Agriculture in Dambos Around Mzuzu City, Malawi; a Sustainability Assessment

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Abstract

This paper concentrates on the examination of existing agricultural systems in dambos around Mzuzu, Malawi. The paper connects onsite investigations conducted in the summer of 2008 and a review of related works. This paper looks at the contemporary agriculture practices and comments on their socioeconomic and biophysical negative impacts. It examines the dependence of farmers on a system that continuously drains the little money they have as well as continuously degrading the natural environment, decreasing productivity and affecting their food security and subsistence. The paper also discusses the ecological importance of dambos and the services they provide. It also comments on how keeping their integrity intact and using sustainable agricultural practices are in the best interest of the farmers and those who surround the dambos.

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Limitations to agriculture in Malawi

Assessing Agricultural Sustainability in Dambos, Mzuzu City, Malawi

A reality faced by 800 million people in our world is their inability to obtain an adequate and secure supply of food year round (The Food and Agricultural Organization of the United Nations [FAO], 2003). One untapped resource with the potential to partially alleviate this burden may be found in the plethora of wetland areas located in Sub-Saharan Africa. Research to date indicates only 1.3% of the 135 hectares of wetlands found in Sub-Saharan Africa is under cultivation (FAO, 1998). Ecologically wetlands are fragile and provide important benefits such as purification of water, an especially important aspect affecting human health if wetlands are located close large populations. The UN-HABITAT (2001) reports that the percentage of urban residents in sub-Saharan Africa is expected to rise from 34 to 46 percent of the total population by 2020. Malawi is one of the least urbanized but is also one of the fastest urbanizing countries in Africa; at a rate three times the global rate and nearly twice the rate of other African countries. (Global Environment Report 3 as cited by UN-HABITAT, n.d.) To add to the stress, according to UN HABITAT's State of the World's Cities 2006/2007 Report, close to 90 percent of these urban dwellers live under slum conditions. (UN- HABITAT, n.d.) If cultivation is to continue or even increase in existing wetlands, sustainable management of these lands is critical (FAO, 1998; Chirwa, 2007; Harou, 1995). Further, any destruction of wetlands could result in adversely affecting the amount of labour and costly inputs required to grow crops. The adoption of more sustainable techniques by urban farmers could have benefits to the environment, to the longevity of the land and to the health and economic sustainability of the population.

The implementation of positive practices by farmers cultivating wetlands around Mzuzu City, Malawi could have substantial impacts on the livelihood of the farmers and the

sustainability of the land. In the northern city of Mzuzu, wetlands (known in Malawi as dambos) surround the city; people utilize the dambos for agricultural cultivation. There is very little support given to these urban farmers either economically or educationally; most education programs tend to focus on rural farmers. Urban farmers do not appear to get the same access to subsidies and educational support because it is believed that those living in urban areas are less poverty stricken. However in reality, within the boundaries of Mzuzu city, farmers living there are quite impoverished. They generally rely on subsistence and have to spend the little income they do have on purchasing inputs.

There have been some efforts made in Malawi to combat the current problems of environmental degradation being faced today. Examples of sustainable techniques that have been applied to create more sustainable agriculture systems include Permaculture (Nordin, 2005; Thornton, 2008) and pond-crop systems (Kapanda, Matiya, N'gong'ola, Jamu, & Kaunda, 2005; Noble, n.d.). Such agriculture systems can have ecological and economic benefits for the farmers involved. There is an additional potential in encouraging farmers to provide examples of successful sustainable techniques and their benefits and building a possible asset for surrounding rural farmers.

A Review of Related Work

The author lived in Malawi for four months in 2008; the following is gathered from personal observations, as well as from a review of relevant literature.

Malawi

The 'Warm Heart of Africa' is a fitting name bestowed on the friendly and enchanting country of Malawi (UNDP, n.d.). Many say Malawi has been 'spoiled by peace' in that it has not experienced many wars or tribal clashes in recent decades, and has enjoyed general political stability. Situated in south eastern Africa, Malawi is a truly beautiful country, with a relatively pleasant sub-tropical climate. Malawi includes Lake Malawi, the ninth largest fresh water lake in the world, and a diverse topography of plateaus, rolling hills and mountainous highland. It is rich in under-utilized natural resources, with the capacity for year round cultivation as well as 600 edible localized indigenous foods documented variously by Nordin, 2005; Williamson, 2005; Hirt & M'Pia; 2001; FAO, 1988, as cited in Thornton (2008). However, Malawi is one of the world's least developed countries and experiences constant bouts of food insecurity, famine and malnutrition; it has a twelve percent prevalence of HIV/AIDS (UNAIDS, 2008; Food and Nutrition Technical Assistance, 2001). The country is landlocked and approximately 118 000 square kilometres in size, with about 14 million people, making it one of Africa's most densely populated countries. The quality of life is poor; according to the Human Development Index, Malawi has dropped from 138th place in 1990 to 165 out of 178 countries (Chinsinga, 2007; UNDP, 2008). Approximately 65 percent of Malawians live below the poverty line and are unable to feed themselves. Peters (2006) explains that the first step to combat the poverty and to avert famine is by ensuring adequate and affordable food. The Food and Agriculture

Organization (FAO) links the food security of a country with a sustainable level of food production (FAO, 1998).

Agriculture in Malawi

Agriculture holds huge importance for Malawians; not only is it responsible for one-third of the Gross Domestic Product (GDP) and 90 percent of its export earnings, but also it is the source of livelihood for about 90 percent of the population (UNDP, n.d.; Government of Malawi [GoM], 2002). Between 85 to 95% of Malawians are subsistence farmers, relying on agriculture for their daily food intake (Ministry of Agriculture [MoA], 2005). Many cultural, social, economic, political and environmental elements have contributed to the current agricultural system in Malawi. During time spent in the country the author observed numerous mechanisms and developed an understanding of practices which contribute some responsibility for the current reality. The traditional diet affects the biodiversity in Malawian gardens; it does not vary widely. It is typically composed of *'nsima'*, currently made from maize, vegetable relish and a small portion of meat. This influences and limits the variety of crops grown. About three quarters of the daily caloric intake comes from maize, the staple crop, which Thornton (2008) attributes to the high rates of under-nutrition. Thornton also cites recent estimates by Sauer, Tchale & Wobst, (2006) and Peters (1999) that indicate maize comprises 90% of Malawi's cereal production and is being cultivated on 70 to 80% of the arable land in Malawi.

Agriculture is such an important part of the culture that children are taught about agriculture in primary schools. For example some of the objectives for the curriculum of a standard 5 class are "to develop a positive attitude towards agriculture, apply appropriate agricultural methods to food, cash crops and animal production, apply knowledge and skills in food preparation and preservation and nutritional values and utilize and conserve natural

resources."(Ministry of Education [MoE], 2000). Thornton (2008) explains that "contemporary agricultural practices combined with increasing land pressure have left Malawi's soil eroded and unhealthy, its forests degraded, and the land prone to drought and flooding, contributing to further food and nutrition insecurity." Chinsinga (2007) observed that food insecurity has plagued the lives of Malawians in both urban and rural areas for decades.

Reasons for the food insecurity are debated, many (Stambuli, 2002; Oxfam, 2002; Lambrechts & Barry, 2003 as cited by Chinsinga, 2007) blame the liberalization of the agricultural sector sponsored by the International Monetary Fund (IMF) and the World Bank. However, even more controversial are the variety of views about solutions that could bring an end to Malawi's food insecurity. Many people, including Jeffery Sachs, former director of the United Nations Millennium Project, believe providing agricultural inputs and government subsides is the way to alleviate the food security issues (Thornton, 2008). Others believe that this type of system extends Malawi's insecurity. Kristof Nordin of Never Ending Foods, a Permaculture project in Malawi, argues that dependence on inputs is unsustainable and further contributes to environmental degradation while still leaving Malawians' food insecure (Thornton, 2008).

The traditional agricultural system in Malawi, influenced by worldwide trends for a modernist approach, has shifted to a contemporary input-intensive type of agriculture. The current agricultural system appears dependent upon inputs such as fertilizers, hybrid seeds and pesticides. Several researchers (Simtowe, 2006; Chiva, 2005; Cromwell et al., 2001 as cited in Thornton, 2008) have identified the active part played by the Government of Malawi in encouraging this agriculture. It has been promoted and spread "through provision of input subsides, support of integrated rural development, and funding of research and extension

services" (Thornton, 2008). The use of fertilizers has been quite consistent throughout the population for years. The Ministry of Agriculture (MoA) has supplied major agricultural subsidies; in a July 2008 interview with the author, Steve Sibande, Extension Officer, MoA, stated that for that year approximately 1.7 million families were targeted for the subsidies in 2007; this increased to 3.4 million families for 2008. He also communicated Ministry calculations that about 70% of the population uses fertilizers. This results in huge financial costs for Malawi farmers. Pilirani Semu-Banda underlined this burden in his article about Malawi, part of the International Federation of Environmental Journalists news series on sustainable development. "Chemical fertilizers cost up to 11 dollars for a 50 kilogram bag - a hefty expense in Malawi, where over 65 percent of people live below the poverty line of a dollar a day, according to the United Nations Development." (Semu-Banda, 2007). Munthali (2007) also points out "the Malawi Government policy encourages use of inorganic fertilizer. Use of chemical fertilizer has been advocated for many years to replace the depleted nutrients. Unfortunately the use of fertilizer is becoming impossible especially for smallholder farmers due to increase in prices. Most of smallholder farmers are poor and unable to buy inorganic fertilizers."

Farmers also use pesticides and non regenerating hybrid seeds. Using the example of hybrid seeds, the Ministry of Agriculture and Irrigation explains the problems associated with the input market; the liberalization policies have facilitated seed imports and privatization of seed companies and because of lack of market monitoring, the prices of seeds have escalated and even sub-standard seeds have been sold. (MoA, 1999). Maize, the most common crop grown, is a very nutrient demanding crop (Snapp and Pound, 2008) and the use of hybrid seed, or 'high-yielding varieties', tend to flourish only with the use of fertilizers and irrigation (Shiva, 1991). However,

increasingly more inputs are being required. As explained by Douglas et al. (1999) “across the country, the maize [both hybrid and native species] response to fertilizer has declined, for example, in Lilongwe District it has fallen from an average of 23 kg (local) maize per kg of nitrogen to 13 kg per kg of nitrogen.” (as cited by Munthali, 2007, 532) This has huge effects on the subsistent families who are now dependent on inputs. The price of these inputs will most likely continue to fluctuate in price especially with the continued increasing oil prices. Aside from the government promoting hybrid seeds, pesticides and chemical fertilizers, there is prominent commercial interest in selling these inputs with promotions and advertising encouraging input purchasing.

