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REVIEW ARTICLE

Role of Agroforestry on Farmland Productivity in Semi-arid Farming Regions of Zimbabwe

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Abstract: Farmland productivity is low in the semi-arid regions (NR IV and V) of Zimbabwe due to desertification and land degradation. Nevertheless, demand for food is increasing geometrically hence the need to increase output per unit area. Agroforestry (AF) which is an ecologically based and dynamic system that integrates multi-purpose trees on farms can increase productivity and offer resilience to climate change vagaries. However, the role of AF in Zimbabwean smallholder farming systems is still not well investigated. Therefore, this review explores the role of agroforestry on agricultural productivity in the semi-arid regions of Zimbabwe. The aim was to enhance sustainable food security among the rural poor through sustainable agriculture. Incorporating multi-purpose trees on agricultural lands can significantly restore soil productivity and offer soil resilience to erosion by water and wind. If well implemented, the AF can be a viable option in mitigating the impacts of drought on agriculture in these drier and marginalized areas.

Keywords: Adoption; Crop productivity; Drought; Low fertility; Multi-purpose trees

1. Introduction

The geometric increase of human population in sub-Saharan Africa (SSA) indicates an increased food demand against a reducing agricultural landscape. The human population in the SSA region is projected to increase by 60% in the next 23 years, overtaking growth in the agricultural sector [1]. National food production is projected to increase in the near future however, the response to demand is unlikely to keep pace [2]. This calls for improved food production methods that can

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sustainably yield high per unit area. Currently, the average yield for most crops is less than 0.5 t·ha^{-1} which could have been further reduced due to the recurrent droughts [13]. This has a negative impact on food security [3]. Low crop productivity is a persistent problem among the smallholder farmers in SSA [4].

Crop productivity in the region is poor due to poor crop management and declining soil fertility [5]. Zimbabwe is among the SSA countries experiencing continuous food shortages because of many reasons e.g poor agronomic practices, poor crop and variety selection in some agro-ecological areas, climate change which are exacerbated by an ailing economy. At farm level, mismanagement of soil fertility contributes more to the low crop productivity and reduces the farmers' abilities to guarantee their own food security [3]. Therefore, without practical food production innovations, the SSA will depend on food imports for food security.

Zimbabwean small-scale farmers rarely apply plant nutrients that are required for crop growth [4] because they do not have money to buy expensive inorganic fertilizers. The most limiting nutrients in the smallholder crop land are nitrogen and phosphorus because the soils are highly leached and acidic [6]. Inadequate nutrient supply and nutrient mining in the communal cropping land has caused high levels of soil degradation in many Zimbabwean soils [7]. Marginalized farming areas (natural region IV and V) have more challenges which are compounded by low rainfall (<650 mm per annum) [4]. In Zimbabwe, the marginalized semi-arid regions fall into two agro-ecological zones (NR) that are NR IV and NR V [8]. The NR IV is characterized by annual rainfall that ranges between 350 mm~650 mm, and is suitable for semi-intensive farming systems like livestock and drought resistant crops. Whereas the NR V which is drier than IV receives an annual rainfall ranging from 400 mm~600 mm and favours semi-extensive farming e.g. cattle ranching. The largest (approximately 84%) of Zimbabwean farming areas can be classified as marginalized (NR III, IV and V) for crop production (Figure 1). Soils found in the NRs IV and V are described as granitic sandy and are characteristically low in organic matter (<2% soil organic carbon) and nutrients content, hence continuous cultivation without nutrient replenishment will rapidly degrade these soils [7].

The Zimbabwe agro-ecological classification was done long ago, and has been used for more than 50 years to date. The classification does not consider the smallholder and communal farming areas and possible boundary changes that may have occurred between the NRs due to climate change and variability. Interestingly, the classification criteria rely on the mean annual rainfall and exclude the effective rainfall this may complicate planning and implementation of the cropping programmes [10]. Factoring the effective rainfall received in an area, a larger proportion of Zimbabwe can be classified as marginalized with poor crop yield under conventional agricultural production systems. Contrastingly, the majority of the Zimbabwean communal farmers are located in these marginalized regions suggesting that a large number of people are vulnerable to food shortages in the country. Over half the Zimbabwean population (57%) are in the communal areas and at least three-quarters of this population lie in natural regions IV and V, where dry-land cropping is risky at best [10]. Communal areas are characterized by small land (< 1 ha) ownership and this creates pressures on the land resulting in high rates of soil erosion which reduce the land value. Many communal areas in Zimbabwe lack infrastructure such as irrigation facilities hence most affected and vulnerable to climate change and extreme weather conditions which further exacerbate low agricultural productivity [11].

