi *et al*. 2008). Traditionally farmers grow crops under scattered trees of *Faidherbia albida*, including the albida/maize system in southern and central Malawi. *F. Albida* has a unique characteristic of shedding most of its leaves during the wet season and resuming leaf growth during the dry season. This makes it possible to cultivate under its canopy with minimum shading effect on the companion crop. Substantial benefits are realized from these practices as resource-use by trees and associated crop components rarely overlap. The cultivation of crops under canopies of F. *albida* is the most notable of such traditional agroforestry practices in the Bwanje Valley in Malawi (Garrity *et al*. 2010). The optimal combination of trees, crops and livestock – is helping small holder farmers understand how to benefit from the myriad ways in which the diversity of species and life forms that nature offers.

However, current tree density for *Faidherbia albida* on farm within the Bwanje Valley is declining at a significant rate due to various factors including pressure for wood for curing fish and for making canoes including charcoal production. In the absence of restocking through seedling regeneration, Bwanje Valley risk losing all its *Faidherbia albida* population. Most of the woody components in agro-ecosystems occur naturally long after years of selective management and mismanagement by farmers. Farmers decide which tree species to retain on farm due to multipurpose uses and allied products. Those retained are mostly woody components that have multiple uses in a wide range of needs including fire wood, poles, soil nitrogen fixing, fodder, medicine, crafts and others. Small holder farmers' decision to manage certain trees on farm is also based on the recognition of ecological services which woody components such as *Faidherbia albida* play in the nutrient cycle for crop production including moisture retention in the agro-ecosystem.

However, despite the high preference for *F. albida* by farmers in the Bwanje Valley and Bawi agro-ecosystems, the species is under great threat by canoe or boat makers who select large diameter trees with huge boles for felling to suit their need. These huge trees are the best seed dispersers for sustained natural regeneration and their removal is a threat to species perpetuity in the agro-ecosystem. Farmers within Bwanje Valley have acknowledged that the perceived threat to the species will likely affect productivity of Bwanje Valley agro-ecosystem in the short to medium term if no technical and social interventions are introduced in the area.

3.4 Socio-ecological management of trees in traditional agroforestry systems

Trees on farm in Bawi and Bwanje Valley are the human dominated agro-ecosystems under small holder management system. Findings in the study site have shown that conversion of woodlands to farm lands brought some disturbances to ecology of Bawi and Bwanje Valley. The findings indicate that disturbance if properly managed creates a conducive environment for some key species which are light demanding and require maximum exposure to sunlight (Chirwa and Mala 2016). Thus, in a state of abundance resource, systems that provide a livelihood like charcoal production and slash and burn agriculture may be the necessary evil (disturbances) that enhance the establishment and development of the regeneration pool of the woody perennials on

farm. Within the study area, provision of human and animal food is particularly important during the peak of the long dry season as livestock are left to browse on farm after harvest. Consequently, these rural communities feel insured within their agro-ecosystem even in the driest part of the year since the system has been naturally designed to support people's livelihoods and further enhanced through imposed management prescriptions on selected species for priority products and services such as fodder production and soil fertility management.

The study found that there are more indigenous tree species than exotic tree species (Table 1) in the study area that are retained on farm. Few tree species (exotic) are deliberately planted while the majority of the species (indigenous ones) are managed within their natural habitat to improve their productivity. Among the most important indigenous tree species include *Acacia nilotica* and *Faidherbia albida* while *Gliricidia sepium, Tephrosia vogelli* and *Leucaena leucocephala* are the exotic agroforestry species. While the woody perennials and annual crop combinations have made minimal increment to maize yield, optimum yield is yet to be realized from these agro-ecosystems. In addition, the effects of woody perennials with their green fertilizers on maize yield vary widely, generating debate on their usefulness for raising maize productivity and strengthening food security (WAC 2009). Under this system the production risk with respect to maize yield is therefore lower in farms with woody perennials (green fertilizer) than in those under conventional farmers' practice. As such, the hard reality facing smallholder farmers in Bawi and Bwanje Valley is the urgent need to develop the best option for replenishing soil fertility as quickly as possible. This calls for incorporation of organic manure in these agro-ecosystems alongside the woody perennials for synergistic effects.

Several exotic and indigenous tree species are regarded as important fodder tree species in Bawi and Bwanje Valley. The indigenous tree species cited as being widely used for fodder include *Acacia nilotica* and *Faidherbia albida* while exotic tree species used as fodder include *Leucaena leucocephala*, *Gliricidia sepium* and *Tephrosia vogelli*.

3.5 Drivers of land degradation in the study areas

The changes in Bawi and Bwanje Valley agro-ecosystems are mostly driven by population growth and demography, agricultural expansion and energy needs. These direct activities are closely linked to policy, market and institutional failures that undervalue forests and woodlands, and overvalue the benefits of destroying them to make way for other forms of land use (Chirwa *et al.* 2015). As such, degradation of the agro-ecosystems in the Bwanje Valley due to human activities has been associated with massive loss of nutrients, fauna, flora and productive ecosystems. Land tenure arrangements and associated equity issues are a major threat to the sustainable use of land resources in Bawi and Bwanje Valley. The customary land tenure system is the most widespread, in which individual property rights are weak. Hence, poor land and tree tenure in the area has likely encouraged over-exploitation. Consequently, the remaining village forest areas face increasing pressure, particularly in response to high population growth rates and increasing poverty.