The types of contemporary agriculture practices in Malawi have many associated negative health environmental and economic consequences. For example pesticides can have adverse health and ecological impacts through water and soil contamination or digestion of chemical residue left on crops. (Niering, 1968) More than five years ago, Gondwe stated that this agricultural system had led to serious soil degradation and the decline in soil fertility was then considered to be a major constraint in crop production (Gondwe, 2001). Munthali points out a continuing situation in “the depletion is a consequence of continuous growing of crops on the same piece of land and in most cases without rotation or fallowing leading to severe nutrient depletion.” (Munthali, 2007). Nordin (2005) as cited by Thornton cautions that monocultures along with the external input dependency have led to high risks of food insecurity and crop failure (Thornton, 2008).. Other practices such as the slash and burn method, where people burn organic matter instead of recycling the scrapping back into the soil (Munthali, 2007 and Thornton, 2008), also contribute to depleting soil quality. Soil degradation was seen as the most

serious environmental issue in the most recent state of the environment report for Malawi (MoFFEA, 1998).

Ecological Value of Dambos

Wetlands, called dambos in Malawi, are lands that have been utilized by many for agricultural land and have much potential for improving food security (FAO, 1998). It is noteworthy that dambos are of a slightly different nature than major wetland systems and as such Harou (1995), among others, believes they have potential for agriculture to meet the food demands of growing populations. Brinkman and Blokhuis (1986) define dambos as "areas that have free water at or on the surface for at least the major part of the growing season. The water is sufficiently shallow to allow the growth of a wetland crop or of natural vegetation rooted in the soil". In their natural condition, wetlands supply numerous ecological and socio-economic products, services and functions to local communities. Such important attributes include flood control, erosion control, sediment and toxicant retention, nutrient retention, biodiversity and many products can be extracted from wetlands such as fish, wildlife, water supply and agricultural resources. Koohafkan, Nachtergaele, & Antoine **(**1998) discovered that many dambos around Africa are already in use by small scale farmers, but as pointed out by the Food and Agricultural Organization of the United Nations (FAO) they are still very fragile eco-systems and need to be managed sustainably (FAO, 1998; Chirwa, 2007; Harou, 1995). Kabii (1998) further explains "the 'sustainable use' of a wetland, refers to the 'human use of a wetland so that it may yield the greatest continuous benefit to the present generation while maintaining its potential to meet the needs and aspirations of future generations." According to the FAO, the sustainable management of these lands should include "the maintenance of integrated and diversified production systems, [which] would avoid un-planned intensification and further

encroachment on more fragile wetland ecosystems." (FAO, 1998). Both Durgan (1990) and Roberts (1988) highlight the negative consequences that can be felt immediately by local people, such as loss of functions in food control, water purification and shoreline stabilization resulting from dambo misuse.

Mzuzu, Malawi

Mzuzu is the main city in the North of Malawi. It is substantially less developed than either Blantyre or Lilongwe (the two main cities in the south). Around the City of Mzuzu, Malawi, there are seven city-owned dambos, each has portions under cultivation. Within the city boundaries of Mzuzu there live very impoverished, subsistence farmers. There has been relatively little research done regarding the agriculture and health of the dambos of Mzuzu City. The farmers do not own the land on which they cultivate. According to Jansen (2006) and FAO (n.d.), land tenure can affect the type of agriculture practices use by farmers. Being set around an urban area, these dambos are potentially exposed to many pollutants and toxins other than just agricultural by-products as other dambos. Chinsinga (2007) observed that these types of lands are especially utilized in winter months as well as in drought times because of their moist qualities Chinsinga (2007).

Sustainable Possibilities

The degradation and loss of wetlands is more rapid than that of other ecosystems, making them particularly fragile. (Millennium Ecosystem Assessment, 2005). Many ecological services are provided by the dambos to farmers, therefore it is in their best interest to maintain the health

of these dambos. There has been some research on improving the productivity and sustainability in dambos through measures such as composting or reusing or recycling organic matter. “Organic manure releases nutrients slowly, reducing the risk of leaching and improves soil water retention and microbial activities that greatly contribute to nutrient recycling in different cropping system.” (Parr, 1986 as cited by Munthali, 2007, 534). Another method is provided through pond-crop systems. These systems integrate fish farming with agricultural and “may enhance cultivation of marginal lands; recycling of crop residues as pond inputs, use of fishponds as water catchments points for irrigation, processing of crop waste and livestock waste into fertilizer and control water supply thereby reducing floods.” (Kapanda et al. 2005; Noble, n.d.). Permaculture is not specific to any area but is rather based around certain concepts. Permaculture aims at a holistic approach which include things such as;

> “adapting agriculture to local environments and optimizing the use of local resources including plants, animals, soils, water, and human labour, reducing the dependency and use of external and non-renewable inputs to reduce damage to the environment and toxicity in humans; animals and the ecosystem as a whole, maximizing the use of renewable resources (e.g. solar), recognizing, appreciating, and building upon indigenous knowledge and incorporating this knowledge with science and technology, empowering local communities to control, manage, and benefit from natural resources and valuing the role that agriculture plays in affecting the environment and ecosystem, and committing to an agricultural system that positively and sustainably integrates all of the goods and services that nature provides.” (Adapted from Chavez-Tafur, et al. 2006, p. 5; Mollison, 1997 as cited by Thornton, 2008, 8)

There are many sustainable systems that can have ecological and economic benefits for the farmers involved. Altieri (2005) provides an in depth look into the science behind sustainable agriculture. Keating (n.d.) explains that understanding the biophysical systems influences the type of agricultural system adopted by farmers and the FAO being explains being able to sustainably management agriculture systems, especially in dambos, “depends largely on people's ability to understand and wisely use the many interactions (social, physical, hydrological,

chemical and biological) which ultimately determine the functions of a wetland." (FAO, 1998) Proper education and knowledge is thus an important part to promoting sustainable agriculture.

Organizations Involved in Agriculture

Since agriculture is a dominant aspect in the Malawian experience, naturally there are many different types of organizations that are involved in agricultural efforts, many of whom promote sustainable forms of agriculture in one way or another. FAIR is an organization that aims to promote the 'ideals that conserves agroecology', whose works focuses on rural farmers (FAIR, n.d.). Catholic Development Commission in Malawi (CADECOM) also has efforts with agriculture trying to improve food security and nutrition (Diocese of Mzuzu, n.d.). There is also a thriving Permaculture Network in Malawi, which promotes creating gardens that have "the conscious design and maintenance of agriculturally productive ecosystems, which have the diversity, stability and resilience of natural ecosystems" (Never Ending Foods, n.d.). It is actually also in the mandate of the Ministry of Agriculture and Irrigation to promote the use of compost, manure, intercropping and other such sustainable techniques along with the use of inputs, however as previously discussed fertilizers and hybrids have been also heavily promoted (MoA, 1999). There are also many church groups and women's guilds that have made efforts. Many of these organizations even have regional offices based in Mzuzu city, however, the majority of Malawi's population is involved in rural subsistent farming and most supports and resources for agriculture are focused towards rural farmers. Urban farmers do not receive the same support (or even access to subsidies).

Investigating Mzuzu Dambo Farming Practices

There is little research available which examines agriculture in urban Mzuzu. The purpose of the research was to examine the type of agriculture being practiced in the dambos around Mzuzu, Malawi and to assess its sustainability and impact both biophysically and socioeconomically; more specifically:

1. To discover if the farmers in the urban dambo areas around Mzuzu, Malawi practice the same input intensive agriculture as the majority of other Malawians.
2. To assess the sustainability and the impact of current agriculture on the lives of these urban farmers, both biophysically and socioeconomically.
3. To comment on the potential benefits of targeting these individuals to promote sustainable agriculture.
   .

Research Methods

An initial background analysis was performed to complement the field research to arrive at a better understanding of the current situation in Malawi. The analysis included literature research, personal experience, interviews with local farmers and interviews with organizations such as the Malawi Ministry of Irrigation, Malawi Ministry of Agricultural, FAIR, Never Ending Food (permaculture) and other agricultural organizations.

On-site interviews. During the month of July 2008 on site interviews were conducted with farmers to collect specific information about garden operations. Interviews following the proven successful techniques in research by Taboulchanas (2000 and 2001) and Chaplowe (1996). Within each interview, surveys (Appendix B) were completed to document information such as the demographics of the participants, the biophysical nature of individual gardens, the choice of crops, the agricultural techniques and inputs used, factors and limitations to choices as well as the farmer's knowledge about the effects of different agricultural techniques.

Target areas and process. The focus area of research was on the seven main dambos that surround Mzuzu City. Starting the last two weeks of July 2008, a research team targeted one specific dambo each day and conducted interviews at as many farms as possible, time and weather permitting. The team started from the most accessible point of the dambo and continued through the dambo. If a substantial part of the dambo had not been covered, it would be targeted the next research day. The research was mainly conducted in the mornings for this is the time when the majority of farmers were found in their fields. 45 surveys were collected over the course of the weeks. The number of surveys completed each day depended upon the number of people present and upon access to the dambo. The survey was written in English, the official language in Malawi, however not all participants speak fluent English. The interviewers were Amanda Klarer, Golden Msilimba and Cohen Sichinga. The survey questions were directly administered by the researcher in an interview format. The reason for this process was to ensure participation, results and in many cases translation of English to Tumbuka, the local language in Mzuzu. The parameters relating to sustainable agriculture are based on the principles of agroecology (Altieri, 1995), permaculture theory (Thornton, 2008) and the sustainability of social, environmental and economic systems. The survey was comprised of both open and closed ended questions. Where possible, the questions posed included the option to respond with further elaborations.

Participants. The particular group of farmers was chosen because of the impact and cascading effects from their inputs and agricultural methods on the sustained health of their land, the surrounding environment and their livelihoods. It was important to understand the characteristics and context of the farmers interviewed, therefore the survey included a series of questions pertaining to the demographics of the subjects. Following from information gathered in

initial investigations, it appeared that a large portion of the people in Mzuzu was not native to the area and had migrated from neighbouring districts. Therefore people were questioned if and from where they migrated and why they migrated to the city. In addition, information about their occupation and source of income was requested in order to draw connections to the importance and dependence on agriculture and reasons for participating in agriculture.

Biophysical and Socioeconomic Indicators

Interviews and surveys were designed to gather information and statistics on a number of specific aspects of urban farmers' practices in the dambos.