Agroforestry involves the intentional growing of perennial woody-trees species together with crops. The woody-trees species are incorporated to promote either the biological functions or increase the economic return of the farm, or both [6]. A healthy agro-ecosystem should be beneficial to humans through provision of goods and services at various scales of production [18]. This usually involves the lateral flows e.g., water and sediment constituting the physical part of the nesting [3]. The effective control of these lateral flows can improve soil moisture availability by more than 30% water holding capacity especially in dry farming regions since water is the most immediate, direct and visible resource in such systems [26].

The agroforestry practices may enhance crop productivity in different ways e.g. promoting high soil nutrition through planting of nitrogen-fixing woody trees species between rows of annual crops [5]. The biomass from the trees can also be harvested and used as green manure. The trees can also simultaneously reduce soil erosion e.g Mutua *et al*. [27], observed a general decrease in soil loss in Arenosols from 0.51 t·ha^{-1} to 0.2 t·ha^{-1} under no-AF and with AF respectively. Agroforestry significantly reduced water loss by >50% and was noted to protect crops against pests as some trees can deter pests. Other benefits of AF are provision of shade for crops which can increase yield and quality in thigmotropic and shade loving crops e.g coffee, increase soil organic carbon (>2%) resulting to modification of the biological, physical and chemical soil properties [2]. Growing of leguminous trees with high biomass production on highly unstable Lixisols in Zimbabwe was observed to improve physico-chemical soil properties [1] (Table 1). In a study by Bharati *et al*. [5]

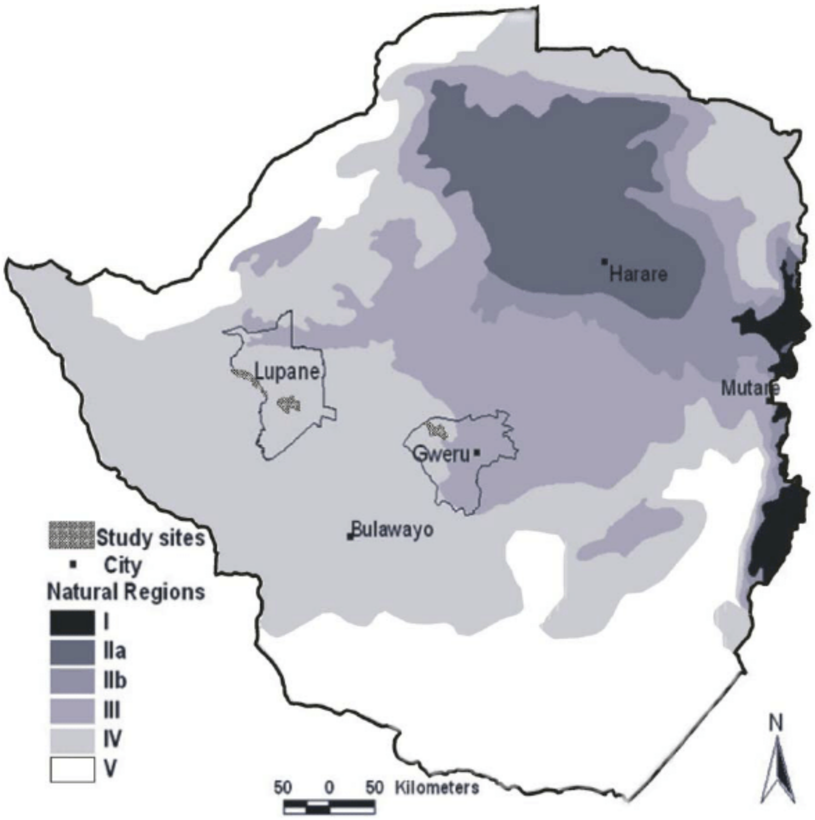

Figure 1. The natural farming regions (NR) of Zimbabwe [9]

the soil organic carbon (%), mean weight diameter (mm) and soil water storage (mm) were significantly improved under agroforestry systems compared to the conventional crop production systems (Table 1). Hence, incorporation of the perennial woody-trees species in an agroecosystem can change both its physical structure and the flow and retention of nutrients in the system [5].

