UNRAVELLING THE OPPORTUNITY, 'OPPORTUNITY COST' AND THREATS OF EUCALYPTUS CULTIVATION TO ADJACENT FARMING HOUSEHOLDS IN LUWEERO DISTRICT, UGANDA.

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DECLARATION OF AUTHENTICITY

I, Namubiru Samalie do declare that all work presented in this dissertation is my own work and has never been submitted to this university or any other institution for any award. Wherever data or literature related to the topic has been adapted, respective sources have been fully acknowledged.

Signature: ..... Date: 15th/9/2019.

NAMUBIRU SAMALIE

APPROVAL

This is to confirm that this work has been developed under my supervision, and is therefore ready for university examination

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DEDICATION

The success of this study is dedicated to my parents for their unconditional support, to my family, friends and everyone that has contributed to my academic success.

Thanks a lot.

ACKNOWLEDGEMENTS

Great applause goes to my parents, family and friends, in a special way, I want to thank my supervisor Dr Taulya Godfrey for his guidance and great support during my research.

I am forever grateful

ABSTRACT

Cultivation of Eucalyptus was identified as one of the options for integrated watershed management in Luwero district yet the species has been blamed for ecologically adverse effects such as disrupting the hydrological cycles. The adverse ecological effects have been contested. Furthermore, there has not been a comprehensive analysis of Eucalyptus' effects on the livelihoods of farming communities in the vicinity. This study was conducted to assess the opportunities, opportunity costs and threats of Eucalyptus plantations to the livelihood of neighbouring farming communities in Luwero district, central Uganda. A structure questionnaire was administered to a random sample of 50 respondents in Luwero district. Among the opportunities evaluated were access to jobs, land for food production, access to free or purchased fuel wood, access to fodder and access building poles. The opportunity costs investigated were availability of water for household consumption and reduction in crop yields. The treats assessed was conflict between neighbouring farms. The data were subjected to multivariate analysis to cluster the respondents into farm types. Non-parametric tests (Chi Square Test) used to test the hypotheses guiding this study. More farming households reported accessing free firewood ($\chi^2 = 5.120$; df = 1; Sig. = 0.024) from the Eucalyptus plantations in Luwero district and they judged the opportunity as being important to their livelihood ($\chi^2 = 12.182$; df = 2; Sig. = 0.002). This opportunity cut across Farm types in Luwero district. Neighbouring farming households were not allowed to cultivate food crops ($\chi^2 = 23.120$; df = 1; Sig. < 0.001) in the Eucalyptus plantation. They also could not harvest free fodder ($\chi^2 = 25.920$; df = 1; Sig. < 0.001) from the Eucalyptus plantations. The neighbouring farming household were unanimous in their view that Eucalyptus reduced ground water sources and their crop yields. This was noted as a potential retrigger for conflict. Even though this was not yet statistically significant, there is a high likelihood for social strife to erupt since the majority of Eucalyptus growers were non-residents to the village in which the affected farming communities. It was recommended that areas where Eucalyptus cultivation is unlikely to pose a threat to depletion of ground water sources be identified for promotion of the agroforestry species. It was also recommended that further studies be conducted to establish alternative tree/shrub species that do not possess the negative effects observed with Eucalyptus.

Keywords: Agroforestry, Building poles, Firewood, Rural livelihood, Uganda

TABLE OF CONTENTS

DECLARATION OF AUTHENTICITY ii
APPROVAL iii
DEDICATION iv
ACKNOWLEDGEMENTS v
ABSTRACT vi
LIST OF FIGURES ix
CHAPTER ONE: INTRODUCTION 1
1.0 Overview 1
1.1 Background 1
1.2 Problem statement 2
1.3 Objectives 2
1.3.1 Main Objective 2
1.3.2 Specific objectives 2
1.3.3. Hypotheses 3
1.4 Significance of the study 3
CHAPTER TWO: LITERATURE REVIEW 4
2.0 Overview 4
CHAPTER THREE: METHODOLOGY 7
3.0 Overview 7
3.1 Study Area 7
3.2 Data Collection 7
3.3 Study Population 7
3.4 Sample size determination 7
3.5 Selection, Inclusion and Exclusion Criteria 7
3.6 Sampling method 8
3.7 Data processing, management and analysis 8
CHAPTER FOUR: RESULTS 9
CHAPTER FIVE: DISCUSSION 21
5.1 Eucalyptus' opportunities to farming communities in Luweero district 21
5.2 Eucalyptus' opportunity cost to farming communities in Luweero district. 22
CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS 23
6.1. Conclusions 23

APPENDICES 24
APPENDIX 1: MAP OF LUWEERO DISTRICT 24
REFERENCES 25

LIST OF FIGURES

Conceptual framework 1 3

Figure 1: Dendrogram showing the diversity of surveyed households in Luwero district (Central Uganda) with respect to biographic information 9

1Figure 2: Box plots for age, duration of residence in study village and farming experience of respondents in Luwero district, central Uganda 10

Figure 3: Variation in formal education attained by respondent (A) and total acreage owned by the household in Luwero district, central Uganda 10

Figure 4: Access to employment opportunities in Eucalyptus plantations in general (A), specific to farm types (C), ranking of the jobs to household livelihood in general (B) and across farm types (D) 11