Labour and land tenure. To look at the labour intensity of the agricultural practices, information concerning the number of people participating and the types of techniques and watering technologies were collected. A sense of ownership to the land and desire to invest in its longevity could contribute to the types of practices used. For this reason the participants were asked who owned their land even though the city actually owns all the land cultivated by all these farmers.

Garden specifics. The size of a garden can affect the inputs used, labour required and resulting productivity (Chirwa, 2005) therefore the garden size in hectares was documented.

Choice of crops. The type and variety of crops grown in a garden can change the quality and stability of the soil, type and quantity of inputs used and the amount of labour required. For this reason the farmers were asked to list all of the crops they had grown over the last three years. In order to understand some of the inputs and selling features underlying why certain crops are grown versus others, a table was developed to record information about each crop grown in the gardens and their associated successes, uses and inputs. For each crop listed, the participants were also asked to list when each of them was planted, the approximated yield in kilograms,

whether it was consumed at home or was sold, whether crops were sold in the field or in the market and whether the crop was irrigated and fertilized.

Inputs and techniques. The farmers were asked about the types of agricultural techniques and inputs used on the gardens. This information was sought out in order to understand the economic contribution they have to make, via input purchasing, as well as the amount of labour that goes into the gardening. It was also asked to understand the environmental impact of their agricultural practices.

Knowledge about agricultural techniques and their implications. To assess the existing knowledge about sustainable techniques they were questioned about belonging to any clubs (agricultural and other) and to comment on the advantages and disadvantages of that association. To test their knowledge about the impacts of different gardening techniques and inputs, they were given a list of sustainable and unsustainable techniques (chosen according to principles outlined by Altieri, 1995 and Thornton, 2008) and were asked to identify which they thought would not degrade the quality of their soil and would help keep your soil fertile year after year.

Any known limitations. The farmers appear to be faced daily with the issues associated with farming in the urban dambos; they were asked open ended questions about any limitations they believe existed for people practicing urban agriculture in that area.

Research Sample

Participants In total 45 farmers were surveyed from seven dambos (Table 1) around Mzuzu city, Malawi.

Table 1 *Distribution of surveys collected throughout dambos*

Dambo	**Number of collected surveys**
Chasefu	5
Chingambo	13
Chiwavi	5
Geisha	4
Kangano	6
Luwinga	3
Lyangwa	9

Table 2 illustrates the extent of participants' migration from other districts; the main being Mzimba and Chitipa. Only one participant was actually from the Mzuzu area.

Table 2 *Home districts of farmers interviewed*

Home district	**Number of farmers**
Mzimba,	17
Chitipa	11
Rumphi	3
Karonga	2
Nkhotakota	2
Balaka	1
Chirafanlu	1
Dowa	1

Kasungu	1
Machise	1
Mtwalo	1
Mzuzu	1
Nkhata Bay	1
Nkhorongo	1
Ntchisi	1

The most common reason for migrating to Mzuzu was for their employment; as was the case for 18 of the people and another 10 migrated in the hopes of finding employment. Six women moved because of their husbands' work, five farmers inherited land in Mzuzu and another four farmers retired or settled in the urban area.

Demographics. The age of the respondents ranged from 18 to nearing 80 years old and almost half the participants were between the ages of 21 to 40. Of the 45 people surveyed, 64 percent (29 people) were male and 36 percent (16 people) were female. Being in an urban area, many of the farmers had additional occupations (Table 3). There were clear divisions based on gender. The women did not classify themselves as farmers; over two thirds (10) of the women classified themselves as housewives

Table 3 *Occupation of farmers divided by gender*

Occupation	**number of men**	**number of women**	**total**
farmer	10	3	13
housewife		10	10
student	5		5
business women		3	3
brick layer	2		2
security guard	2		2
builder	1		1
city assembly	1		1
garden boy	1		1
Lunyangwa Research Station employee	1		1
MTL employee	1		1
Nicholas construction company employee	1		1
Sacramento employee	1		1
self employed	1		1
youth worker	1		1

Three women considered themselves farmers (two of whom were widowed) and four women were business women. In terms of income, only the three business women were potentially earning income independent from their husbands' salary and income from the sale of the crops grown in their garden. Ten men were farmers only, five men were students and the other 14

occupations varied greatly from brick layers, security guards, teachers to being a worker at the Lunyangwa Research Station. Table 4 illustrates general income sources of the participants.

Table 4 *Income of farmers divided by gender*

Income	**Number of men**	**Number of women**
Formal employment	13	
Only produce	6	7
Piecework	5	
Pension	4	
Another person's salary	1 (student supported by elder who works as boarding mother at the Church of Christ)	6 (husband's salary)
Self		3

Only 6 of the men depended solely on income generated from the sale of their crops, four had pensions, five men performed casual piecework and one was a dependent student. 13 people interviewed (all male) had formal employment.

Research Findings

Reasons for farming. When questioned about the reasons for participating in urban agriculture, 39 farmers indicated it was to generate income. Food security was the next commonly responded reason and then followed by subsistence. Health and environment were of little consideration to the farmers (Figure 1). However less than half (19 farmers) indicated that the food they grow in their garden is sufficient to meet their household consumption needs.

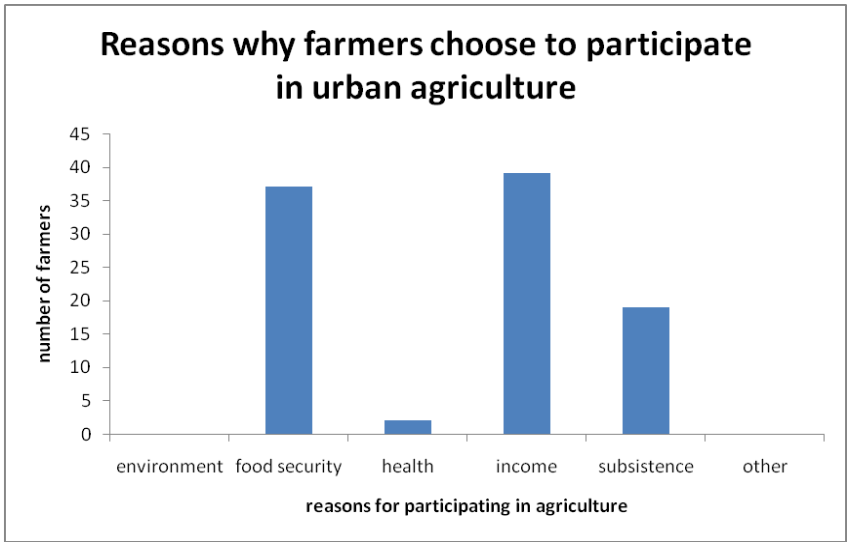

Figure 1. *Why farmers chose urban agriculture.*

Participants were asked to chose one or more of the options given; subsistence, income, food security, health or environment. The participants were also given the option to suggest other reasons. Additionally, it was far more common for people to be selling their produce from their field rather than from the market (Figure 2).

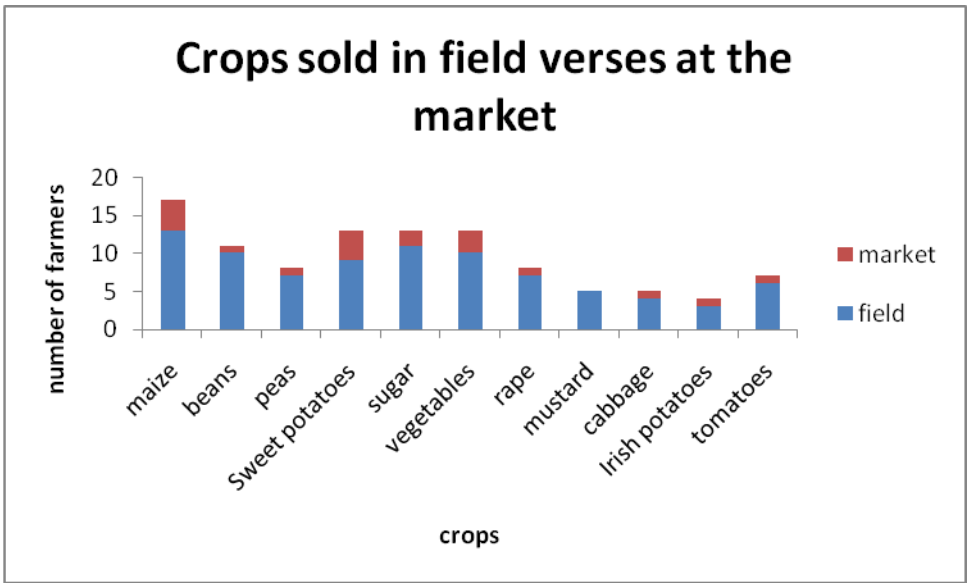

Figure 2. *Crops sold in the field versus at the market*

The gardens are mainly family run, with on average two people maintaining the garden, but ranging from one to seven people. There were 16 gardens maintained by only one individual, two gardens had a hired worker and two other gardens were run by clubs with between 10 to 26 members. Three of the interviewees belonged to clubs, two of which were horticulture clubs; one where land is shared and the other which is more of a collective where everyone still has their own separate plots. Advantages of being part of a club discussed by the farmers included having access to knowledge sharing system and the potential to get money. However, the club participants indicated that the funds were very limited and therefore the clubs were not very successful. Another individual indicated that not being part of a club was a disadvantage because he doesn't have ownership over a plot.

Land tenure. Within the study 18 farmers believed they owned the land, 17 others claimed it belonged to other individuals and only 10 were aware the land belonged to the city. Traditional means was the most commonly identified way land was said to be attained among the farmers and eight people said their land was inherited from family members. Six people were aware that the land was given to them by the city and is still owned by the city and another 4 people claimed they got their land from the city but they are now the rightful owners of the land they cultivate.

Garden size. The majority of the plots were smaller than 0.4 hectares, but ranged from between 0.05 hectares to 5 hectares (Table 5). The three largest plots were 1 hectare, 2.4 hectares and another belonging to a chief that was 5 hectares.

Table 5 *Size of the gardens*

Size of garden (hectares)	**Number of gardens**
0.0-0.19	16
0.20-0.39	12
0.40-0.59	9
0.60- 0.79	4
0.80- 0.99	1
1.0- 5.0	3

Experience in farming. Due to inconsistencies in interviewing, only 6 respondents were asked how long they had been cultivating the land. The responses ranged from a couple months to 50 years, however the majority responded 2 to 5 years.