Agroforestry can increase soil and crop productivity, and provide economic benefits to the farmers under different climatic zones [12]. Besides, the agroforestry practices can modify the farming ecology which can be more important than the potential agricultural and economic ben-

Table 1. Effects of time and different agroforestry systems on the soil organic carbon (SOC), mean weight diameter (MWD) and soil water storage (SWS) in Lixisols, Zimbabwe

		Time (years)						
Agroforestry system	**Soil property**	**1**	**2**	**3**	**4**	**5**	**6**	$LSD_{0.05(CS\times T)}$
Improved fallow	SOC (%)	0.46	0.82	1.3	1.8	2.1	2.4	0.4
	MWD (mm)	0.32	0.48	0.53	0.63	0.64	0.68	0.08
	SWS (mm)	19.3	25.2	35.5	36.8	37.9	39.1	1.1
Alley cropping	SOC (%)	0.46	0.76	0.89	1.1	1.4	1.5	0.11
	MWD (mm)	0.32	0.41	0.49	0.54	0.60	0.62	0.06
	SWS (mm)	19.3	23.5	27.5	33.2	35.2	36.1	1.3
Rotational woodlots	SOC (%)	0.46	0.79	1.2	1.7	2.0	2.2	0.3
	MWD (mm)	0.32	0.47	0.52	0.61	0.63	0.66	0.08
	SWS (mm)	19.3	24.8	29.8	35.6	36.8	37.2	1.2
Conventional	SOC (%)	0.46	0.45	0.39	0.38	0.40	0.41	0.3
	MWD (mm)	0.32	0.30	0.31	0.29	0.27	0.26	0.07
	SWS (mm)	19.3	20.1	19.6	19.3	18.4	17.8	1.3

**Conventional= growing annual crops without trees. Data adapted from FAO [1].*

efits from the system [3]. These ecological benefits lie in that inclusion of woody-tree species on farmlands which changes the physical structure, bio-diversity, and general functioning of these systems, transforming them into natural ecosystems than traditional farmlands that excludes trees. For instance, agroforestry can change the structure and function of agroecosystems e.g comparison of two types of coffee cultivation which are "shade coffee" and "sun coffee" [11]. However, the role of AF in enhancing agricultural productivity in dry and marginalized areas has not been well quantified since very few studies on this were done. Considering the continuous decline in crop productivity in the marginalized crop land (NR IV & V) of Zimbabwe, non-conventional crop production systems e.g. agroforestry are required. This paper presents a comprehensive review and discussion of the: (1) adoption of agroforestry technologies and practices in Zimbabwe, (2) describe the benefits of agroforestry inclusion in the dry regions of Zimbabwe, and (3) provides an insight on some challenges in adopting agroforestry in the dry areas of Zimbabwe.

2. Agroforestry and Biodiversity Conservation

Higher biological diversity enhances agro-ecosystem stability and productivity, unfortunately, the simplification of farmland is a major factor of biodiversity loss and this reduces the provisioning of an ecosystem [3,15]. The AF promotes the farmlands to create environmental, economic and social benefits, through combining high agricultural and biodiversity goals. The diversification of tree species can reduce seasonal variation in the provision of goods and services and thereby protect farmer incomes [4]. Agroforestry farmlands are characterized by diversity both within (intraspecific diversity) and among trees (interspecific diversity) which can enhance the farm productivity as a whole [21].

Agroforestry systems can be classified and traditional or modern depending on the designs involved (Tables 2 & 3). The traditional AF systems like home gardens and shifting cultivation (Table 2) perfectly mimic the natural ecosystems and provide a variety of niches and resources that support a high diversity of plants and animals [13].