Subsistence communities often have no choice but to rely heavily on wood as fuel and wild plants, small animals and other resources that natural forests and woodlands provide. Fuel wood is one of the primary sources of energy for domestic use and processing (curing tobacco, drying fish) throughout the Bwanje Valley. Within the study area, a high number of people owe their livelihood to the charcoal industry. In fact, the whole southern and central Malawi is virtually devoid of forests characterized with few remaining state-owned forests. Those few trees retained on farm in combination with crop production (Kambewa *et al.* 2007) are also threatened by exploitation. Large tracts of woodlands are being converted to either agricultural fields or abandoned charcoal production sites. Croplands, abandoned fields and fallow at various stages of present recovery form a typical mosaic landscape in Bwanje Valley. Mosaic landscapes, to some extent, has affected the spatial integrity of most of the woodlands in the study area. This is because when converting woodlands to agriculture, not all trees are cleared and, as a result, cultivated land is often dotted with trees such as *Adansonia digitata*, *Sclerocarya birrea* and *Faidherbia albida*.

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

The findings of this study provide a synopsis of associations between annual crops and woody perennials on farms in Bawi and Bwanje Valley. Most communities do practice the land use system of combining annual crops and woody perennial either by choice or by chance with maize as the main annual crop followed by groundnuts, rice, soya, pigeon peas and cotton. The woody perennials are retained on farm deliberately for different reasons in what is known as traditional agroforestry system whose interaction is either neutral or positive. The most demanded tree species within Bwanje Valley include *Faidherbia albida, Khaya anthotheca* and *Acacia polyacantha* considering their multiple uses, products and services that they provide. Nonetheless, the sustainability of these species in the agro-ecosystems is so much dependent on the positive and negative attitudes of the people regarding regeneration and their production potential.

The study has found that the ecosystem in the study area has been influenced by both natural and anthropogenic factors such as fire, cultivation practices and charcoal production which have had an impact on biodiversity and its occurrence in the area. Bwanje Valley as an agro-ecosystem has for centuries thrived on the versatile and resilient *Faidherbia albida* under small holder management system. Findings in the study site have shown that conversion of woodlands to farm lands brought some disturbances to ecology of Bawi and Bwanje Valley which may have facilitated the annual crops and woody perennial combinations on farms. This is evident through the higher number of indigenous than exotic tree species retained on farm.

The changes in Bawi and Bwanje Valley agro-ecosystems are mostly driven by population growth and demography, agricultural expansion and energy needs. These direct activities are closely linked to policy, market and institutional failures that undervalue forests and woodlands, and overvalue the benefits of destroying them to make way for other forms of land use. It is obvious that subsistence communities often have no choice but to rely heavily on wood as fuel and other resources that natural forests and woodlands provide. Such being the case, within the study areas, a high number of people still owe their livelihood to the charcoal industry.

4.2 Recommendations

Lack of investment in the farming systems has brought changes in the agricultural production systems that are shifting from diversified cropping systems towards ecologically more simple cereal based systems which is already contributing to poor diet and crop diversity. It is imperative that crop diversity is promoted within agro-ecosystems so that different products and services are derived from such ecosystems.

Agroforestry adoption has been generally slow even after centuries of practice because strategies to involve people in natural resources management through agroforestry have failed to recognize existence of both positive and negative attitudes among heterogeneous communities that practiced it. National policies promoting agroforestry need to consider the differences in people's

attitudes when designing strategies to accelerate agroforestry adoption so that they reflect local conditions and needs of a particular agro-ecosystem.

Small holder farmers' decision to manage certain trees on farm such as *Faidherbia albida* and others is motivated by the desire to increase yield of annual crops more especially the staple maize. However, there is production risk with respect to maize yield which tends to be lower under this system (maize under *F.albida*) than in those under conventional farming. As such, the hard reality facing smallholder farmers practicing agroforestry across all landscapes is the urgent need to develop the best option for replenishing soil fertility as quickly as possible by incorporation of small doses of inorganic fertilizers and substantial amounts of organic manure in these agro-ecosystems for synergistic effects and high yields.

Land tenure arrangements and associated equity issues are a major threat to the sustainable use of land resources in Bawi and Bwanje Valley because customary land tenure system is the most widespread and individual property rights are weak. To ensure that land and tree tenure in these areas are not subjugated, farmers should take advantage of the new customary land laws to have their land registered to enforce land ownership and enhance property value.

Large tracts of woodlands are being converted to either agricultural fields or abandoned charcoal production sites. Cropland, abandoned fields and fallow at various stages of recovery form a typical mosaic landscape in Bwanje Valley and beyond. Mosaic landscapes affect the spatial integrity of most of the woodlands in the study area and other parts of the country and as such, a suitable management regime to these landscapes should be designed to enhance their restoration rate.

An understanding of the trade-offs and strategies by which communities attempt to develop sustainable livelihoods should provide policy makers with a better platform from which to tackle food security and poverty reduction for sustainable development in mutually reinforcing ways so that the role of woody perennials in agro-ecosystems are appreciated.

Technical gaps exit in the way traditional Agroforestry is managed by communities which raises sustainability concerns of the practice. Technical capacity in terms of regeneration means, positive combinations for annual crops and woody components, including overall management is therefore required for both extension workers and farmers to ensure that the productivity of the system is improved for greater gains.

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