Research Findings – Crops

Crop variety and concentration. The most commonly planted crop is maize. Every farmer listed maize as a crop except for one farmer who had just started cultivating the land months prior, but had plans to grow maize. The next most common crop was beans, which was grown by about two thirds of the farmers of the participants, followed by peas, then sweet potatoes and sugar cane. Thirteen of the farmers did not grow 'vegetables', cabbage, rape, pumpkin leaves, champiru or mustard (the most common crops used to make traditional vegetable relish). Figure 3 illustrates the range of crops and number of farmers growing each.

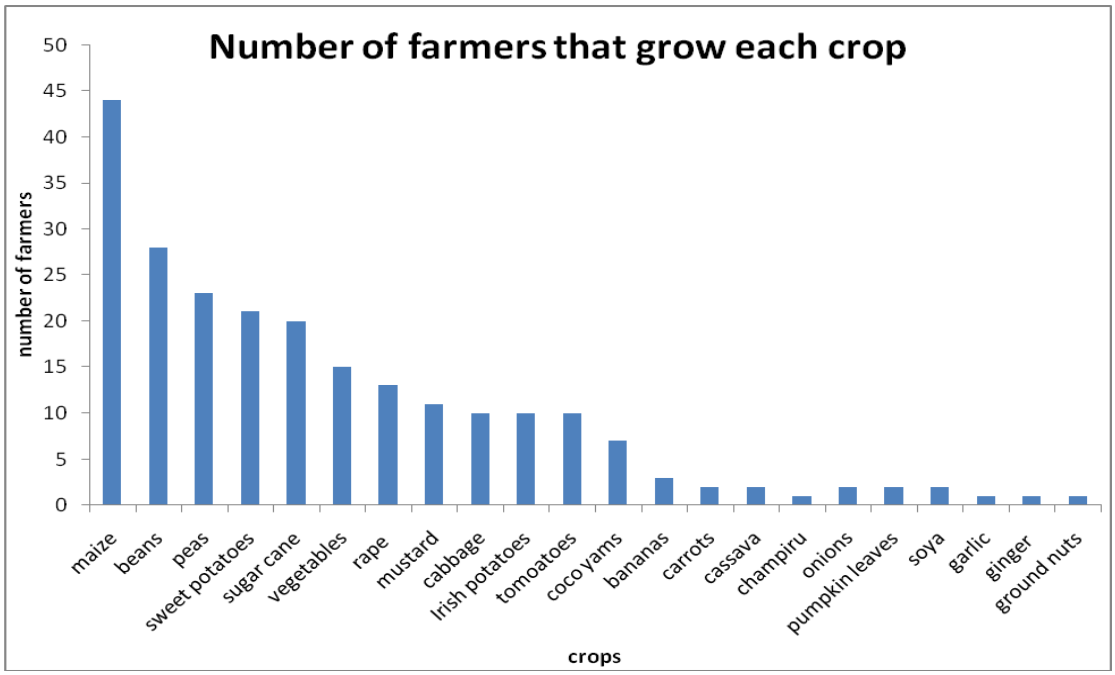

Figure 3. *Number of farmers growing each crop*

Note: The word 'vegetable' is generally used to refer a green leafy plant such as pumpkin leaves.

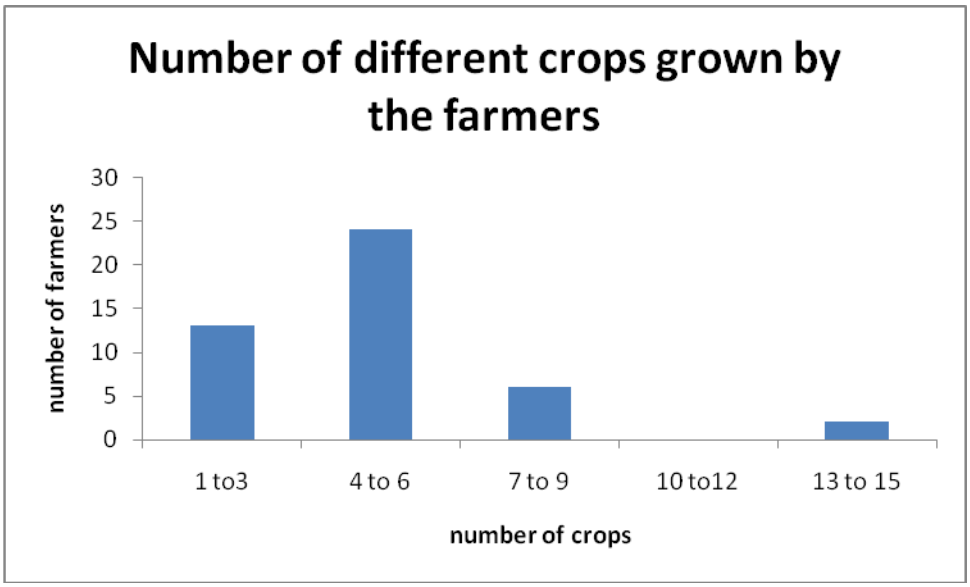

Figure 4. *Number of different crops grown*

The average number of crops grown was only five; which ranged from one crop to 15 crops. To further breakdown the variation of crops, 13 farmers grew between one and three crops, 24 farmers grew between four and six crops and only two farmers grew over ten crops (see Figure 4 illustration).

Crop planting. In answer to the questions in what month each crop was planted, respondents indicated maize was the crop that had the most consistent planting time period among the farmers. It was planted by 32 farmers between August and September (Table 6), however, the months maize was planted ranged from July to December. Overall the farmers chose to plant their crops in a vast variety of months. Each crop (that was planted by over ten farmers) had at least four different months in which it was planted. Peas, sugar, vegetables, rape and tomatoes were all identified by one or more famers as a crop they would plant anytime of the year.

Table 6. *Months when crops were planted*

	January	February	March	April	May	June	July	August	September	October	November	December	Anytime
Maize							4	16	16	2	1	1	
Beans						1	15	6	1	1			
Peas		1	8	5	4	1	1						1
Sweet potatoes	1		10	2	2	1			1			2	
Sugar Cane			6	1	1	1	1					1	6
Vegetables		2	1		2	6		2		1			1
Rape				2	2	4	3						1
Mustard				1	3	5	1						
Cabbage			1		2	3	2					1	
Irish potatoes			2			2	3				1	1	
Tomatoes		1			1	1	2	2				1	1

Number of Farmers 1 to 2 | 3 to 9 | 10 to 16

Note: All crops that were grown by fewer than ten farmers have been excluded from the table

Crop yield. The most commonly known yield from the previous year's harvest was that of maize (Table 7). Over two thirds of the farmers growing maize knew its yield. The average yield of maize from the 30 provided yields was just less than 500kg, ranging from 40kg to 1250kg.

Table 7**.** *Crop yield from previous year's harvest*

crop	maize	beans	pea	Sweet potatoes	sugar	vegetables	rape	mustard	cabbage	Irish potatoes	tomato
Responses of yields/ number	30/44 = 68%	13/28 =46%	12/23 = 52%	5/21 =24%	3/20 =15%	2/15 = 13%	7/13 =54%	4/11 = 36%	5/10 =50%	6/10 =60%	4/10 =40%
YIELD (KG)	1250 1080 1050 1050 1000 1000 850 800 750 600 500 500 500 500 400 400 300 300 300 250 250 200 200 200 150 150 150 100 100 40	5000 150 110 100 100 100 100 100 80 80 75 50 50 10	100 80 60 45 40 40 30 30 17 15 10 1.5	100 100 80 60 50	2000 1000 1000	20	1000 200 40 4000 3500 75 20	2000 2000 75 20	10000 5000 5000 100 75	5000 300 250 90 45 30	500 320 160 1.5

Crop consumption. Maize was also the most commonly grown crop for the purpose of home consumption. Even though more people consume maize than sell it, it is still the most common crop sold from the crops grown in the study area. Sweet potatoes, beans then peas were both the next most commonly sold and grown crop.

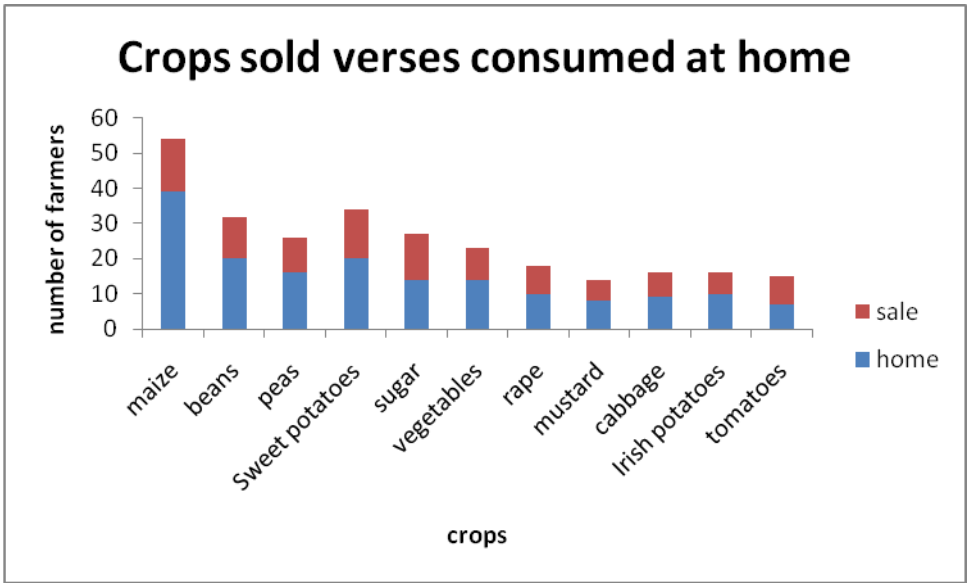

Figure 5. *Crops sold versus home consumption*

Over three quarters of the farmers consumed the majority of their crops at home. Only ten farmers said that the majority of their food was available for sale.