The traditional agroforestry systems are ecologically sustainable and diversify the livelihood of local communities hence are considered as excellent tools for biodiversity conservation [4,26]. Whilst the modern agroforestry systems (Table 3) is characterized by sets of standalone technologies that together form various land use systems in which trees are sequentially or simultaneously integrated with crops and/or livestock [21].

Table 2. Traditional agroforestry systems in Zimbabwe

Agroforestry system	Description
Shifting cultivation	There are fallows that are composed of multi-purpose trees with high biodiversity in them; There are intense inter-and-intra-species interactions; Normally long periods of 15-20 years enhance wild species diversity.
Forestry gardens/agro-forestry	It is characterized by high species diversity that is similar to the natural forestry though it may include a few carefully managed economically value tree species.
Trees on farmlands	Characterized by more inter-and intra-species diversity at the landscape level rather than at field level.
Parkland systems	A variety of field crops are grown together with naturally propagated tress to enhance species diversity.
Home-gardens and compound farms	Are characterized by high inter-and intra-species diversity of many fruit trees, fodder, food crops, timber trees, medicinal and other plants of economic value to the farmer.

Table 3. Modern agroforestry systems in Zimbabwe

Agroforestry system	**Description**
Improved fallow	Mainly based on mono-tree species e.g. fertility improving tree species.
Fodder banks	It is characterized by a sole stand of either shrubs/leguminous trees or high biomass producing grasses. It is a less diverse system.
Hedgerow intercropping/ alley cropping	There are few tree species involved that are planted in alternating rows.
Tree based intercropping system	It is less diverse as single species are planted.
Rotational woodlots	They are established using a sole stand of fast-growing tree species for short-cycle harvest.

The modern AF technologies are generally developed using only a few selected tree species which are often mono-tree species systems, with high yielding, fast grown nitrogen fixing trees and arboreal structure in the communal areas of Zimbabwe. This suggests that the modern AF technologies reduce farm diversity and hence are vulnerable to pests. In Africa, the AF have prevailed despite persistent attempts to focus on monocropping of annual crops [12].

Understanding that trees on farms provide livelihood benefits is not new though the practical use and adoption of this system are relatively low [14]. In light of the recurring food shortages and projected climate change, the adoption of agroforestry can be a panacea to the effects of climate change on agricultural production in many parts of Africa [20].

3. Adoption of Agroforestry

3.1 Farming System and Practice of AF in Zimbabwe

The bio-diversity within agroforestry can increase crop productivity and enhance resilience to climate change. Nair *et al*. [3], concluded that mixed farming which combines wood-tree species with annual crops and/or vegetables can improve the farmland productivity. For instance, integration of crops such as coffee and rubber with trees, or in forest mosaics was observed to increase production by at least 30% compared to monocropping [13]. Cocoa production was increased by 15% when shade-trees were included in the plantations compared to a single stand of cocoa crop. Besides, their direct positive influence on yield and quality, the multipurpose trees can also provide timber, non-timber products like fruits, honey, mushrooms and other products and ecosystem services at landscape levels [25].

Agroforestry can be effective in land reclamation, mitigation of climate change as trees can sequester carbon from the atmosphere and secure rural livelihoods through provision of ecological and economic benefits [11]. In addition of leguminous trees such as *Acacia tortolis* and *Adenanthera pavonina* were noted to build the soil healthy and fertility and this could be very useful in the smallholder farming areas of Zimbabwe since more than 72% of the land is characterized by inherently infertile soils [14]. Crop production is low in such soils due to the low fertility therefore incorporation of the leguminous trees in the cropping systems will enhance productivity. The multipurpose trees can also provide ecosystem services and functions which are essential for environmental sustainability. However, the role of wood-trees species on farm productivity is still marginalized among the small-scale farmers in Zimbabwe and has received scant attention [23]. This could be explained by the low adoption of agroforestry practices among the farmers regardless of some successful agroforestry stories. The low uptake of AF practices could be due to reasons related to the performance of these AF practices, the political and socioeconomic environment or simply farmers' disposition towards trees on their farms [15].