0-20%, 21-40%, 41-60%, 61-80%, 81-100%

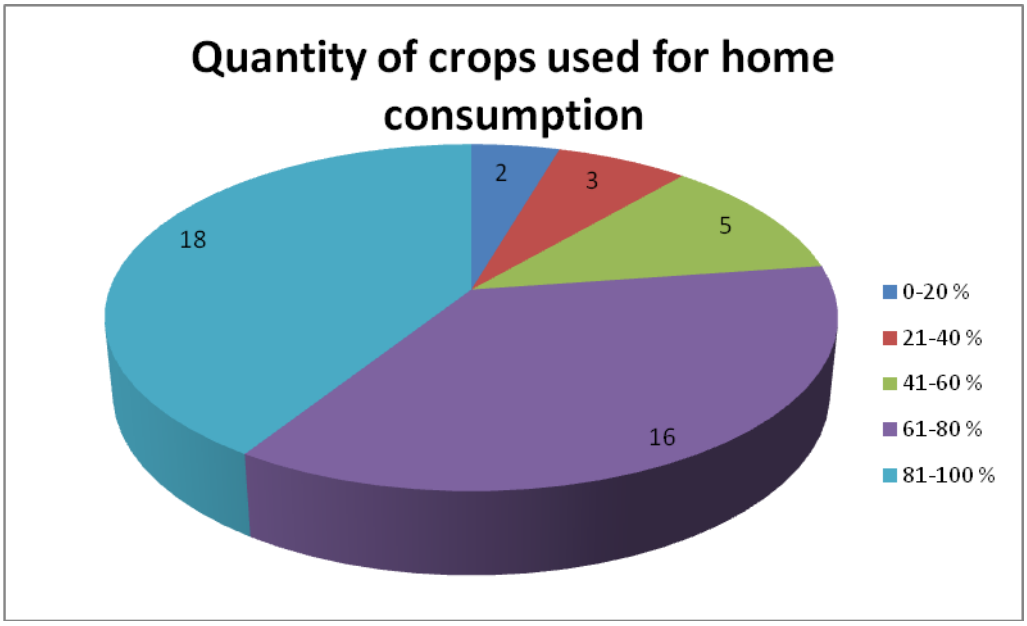

Figure 6. *Quantity of crops used for household consumption*

Factors influencing crop choice. Food preference was the primary reason why certain crops were chosen. Market prices were a consideration for 19 farmers and nutrition was an influencing factor for 18 of the farmers. Traditional choices were a factor only identified by three farmers and one person considered social status to be part of their decision making.

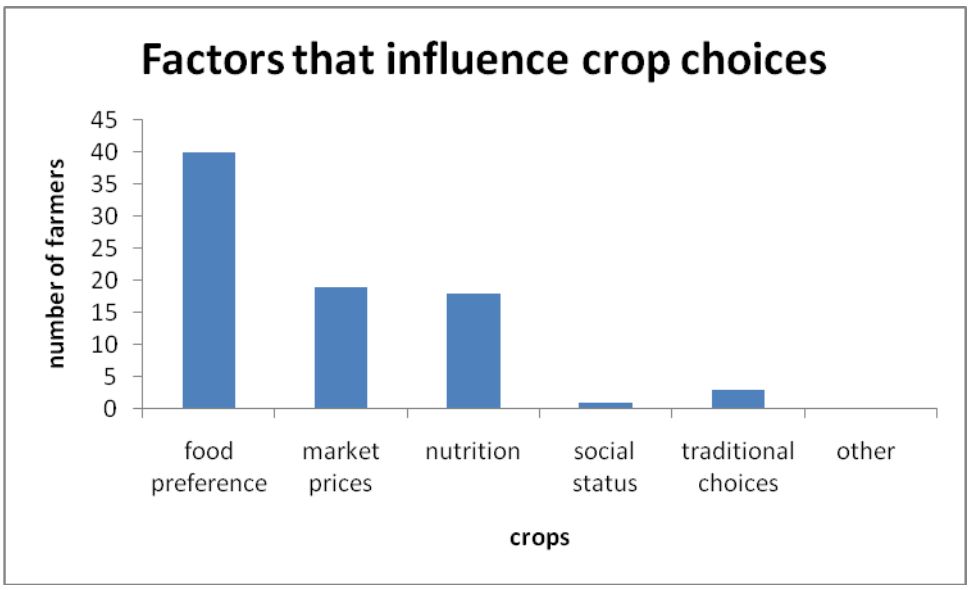

Figure 7. *What influences the choice of crop planted*

Findings About Agricultural Inputs and Techniques

The study posed several questions about the various farming methods used to enhance crop production.

Use of chemical fertilizers and irrigation. Figure 8 illustrates the findings that over half the farmers growing maize apply chemical fertilizer. Just less than half the rape and mustard plants are also fertilized. The use of chemical fertilizer on all the other crops is much less common. Five farmers also apply chemical fertilizer to their beans and one farmer applies fertilizer to his peas.

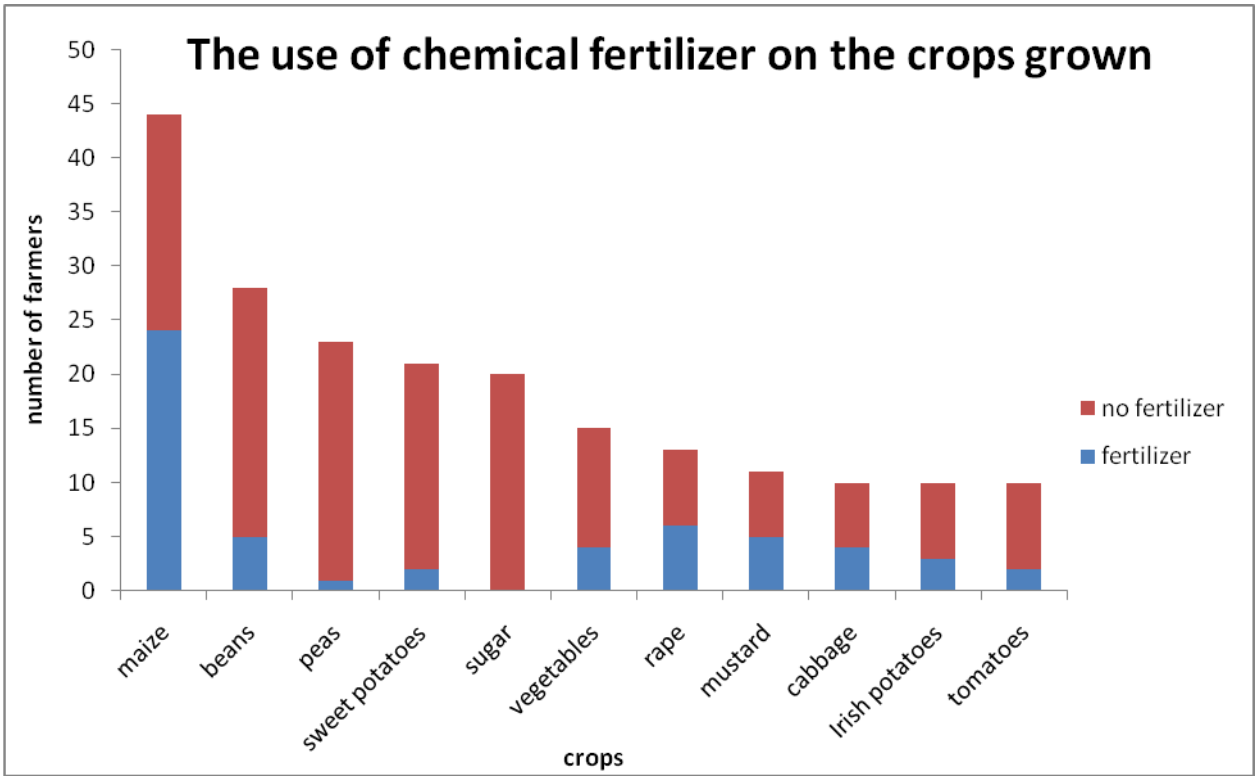

Figure 8. *Use of chemical fertilizers*

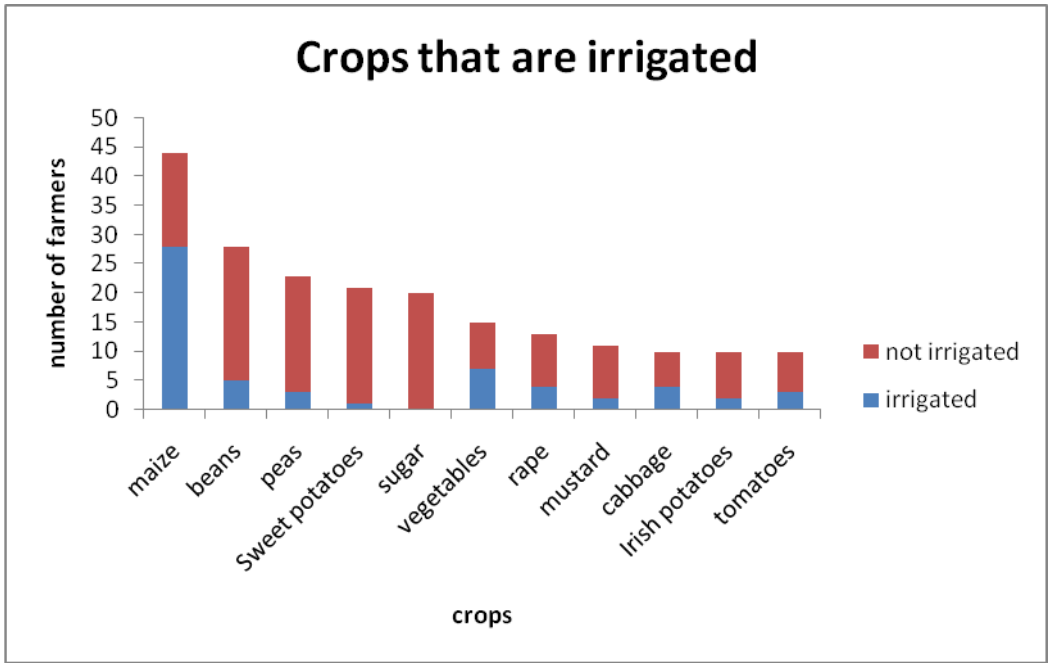

Figure 9. *Use of irrigation*

Maize is the most commonly irrigated crop. Just shy of half the 'vegetables' are also irrigated. All the other crops tend not to need to be irrigated.

Use of organic and inorganic inputs. The farmers interviewed used both organic and inorganic inputs. Almost all use chemical fertilizer and about a third of the farmers identified pesticides as an input for their garden. Over half the farmers say they use compost and approximately three quarters of the farmers apparently apply animal manure. It should also be noted that there were no visible signs of compost heaps; many farmers tend to wrongfully identify un-tilled, un-composted materials left on the land as compost.