Parwada *et al*. [14], noted a low level of adoption in agroforestry technologies such as biomass transfer, improved fallow and soil fertility improving trees among communal farmers in Buhera, Zimbabwe. The major barriers to adoption were the lack of support through public policies for example poor seed policies, limited knowledge about the agroforestry and that agroforestry benefits are normally realized after a long period of time. In Zimbabwe, agroforestry is excluded in recommendations for ensuring food security under climate change policy [24]. Fortunately, some practices and technologies e.g. in Tables 2 & 3 showed to be beneficial for rural development, buffer against climate variability, assist rural farmers adapt to climate change and mitigation to climate change [12].

In Zimbabwe, the largest proportion of the community prefers to grow annual crops usually without trees because they believe the trees have a negative effect on their crop e.g shading resulting in poor crop growth [14]. The staple crops and non-food cash crops are grown in the tree-cleared main fields, and vegetables grown from small gardens usually along perennially flowing rivers. Fruits either come from wildly growing trees or planted trees around the homesite [3]. A common practice on the communal farmlands is the clearance of trees within the field but few farmers may leave few sparsely spread indigenous fruit trees in their fields. This clearly shows that there is low biodiversity in the communal farming lands of Zimbabwe and this could contribute to their low productivity hence food insecurity among the farmers. The farmers may keep livestock for the provision of inputs. The farmers usually apply manure in their fields every 4 to 5 years, where the multi-purpose trees are grown, the leaf litter will be the source of fertilizer. Organic manure is the most appropriate type of fertilizer in areas low (<2%) in organic carbon like the communal lands in Zimbabwe.

3.2 Agroforestry Systems in the Zimbabwean Communal Areas

The common agroforestry systems in Zimbabwe are mostly not by farmer's desire rather by default with a few systems that have been intentionally designed [14]. Although agroforestry is an ancient practice, it remains unpopular among most farmers in Zimbabwe [1]. Generally, there are four agroforestry systems identified in Zimbabwe, which are systems centered on (a) main fields (b) grazing areas (c) small garden plots and (d) home sites and home fields [3]. Management of the agroforestry systems involves two major strategies that are the growing of exotic trees around home sites and in gardens, and the selective conservation of indigenous trees (mainly fruit trees) in main fields and grazing areas [12]. Nevertheless, there is very little information about management of indigenous trees among the communal farmers as there is no care given to these trees. However, the farmers are encouraged to diversify plants in their farms as this promotes crop productivity compared to monocultures. Trees can occupy all the niches available in ecosystems, enabling the plants to be more effective in use of growth requirements such as soil nutrients, light and water [1]. The agroforestry trees can indirectly enhance crop productivity e.g by host pollinators required to pollinate cash crops such as butternut.

Intraspecific diversity within species enhances ecosystem functioning by increasing soil productivity and stabilizing the plant populations [15]. The intraspecific diversity has been utilized and tree improvements through breeding have been done for forest trees, but very little improvements have been done to get ideotype agroforestry trees species that can suit particular areas [1,3,12]. In planning an agroforestry system and capturing the production-enhancing niche approach, species suitability maps should be developed to analyze the distribution of different tree species, including locally available trees suitable for different ecological conditions [5]. Nevertheless, research is still required in the designing of agroforestry systems that minimize negative interactions between the trees and annual crops and provides multi-benefits to the farmers. Currently, the selection of agroforestry tree species is done without considering their interactions with the major crops on farmers' fields (and vice versa) [23]. The interactions should be considered if sustainable productivity increases for the entire system are to be realized.

Indigenous tree species still remain a distinctive feature of some farmlands in Zimbabwe but no planted trees are found in the main field area [3,16]. The trees are usually left primarily for their beneficial services such as fruits and shade. This agrees to Matata *et al*. [28], who recorded about 80% edible fruit trees in the main fields of communal farmers in Tanzania. This could explain the noted insignificant decrease in abundance of fruit trees even in the most deforested areas of Zimbabwe [14,16]. However, Bharati *et al*. [5], also recorded trees with non-edible fruits on farmlands and this showed that the trees may have other uses besides the provision of fruits. These trees (*Combretum imberbe, Kirkia acuminata, Colophospermum mopane*) are used for shade. Some trees are for social significance e.g. the *Parinari curatellifolia* which are often used as meeting places and others have medicinal and/or spiritual significance to the farmers e.g. *Kigelia africana* and *Pseudolachnostylis maprouneifolia*.