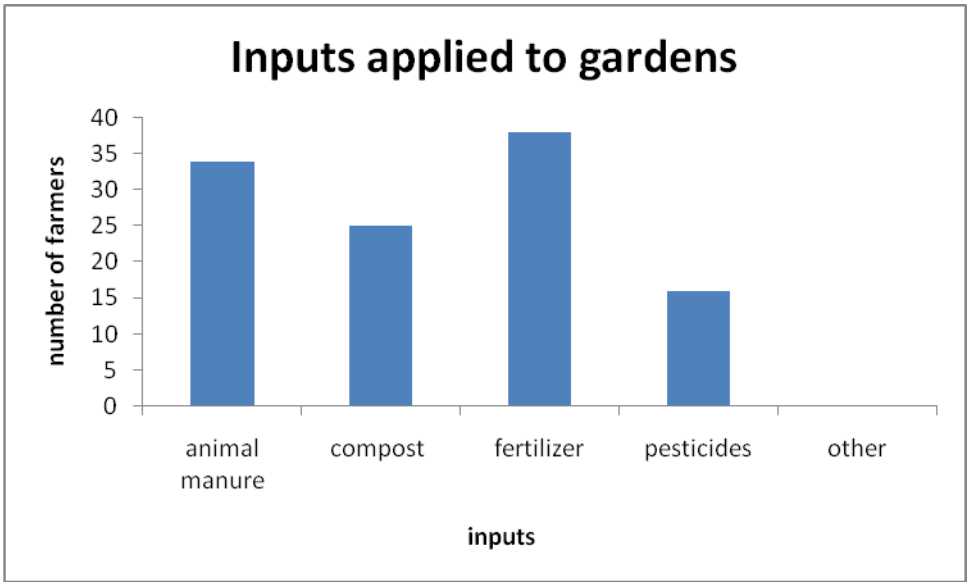

Figure 10. *Inputs applied to the garden*

From the 38 farmers who use animal manure, the most common source of the manure was from chickens, followed by cattle, pig, goat and one even identified rabbit as their source. Figure 11 illustrates the sources of animal manure indicated by participants.

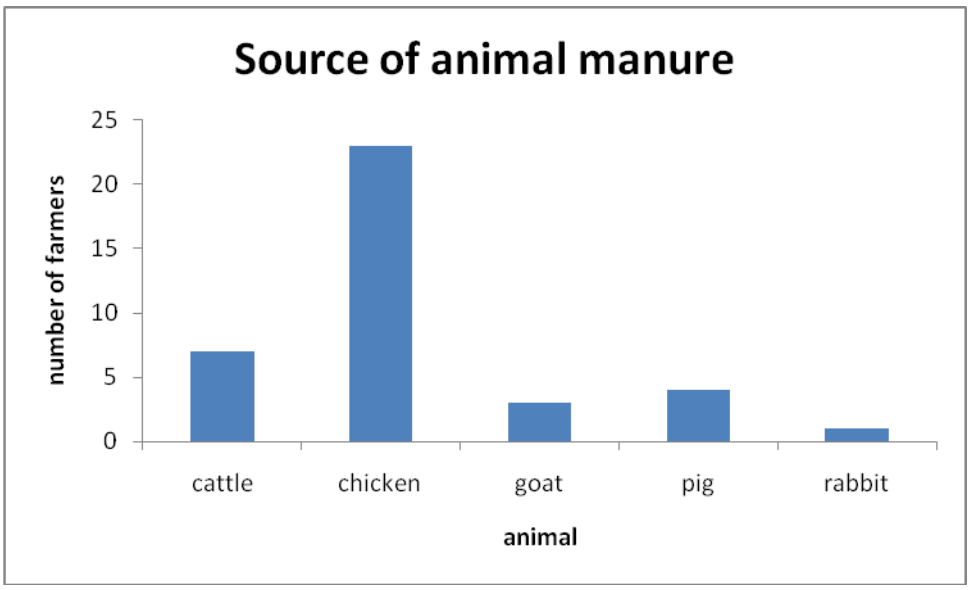

Figure 11. *Manure sources*

Farmers were asked about the use of agricultural techniques - intercropping and crop rotation were most commonly identified and very few farmers identified the use of monoculture, agrochemicals or integrated pest management (IPM). (Figure 12)

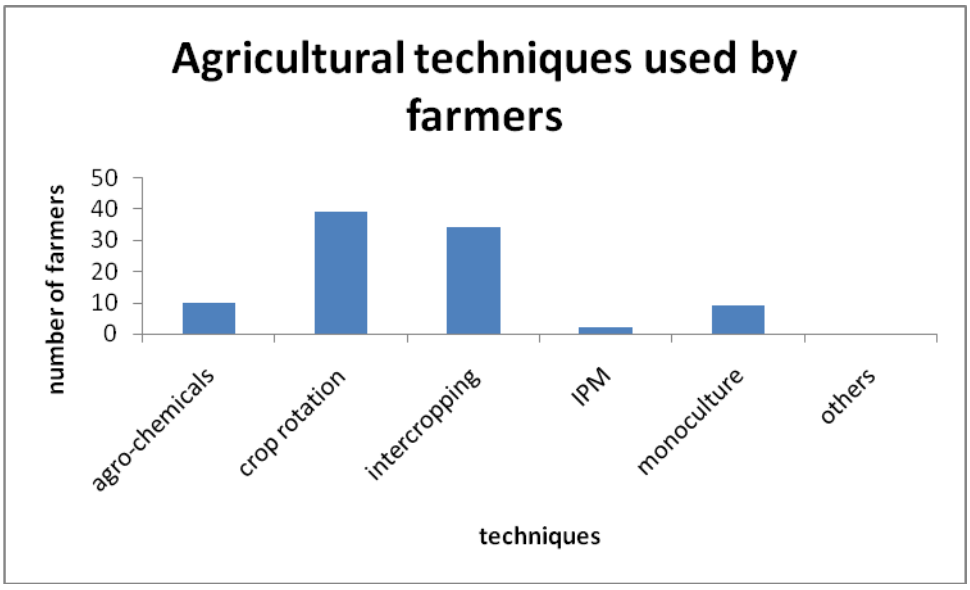

Figure 11. *Techniques used*

Water use. The source of the water for all of the farmers was residual moisture and water straight from the dambo. There was virtually no use of technology to water the crops. All but two farmers used a watering can, five farmers had access to a treadle pump and the one farmer utilized a water diversion system.

Knowledge and Limitations

Knowledge about the effects of agriculture on sustainability In answer to a specific question "Are you aware of the benefits of using certain growing techniques versus others? For example, how the use of compost manure can help ensure your soil stays fertile year after year and make you less dependent on the changing and costly price of fertilizer." Many farmers were confused but some remembered things they had been taught about the benefits long ago in school or at church by the Catholic Development Commission in Malawi (CADECOM) or by extension officers on the use of chemicals. Four of the farmers did identify that compost helps with soil fertility, another noted the benefits of beans (but mentioned he still uses chemical fertilizer). Health benefits and possible market independence was also mentioned. Another farmer indicated how it was hard to go outside what he had access to such as other technologies and another admitted he does not understand how to utilize natural systems. Participants were further asked to identify from a list of choices the agricultural methods and inputs that they thought would not degrade the quality of soil and would help keep the soil fertile year after year. Some explanations were added to clarify terms such as intercropping (planting different crops together), monocultures (planting only one type of crop) integrated pest management (IPM), and crop rotation (growing something different in plots from one year to the next).The results are illustrated in Figure 12.

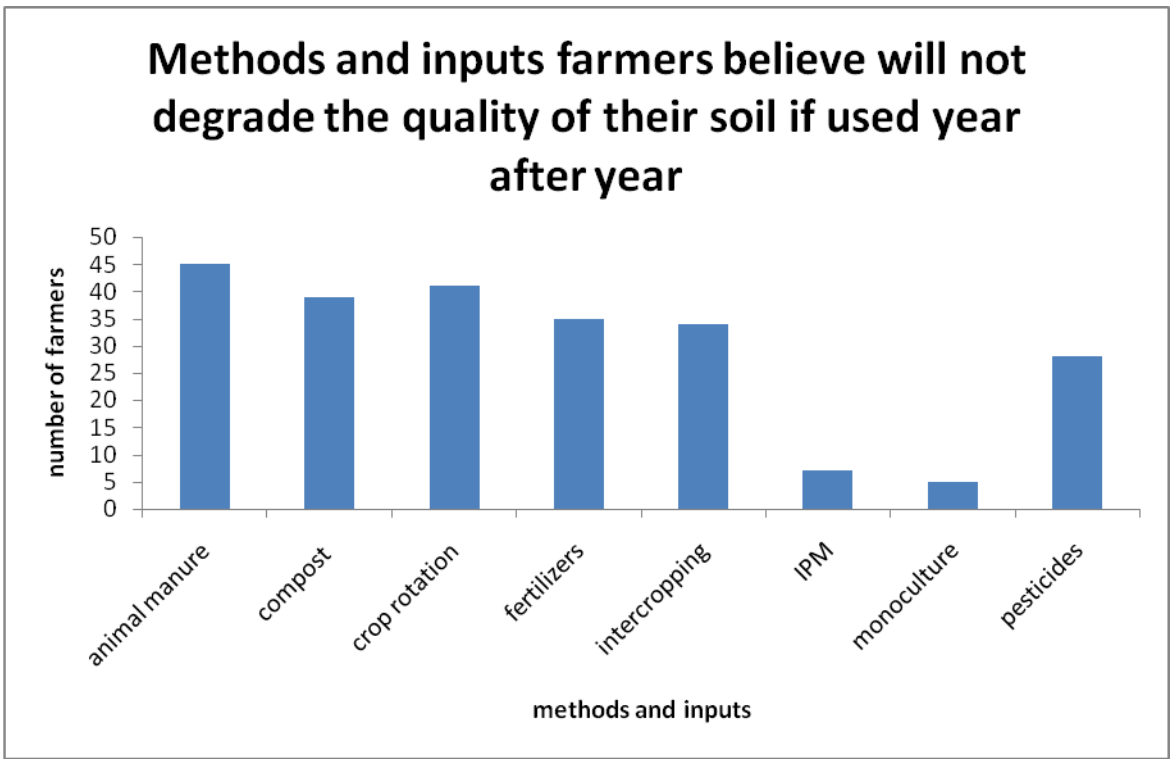

Figure 12. *Methods believed of use year after year without degrading soil quality*

Every farmer listed animal manure as an asset to soil fertility. Crop rotation, compost, fertilizers, intercropping and pesticides were also commonly identified as soil improving techniques. Fewer than seven farmers identified IPM and monocultures as beneficial techniques.