Numerous multi-purpose trees can be used to improve soil and crop productivity in marginalized areas of Zimbabwe through improvement of soil fertility e.g *Tephrosia vogelli* and *Faidherbia albida* and moisture conservation [12]. A study by Du Toit & Campbell [16], showed that some multi-purpose trees had a positive influence on soil fertility and crop yield among the communal farmers in Zimbabwe. However, the role of these trees in soil amelioration and crop production was somewhat controversial, as the effects were observed to be greatly modified by rainfall received in a particular area per any given season [17]. The trees could influence crop growth and productivity in many ways e.g through modification of fertility, light, moisture around the crop and foci for animals [5]. Some farmers have since recognized these positive effects of including trees on farmlands and have restricted the application of fertilizers under the canopy (Table 4). Growing of trees together with maize was observed to gradually increase the maize yield with time under different agroforestry systems (Table 4). The maize grain yield was increased by an average of more than 30% in year 1 to year 6 of practicing agroforestry (Table 4). These results confirm to Nair *et al*. [3] and Rahn *et al*. [15], who also noted a gradual increase in maize grain yield with time under an improved fallow with *Calliandra calothyrsus*. The fertility and crop yield benefits of agroforestry practices may however need not to be generalized and the growth performance of the trees in an agroforestry system influenced by climate and soil characteristics in a particular area. Therefore, further research is required to quantify the effects of these trees on crop and soil productivity in particular climatic zones.

Table 4. Effects of time and different agroforestry systems/cropping systems on maize grain yield ($t \cdot ha^{-1}$) under smallholder farmer management

Agroforestry system	Time (years)					
	1	**2**	**3**	**4**	**5**	**6**
Improved fallow	0.51	0.62	1.2	2.5	2.7	2.9
Alley cropping	0.40	0.53	0.84	0.96	1.4	1.6
Rotational woodlots	0.50	0.61	1.0	1.8	1.9	2.1
Conventional	0.9	0.8	1.0	0.9	0.85	1.2
$LSD_{0.05(CS \times T)}$			0.5			

*CS = cropping system, T = time, **Conventional= growing annual crops without trees*: *Data obtained from FAO* [1]

Planted or retained trees in grazing areas can modify the soil status either directly, through the use of litter for composting or indirectly, by their effects on the productivity and size of the cattle herd which influences higher quantities and better-quality manure production [16]. The indirect effect occurs largely because many dominant trees in the grazing areas can provide good browse e.g the *Julbernardia globiflora*, *Colophospermum mopane* and *Terminalia sericea*. Besides browsing, the savanna trees were found to enhance nutrition in grasses, to increase soil infiltration rate and moisture content, decomposition rate and the content of extractable P, N and organic matter in the soil by 2-5 times as compared to open areas [15,17]. In this regard, agroforestry can improve crop productivity in dry areas such NR IV & V of Zimbabwe by modifying the soil hydro-properties. Hence, food security can be achieved in these drier regions if the agroforestry can be promoted in these regions. Briefly, agroforestry can reclaim the soil fertility, reduce erosion rates by increasing the organic matter content of the soils, fix N and recycle nutrients in these marginalized areas. The AF can conserve both quantity and quality of soil water through increased infiltration and less surface runoff. Agroforestry can reduce the rate of climate change through C sequestration in soils and in the woody biomass. Thangata *et al.* [25], concluded that the total C in a silvopastoral system varied between 4 68 - 204 t ha^{-1}, with soil storing the most C and the annual C increments varying between 1.8 to 5.2 t ha^{-1}. Suggesting that if well designed and managed agroforestry can be effective in reducing climate change in many parts of the world [15].