Limitations to agriculture in Malawi The survey sought the opinions of farmers about what limitations exist for people practicing urban agriculture in Mzuzu. The most common response (from 22 farmers) was that there was limited information access to inputs such as fertilizers, pesticides and seeds. Theft was identified by 14 farmers as a huge problem. Ten

farmers listed lack of land, laziness and poor drainage as limiting factors. Lack of access to technologies such as the treadle pump, mechanized water pumps, pests, and a lack of capital, no interest in farming, lack of support from government extension officers and lack of education were also mentioned. Two farmers raised issues with complacency and conflicts of land. Other issues discussed were access to natural products (such as animal manure), access to water, disease, health, labour, agreements for drainage channels, inexperience, time, limited knowledge about health of soil and no support clubs. (Table 8)

Table 8**.** *Limitations to Urban Agriculture described by farmers*

Limitations to urban agriculture	**Number of farmers**
Inputs: mainly fertilizer, pesticides and seeds	22
Theft	14
Land	11
Technologies; treadle pump, mechanized pump	11
Water logged conditions- poor drainage	11
Laziness	10
Support from government extension officers; education about techniques e.g. composting	9
Pests	7
Capital	6
No interest	4
Time	3

Access to water; Oct and Nov very dry – drawing water over large distance	2
Complacency	2
Conflicts over land	2
Access to natural products (hard to get and apply)	1
Disease	1
Easy life; piece work	1
Free ranged chickens eating vegetables	1
Health (personal) and strength	1
Labour	1
No agreements to make drainage channels	1
Inexperience	1
Rental of land	1
Soil analysis (lacking)	1
Support clubs (lacking)	1

Research Limitations

Various limitations exist both in the research performed and to results received. The research was a quick snapshot of a full picture. There was a small sample size and the respondents were chosen by chance, decided by chance encounter the day the interviews were conducted at the site. Not all questions were answered by interviewees. There may have been inconsistencies in the method of questioning as the surveys were administered by three different people. The necessity of having surveys freely translated into Tambuka on site may have resulted in inconsistencies between the survey questions and responses (for example rewording could have resulted in leading questions). It is possible that if interviewees did not understand the questions and failed to seek clarification, answers could have been affected. Interviewees' English proficiency varied. When questions were clarified as required, aspects of the answers may have been influenced by the clarification. Some more complex questions may not have been fully understood, however, "yes" and "no" questions allow for easy responses. Furthermore open ended lists requested could have been incomplete, therefore skewing the results. This could especially be true when listing off types of crops and associated inputs and uses in that the process could have been too long and farmers might not have answered fully. Some questions were even left blank and unanswered. Another limitation could have been that some terms may not have been properly understood. For example even though examples were given, a farmer might use techniques called by another name such as Integrated Pest Management. Another example is the term 'compost' which could have been interpreted differently. This was apparent as for example, many respondents said they used compost, but no evidence of compost piles existed. What they might have been referring to was the re-integrating of organic matter back into the soil, or the 'no till' method. Additionally, it is understood that some people will 'tell you

what you want to hear', for example knowing that the sustainability of their practices was being assessed, farmers could have related practices that they knew to be sustainable but had actually never undertaken.

Discussion

Mzuzu Dambos and Social Concerns

Food security and health The study found most of those farming the dambos migrated from other areas of Malawi and the majority farmed because of their own food needs, a few to supplement income. The research reinforces previous connections made between food security and agricultural production (FAO, 1998). From known projections, Mzuzu's population is expected to rise, so in the future the Mzuzu dambos can be expected to attract more farmers and play an increased role in generating extra income and responding to food security needs. Given that the farmers continue to be quite dependent on the productivity of the land, it could potentially have an effect on the level of importance they might place on sustaining the land. Previous studies by Koohafkan et al, (1998) and Durgan (1990) emphasized that the loss of dambo attributes had grave impacts on the farmers themselves as well as individuals in the surrounding area. The unsustainable use of dambo cultivation in the context of Mzuzu City has lead to many ecological, socioeconomic and health issues, the potential exists for this continuing and even increasing. Further the loss of helpful characteristics such as water purification affects the quality of the water both on site as well as for the individuals further down the dambo and creates potential health hazards. This is especially important when considering the use of fertilizers and pesticides (see discussions below), the close proximity to roads and to the city and the potential pollutants that may exist in the waters. This study revealed that the Malawi

government encourages fertilizer use and has double its subsidies to rural farmers, but there exists little financial support for those farming the Mzuzu dambos.

Land ownership and gender Land ownership was not a major emphasis in the study as the City of Mzuzu technically owns all of the land on which the respondents of the study farm. Previous research from Jansen (2006) and FAO (n.d.) has suggested that when people own land they tend to want to invest in more long term sustainable systems. As put by the FAO (n.d.), "farmers are more likely to invest in improving their land through soil protection measures, planting trees and improving pastures if they have secure tenure and can benefit from their investments." However this study of farmers in the Mzuzu dambos reflected a different reality: 18 farmers believed they own the land, 17 others claimed it belonged to other individuals and only 10 were aware the land belonged to the city. Many who cultivated this land still work according to the chiefdom system where land is distributed by Chiefs, some are even paying rent to those who first claimed the land. There was no evidence from this study that the farmers had less desire to invest in the long term success of the land because they did not own it.

A clear gender division however was discovered. Similar to the findings of Bunderson et al. (1995), the study found few women generated any income beyond the sale of the crops therefore underlining for the women the importance of success of the gardens and harvests.

Farming Practices in the Mzuzu Dambos

The research found in general the agricultural practices used by farmers in the dambos around Mzuzu City reflect those found throughout Malawi.

Choosing what to grow The study revealed that maize was grown by every farmer but one (who actually had future plans to plant maize); it was also the first crop listed and was the crop which everyone could concretely answer specific questions; in terms of month planted and

yield. This reflects the importance that is placed on maize and confirms findings of Sauer, Tchale & Wobst, (2006) and Peters (1999) of a practice common throughout the country. When asked to list the crops they grow, farmers tended to first list all of the carbohydrates. Importance put on different crops effects what crops are chosen to grow. From the Malawian food guide, Malawians have been taught to think in terms of energy (carbohydrates), body building (protein) and vitamins (vegetables). The mentality that this encourages is reflected in the typical Malawian diet. In order to go about doing things in a day one needs energy (i.e. Carbohydrate, usually maize). Vegetables usually refer to green leafy crops that can be turned into relish, such as rape, pumpkin leaves or even cabbage (when listing crops many listed ‘vegetables’ as a crop of its own). This is because the word vegetable actually translates into 'relish of leaves'. This reality means that vegetables are seen in a different light in the Malawian diet, more as a side than a main portion of a meal.

Maize production has ecological and socioeconomic consequences. As explained by Chirwa (2005), the majority of small holder lands tend to be devoted to only maize production. Chinsinga (2007) suggests that since dambos can experience waterlogging, maize in particular may not be the most ideal crop in those areas. In the study 11 of the farmers mentioned waterlogging as a limitation to farming in the dambos. According to the results maize, is also the most commonly fertilized and irrigated crop. The irrigation is almost always done manually with the use of a watering can. Therefore making maize the most costly and labour intensive crop grown in the Mzuzu dambos. Roberts (1988) alerted that the degradation of vegetation affects the dambo hydrology and the soil, as a result issues that could arise in Mzuzu could include decreased soil stability and increased flooding; potentially taking away crops and soil, soil exposure; depleting water and nutrient retention since it is used to being a lush moist

environment and loss of biodiversity; reducing resilience of ecosystem and further depleting nutrients. These environmental damages can be costly in the short term; potentially increasing the level of irrigation and inputs of costly agrochemicals needed to sustain a garden. In the long term, the continued use of such a system could have exponentially increasing costs. Snapp and Pound (2008) state that ecologically maize is quite nutrient demanding. Thornton (2008) discovered that hybrid maize is most commonly used in Malawi agriculture. Hybrid maize does not regenerate seeds and therefore new seeds have to be purchased year after year, unlike traditional strains which can be collected and kept for the next year's planting. Study participants indicated that lack of access to seeds was one of the limiting factors to garden success. The Malawi Ministry of Agriculture and Irrigation affirms that access to seeds is also a major constraint to crop production and crop diversity (Government of Malawi, Ministry of Agriculture and Irrigation, 1999). An economic burden is therefore associated with the use of hybrid maize, which tends to need fertilizers and irrigation to flourish (Shiva, 1991).

Diversifying crops The study found the mean number of crops grown by the farmers interviewed was five, whereas according to Chinsinga (2007) it is possible to grow large variety of crops in such areas as dambos. Diversifying crops and choosing the right crops can have monumental effects on the sustainability of crops. A multitude of crops further helps with nutrient diversification of the soil. More biodiversity means decreased susceptibility of the garden to insect and disease infestations. The study respondents commonly stated that pests were a limitation to garden successes. Diversifying the use of herbs or other strong smelling plants can be an effective integrated pest management (IPM) technique to deter pests and attract beneficial insects (Altieri, 1995). Furthermore crop diversification could allow for an increased variety of the crops being consumed. Munthali (2007) and Thornton (2008) have both made the case for

crop diversification to benefit both the land and the population. A more diverse selection of fruits and vegetables with different growing seasons would also ensure a more constant food supply. This would be of great benefit considering in recent years, even in climatically favourable cropping seasons, up to 70-80% of smallholder farmers do not produce enough to feed them for much more than four months after harvest (Chinsinga, 2007). Crop diversification could also enrich the Malawian diet and improve nutrition, especially helpfully considering almost one million Malawians suffer from HIV/AIDS and nutrition is a key component to their survival (UNAIDS, 2008 and Food and Nutrition Technical Assistance, 2001). As explained by Kristof, Nordin "you can bring all of the maize in the world to Malawi, and people will still be malnourished, sick and dying" (K Nordin, as cited by Thornton, 2008).

In addition, crop diversification could increase the types of crops being sold, potentially increasing incomes. However, cultural factors can place barriers and affect crop choices. In Malawi a common view is that maize is the staff of life; 'chimanga ndi moyo' (maize is life) (Peters, 2006); other cultural stigmas exist that associate vegetables as being a 'poor man's food' (Thornton, 2008), or that only people with HIV/AIDS need to eat six food groups (Thornton, 2008, 49).

Using inputs-chemical fertilizer The data collected indicated that almost all the farmers said they used chemical fertilizers and about a third identified pesticides as an input. The use of agrochemicals has health risks, biophysical and economic implications. Pesticides residues can be ingested and can contaminate soil and water, causing subsequent negative health and environment impacts (Niering, 1968). Chemical pesticides and fertilizers alike are also costly, therefore having an economic impact. Furthermore the price of the agrochemicals is continually on the rise since it is based on the fluctuating global market, and these farmers do not have access

to government subsidies. The dependence on agrochemicals is a drain of resources and is economically unsustainable for these farmers especially since they have very little income to spare. This confirms the dilemma Munthali (2007) described as a consequence of Malawi government policy. There are ecological implications such as soil salinization, de-oxygenation of water; endangering aquatic species and associated environmental costs of fertilizer production; such as emissions from factory production, packaging and transportation. The use of fertilizer is also a problem because it tends to decrease the use of organic fertilizers. The continued use of chemical fertilizer actually depletes the soil's ability to retain nutrients and therefore the continued soil depletion can actually increase the need for fertilizer. Almost half the farmers in the study in Mzuzu identified the lack of access to inputs such as fertilizers and pesticides as being a limiting factor in their cultivation. This may mirror the findings of Douglaset et al. (1999) on the declining response of maize (both hybrid and native species) to fertilizer in Lilongwe District (as cited by Munthali, 2007).

Using organics According to the study results, over half the farmers said they used compost and about three quarters said they used animal manure. The study researchers noted little evidence of compost heaps. In the author's personal experience very few people actually made proper compost. Some may have been referring to the use of the 'no-till' method, which involves directly reintegrating organic matter back into the soil. Also, there is evidence of burnt organic matter, a process which appears quite common (data was not gathered as part of this study). The benefits of composting and reusing or recycling organic matter are well known and also have been discussed by Munthali (2007). The presence of organic matter in soil also helps with soil stability, which in the case of these dambos is helpful since many are on inclined lands or have diminished soil compaction.

Other techniques The study results show that when the farmers were asked about the use of agricultural techniques, intercropping and crop rotation were most commonly identified. There was evidence of some intercropping but it did not appear to be extensive and observations were not always consistent. Many gardens belonging to farmers who said they used intercropping did not appear to have intercropped crops, therefore the validity of this data is unsure. There was no way to observe crop rotation since the results were only collected in one growing season, therefore no way to confirm the validity of the results. Very few farmers identified the use of monoculture, agrochemicals or integrated pest management (IPM). There may have been a difference in the definition of a monoculture, for many of the farmers appeared to have segregated beds with only one crop growing. This is further reflected in the low acknowledgement of agro-chemical use. For other results showed that a majority of the farmers use fertilizers and many also use pesticides. Additionally even though examples were given, more people might possibly have used IPM techniques, but may not have termed them IPM. There are many possible explanations of these results. It could be, as was discussed in the limitations section, that some of the questions were leading or that some people tend to tell you what they think you want to you hear. In primary school agriculture is part of the curriculum. (MoE, 2000) As is further explained in the following section, too many had been taught long ago about sustainable agriculture techniques from church groups and clubs. Techniques such as composting, crop rotation, intercropping and IPM are taught. However the application of such techniques seems to be less consistent. Other explanations could be that the crops may not have bloomed and therefore were not visible for observation.

Access to Information

The study found a limiting factor to success in agriculture in the dambos was access to government extension officers and knowledge about techniques. Even though school curriculum provides some form of education at some point in their lives about sustainable techniques. From the responses received assessing the farmers' knowledge about sustainable gardening practices, it became apparent that some of the farmers had received more information than others. Some mentioned getting education from church groups or organizations such as Catholic Development Commission in Malawi (CADECOM). It is not known whether they received this education while farming in Mzuzu or if that education was attained prior to migrating to the city. Additionally as previously mentioned, agriculture is part of primary education, but many of the participants may not have gone to school. Although the level of education was not part of the information collected on the survey, it was evident that the levels of education varied throughout the participant group based on the varying levels of English known. English is the official language of Malawi and is therefore the language used in formal education. People who could not speak English tend to be those who have received less formal education. However of those who did receive information about sustainable techniques, most were practicing them. There are many potential reasons for not applying sustainable techniques beyond lack of education such as lack of practical application, true understanding of the biophysical impact or cultural stigmas (as was discussed previously). According to research on Kenyan farmers doing similar maize production the farmers "were unaware of the biological and physical forces that influence or control the systems they manage"(Keating, n.d.). In a study looking at the adoption of Permaculture techniques in Malawi, it was found that even if extensive education and training was provided only half the people exposed to Permaculture would adopt a portion of the techniques, one of the reasons identified was that adopting "Permaculture is very different from

contemporary agriculture practice and requires overcoming cultural barriers associated with being "different". (Thornton, 2008, 53).

Recommendations

For the sustainability of the farmers

Recommendations for the type of action that should be sought to deal with the negative socio-economic and environmental consequences of contemporary agriculture practices are based on the capacity of the farmers as well as the goal of the agriculture in study. The farmers cultivating in the dambos around Mzuzu City are generally dependent on the agriculture and have very minimal income. The agriculture performed in these areas is not for cash crops but are mainly for home consumption or for sale to their neighbours.

It is recommended that these farmers adopt more low input, self-sustaining systems that decrease dependence on external inputs, improve soil quality and can be sustained in the long term. It is suggested that such techniques outlined in Agro-ecology (Altieri, 1995), Permaculture (Nordin, 2005 and Thornton, 2008) and pond-crop systems (Kapanda, et al., 2005) should be explored for their potential success in the dambos.

Other potential benefits and opportunities

There are still many areas of the dambos not under cultivation, the reality exists that this land will probably by sought after for cultivation as the population grows. It is recommended that a precedent be set regarding the sustainable use of the dambos, via the creation of demonstration plots, exhibiting various garden options and their benefits and trade-offs.

The farmers farming in Mzuzu city could be used as a great resource to help promote sustainable practices. Since these dambos are in an urban area, they are in very close proximity to a large portion of people. The city is also a common destination for many rural dwellers such as farmers who come to the city to sell their goods in the market. Therefore if demonstration sites were erected in these areas, many people would have easy access to them. As was discovered by Thornton (2008) adopters of Permaculture found that adoption of techniques was aided by being able to visit demonstration sites numerous times.

There are many possible approaches that could be taken, for example these demonstration plots could possibly be erected and run by one or a collaboration of various organizations, but should be available for everyone and anyone to visit. Since many organizations have offices in Mzuzu, as previously mentioned, demonstration sites could be easily monitored by organizations and individuals involved. Spreading this education through practical demonstrations could empower Malawian farmers and enable a 'bottom-up' approach to solving Malawi's issues with food insecurity and environmental degradation. It is also important to understand the cultural barriers that exist and work as best as possible to incorporate cultural barriers into efforts made.

Conclusion

Contemporary agricultural practices being used by farmers cultivating in the dambos around Mzuzu, Malawi are socioeconomically and environmentally unsustainable. These practices potentially adversely affect the health of the fragile dambo ecosystem leading to the loss of helpful characteristics and increasing the need for inputs and labour. It is in the best interests economically in the short term to reduce dependence on current contemporary inputs as well as in the long term; considering continued use of land in the same manner will only increase dependence on inputs and continued environmental degradation will result in an increasing laborious and time consuming rehabilitation (if even possible). The adoption of more sustainable techniques could help improve ecological efficiency, health and sustainability of the land being cultivated, improve human health, improve food security, relieve economic burden associated with the current high input practices and overall create a more sustainable system for these farmers. Since these gardens are in close proximity to an urban area, if new techniques are adopted, the benefits could have cascading educational effects on other urban and rural dwellers.

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Appendix A.

Research Letter of Intent

Dear participant,

This questionnaire is part of research being conducted through the University of Mzuzu. The goal of this research is to analyze the current use of land for agriculture within Mzuzu city. We are visiting urban agriculture participants throughout the city looking at the diversity and sustainability of agriculture around the urban setting. Upon completion of the research, a paper will be produced looking at the characteristics, potentials and challenges of sustainable urban agriculture within Mzuzu city. Your knowledge and honesty are greatly appreciated.

Thank you kindly for you participation,

Mr. Ignasio Jimu, Department of Geography, University of Mzuzu, Malawi

Amanda Klarer, International Development Studies and Environmental Science, Dalhousie University, Halifax, Canada

Dr. Golden Msilimba, Department of Geography, University of Mzuzu, Malawi
Cohen Sichinga

Appendix B.

Urban Agriculture Questionnaire

Age (years): 0-20 21-40 41-60 61-80 81-100

Sex : male female

Occupation: _____

Garden Location: _____

Size of garden _____

How many years have you been cultivating in your garden?_____

Sources of income _____

Home district _____

why did you come to Mzuzu ?_____

Who owns the land which you cultivate? _____

From whom did you get the land? _____

Do you belong to a club_____
Adv/disadv. _____

Do you work on your own or do you belong to a club?
What are the advantages/disadvantages of belonging to a club or vies versa?

What crops did you grow in garden, when they are planted and yielded quantities over past three years? (see table)

Type of Crop	month planted	yield (kg)	main food crop	main cash crop	home consumpt	for sale	use of inorganic	grown under	sold in market	sold in field	
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											

1. Why do you choose to participate in urban agriculture? (please circle all that apply)

Subsistence/ to feed yourself
Financial income
Food security
Health
Environmental
other _____

2. Do you grow enough food for home consumption needs?

3. Who else contributes to your urban farming?

What is the age and sex of the people who participate in the agriculture? Are they members of the household or hired help? (please list)

Sex	Age	ROLE: Household member, hired help, other
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

4. How long have you been operating in this field?

5. Why influences your choice of crops?

Nutrition
Social status
Tradition choices
Food preference
Market prices
other _____

6. What quantity of your crops do you use for household consumption? (please circle)

0-20%, 21-40%, 41-60%, 61-80%, 81-100%

7. What inputs do you apply to your garden? (please circle all that apply)

compost manure
animal manure
chemical fertilizers
pesticides
Other_____

8. If you use animal manure, what is the source of the animal manure?

9. Which of the following techniques do you use to water your garden? (please circle all that apply)

Watering can
Drip irrigation
Treadle pump
Hose
Other _____

10. What is the source of water used for your crops? (please circle all that apply)

Residual water
Dambo/ stream
City tap water
Rain water
Other_____

11. Which of the following techniques do you use in your garden? (please list)

Intercropping
Monocultures
Crop rotation
Integrated Pest Management
Agro-Chemicals
Other

12. Are you aware of the benefits of using certain growing techniques versus others? For example, how the use of compost manure can help ensure your soil stays fertile year after year and make you less dependent on the changing and costly price of fertilizer.

13. In your opinion what limitations exist for people practicing urban agriculture in Mzuzu?

14. Please identify which of the following agricultural methods and inputs that will not degrade the quality of your soil and will help keep your soil fertile year after year.

Compost manure
Animal manure
Chemical fertilizers
Pesticides
Intercropping (i.e. planting different crops together)
Monocultures (i.e. planting only one type of crop)
Crop rotation (i.e. growing something different in your plots from one year to the next)
Integrated Pest Management (such as using tobacco leaves to control aphids)

15. Other comments:

[Figures – note that this page does not have the manuscript header and page number]