The inclusion of nitrogen-fixing trees e.g. *Acacia angustissima, Gliricidia sepium, Sesbania sesban* and *Calliandra calothyrsus* or deep-rooted trees and shrubs, increases N availability through biological-N-fixation (BNF), nutrient pumping from deeper zones and addition of soil organic matter. Barrios *et al*. [19], concluded that tree roots can fix 1049 kg C ha^{-1} to 3304 kg C ha^{-1} and 41.5 kg N ha^{-1} to 133 kg N ha^{-1} which are sufficient for health growth of many tropical crops. Low soil fertility is one of the major factors affecting crop production among the smallholder farmers in Zimbabwe. The average crop yield continuously declined due to poor soil fertility and limited moisture in the NR IV and V (Figure 1). Many farmers in these semi-arid regions are poor and cannot afford to purchase fertilizers therefore integrating multi-purpose trees together with the annual crops can be a sustainable solution to the low fertility problem. Nevertheless, there is limited research on the N availability under different agroforestry systems in Zimbabwe however, most conclusions are generalized. This suggests that the information on the effects of these agroforestry systems on crop yield can also be general. Therefore, it is prudent to quantify the available N fixed by a specific agroforestry system under specified environmental conditions as the N availability can be influenced by factors such as the inorganic soil N or aerobic N mineralization at 0 cm to 20 cm depth. Crop yields were noted to be significantly higher under the N fixing trees than under other tree species or grass fallow [15].

4. Importance of Agroforestry

4.1. Water Supply and Water-Use Efficiency

The agroforestry systems can be used to secure water supplies (quantity and quality) especially in drier farming regions but it is the least researched service function of agroforestry [28]. The trees can influence water cycling by intercepting the rain, increase transpiration and water retention in the soil, retards runoff and promoting infiltration. Barrios *et al.* [19], observed that infiltration in areas under maize or soya was five times less than under riparian strips cultivated with a variety of plant and tree species. This suggests that trees had a much higher potential of limiting surface runoff thereby reducing the rate of contaminating substances reaching water bodies. In addition, the trees in agroforestry can conserve soil nutrients by reducing their loss through leaching [20,3]. Therefore, agroforestry can reduce ground water contamination by agrochemical residues such as nitrate and other substances that are harmful to the environment and human health. This is in agreement to Nair *et al.* [13], who noted that the micro-watersheds with agroforestry systems covering a large percentage of the soil surface had high quality water compared to non-agroforestry systems.

4.2 Economic Benefits of Agroforestry

The agroforestry can enhance the on-farm profitability among the smallholders. It promotes higher and more diversified income flows among the farmers from the sale of AF products and services [21]. Many studies on agroforestry have shown the benefits to farm profitability among the smallholder farmers in Africa [22,25]. Planting specific shrubs in fallow for two years and then cutting them back before growing maize for two to three years increased maize yields by more than 50% compared with planting continuous unfertilized maize [3]. Livestock farmers can grow fodder shrubs for their animals which can increase production such as milk production by replacing relatively expensive purchased dairy meals thereby raising the farmers' income [23]. Agroforestry systems may pose specific challenges to farmers, however, if these constraints are removed, resource-conserving the agroforestry can sustain agricultural intensification by regulating ecosystem functions [22,19]. Trees can create a microclimate around crops e.g by reducing temperature and increased humidity that buffers the effects of water stress caused by droughts and high rainfall variability thereby increasing crop productivity in SSA particularly in Zimbabwe.

5. Conclusions

Agroforestry provides a myriad of benefits such as soil fertility improvement, increasing soil water holding capacity, reduction of runoff and creation of microclimates that enhances crop productivity in the semi-arid regions. Agroforestry in its many manifestations is a scalable option for improving farmers' incomes, food and nutrition security with co-benefits for the sustainable delivery of ecosystem services and the environment. Nevertheless, the roles of agroforestry on farmland productivity are still unclear among the smallholder farmers in Zimbabwe. There is a need for integration of local ecological knowledge with sciences to further strengthen the usefulness of these agroforestry systems. The AF can be used as a fundamental tool to increase farmland productivity and offers resilience to climate variability and other hazards, thus reducing production-associated risks among the smallholders farmers in Zimbabwe. It is however important to note that the performance of an AF system is site specific and there is need for research to quantify the effects of various AF systems on soil and crop productivity in different agro-ecological regions.

Conflict of Interest

There is no conflict of interest.

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