1Figure 5: Access to Eucalyptus plantations in general to grow food crops (A), specific to farm types (C), ranking of the food produced in Eucalyptus plantations to household livelihood in general (B) and across farm types (D) 12

1Figure 6: Free harvest of firewood from Eucalyptus plantations in general (A), specific to farm types (C), ranking of the free firewood from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D) 13

1Figure 7: Purchased firewood from Eucalyptus plantations in general (A), specific to farm types (C), ranking of the purchased firewood from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D) 14

1Figure 8: Free grazing livestock in the Eucalyptus plantations in general (A), specific to farm types (C), ranking of free grazing of livestock in the Eucalyptus plantations to household livelihood in general (B) and across farm types (D) 15

1Figure 9: Purchase of construction poles from the Eucalyptus plantations in general (A), specific to farm types (C), ranking of purchasing building poles from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D) 17

1Figure 10: Source of water for domestic consumption in general (A) and across farm types (B), and change in availability of water for domestic consumption since introduction of Eucalyptus (Euc.) in general (C) and across farm types (D) in Luwero district, Uganda 19

1Figure 11: Perceived change in crop yields adjacent to Eucalyptus (Euc.) in general (A) and across farm types in Luwero district, Uganda 19

1Figure 12: Conflict over impacts of Eucalyptus (Euc.) on adjacent crops in general (A) and specific to farm types (B) in Luwero district, Uganda.....20

1Figure 13: Residency of Eucalyptus owners in Luwero district, Uganda.....20

CHAPTER ONE: INTRODUCTION

1.0 Overview

This first chapter comprises of the overview of this study, it looks at the background, problem statement, objectives and the significance of this study.

1.1 Background

Agriculture is the backbone of Uganda's economy (Aggrey, 2009). A very large number of the total population depends on agriculture for a living (Gollin and Rogerson, 2010). However the trend in agriculture has been that farmers diversify the sector and invest in growing of trees (Gombya-Ssembajjwe, 1999). The major tree planted for commercial benefit is the eucalyptus (Dessie, 2011). Eucalyptus species were introduced to the different countries of East Africa between late 19th and 20th century and by the early 1970s, the area covered by eucalyptus in Uganda, Ethiopia, Rwanda, Kenya and Sudan reached 95,684 ha (Dessie, 2011). Among its merits over other tree species as stated by (Dessie, 2011) is its relatively fast establishment compared to other tree species like pine which take longer to establish. This gives it greater economic advantage compared to other tree species. Therefore, it is the most widely grown tree species world-wide, including Uganda. Among the economically important products form Eucalyptus are timber, fire wood and poles (Jagger and Pender, 2003). Eucalyptus also offers important services such as ground drainage (Kidanu, 2004) to permit cultivation of crops that are sensitive to water-logged soils. These products and services can be of economic benefit to the tree growers, the neighbouring farming households and beyond. However, there are many concerns about the negative impacts of planting Eucalyptus, to the neighbouring farming households.

Complains against Eucalyptus' interaction with the environment, like draining ground water sources, enhancing soil erosion and supressing undergrowth (Dessie, 2011; Bilal, Nisa et al., 2014; Hardie, Mendham et al., 2018).Eucalyptus whether grown in rotation or in mixture with other crops, has adverse effects on the productivity of associated crops (Suresh and Vinaya Rai 1987). In spite of the debate among the ecologists and environmentalists cultivation of Eucalyptus is gaining momentum globally, and in Uganda as well. This is especially true for areas that are adjacent to major urban centres where the rapid rise in construction has fuelled the demand for Eucalyptus products. One such area is Luwero district, in central Uganda, which is located about 55 km north of Kampala city. Growing

Eucalyptus by private farmers has been identified among the options for integrated watershed management in Luwero district (Namara et al., 2013).

1.2 Problem statement

The increasing demand for wood products (Dessie, 2011) has fostered the trend towards tree cultivation. Eucalyptus is among the best options due to its fast growth rate and high adaptability to vast eco systems (Liu and Li, 2010)**.** Despite the importance and gains of these trees to farmers, neighbouring farming households and environment at large, there are various complaints regarding the negative impacts of eucalyptus to the environment (Mekonnen, Kassa et al. 2007)**.** This angle has been widely studied and reported. However, a comprehensive analysis of the tree impacts on the various aspects of rural livelihoods is yet to be done. This study was designed to examine the potential impacts of Eucalyptus to the livelihoods of neighbouring farm households; an aspect that has received little attention in the ecological debates regarding the cultivation of the tree.

1.3 Objectives

1.3.1 Main Objective

Assess impact of eucalyptus on the livelihood opportunities of adjacent farming households in central Uganda

1.3.2 Specific objectives

1. Characterise the diversity of farming communities neighbouring Eucalyptus plantations in Luwero district with respect to their socioeconomic variables (age, duration of stay in the village, farming experience, land area owned, formal education level and primary occupation).
2. Evaluate the contribution of Eucalyptus to the livelihood opportunities (job opportunities, cultivation of food, free or purchased firewood, free fodder and purchased building poles) across the diversity of farming households Luwero district.
3. Assess the ‘opportunity cost’ (access to water and crop yield penalty) to their livelihood the diversity of farming households incur from neighbouring Eucalyptus plantations in Luwero district.

   Evaluate the threats (conflict) that the diversity of farming households face from neighbouring Eucalyptus plantations in Luwero district.

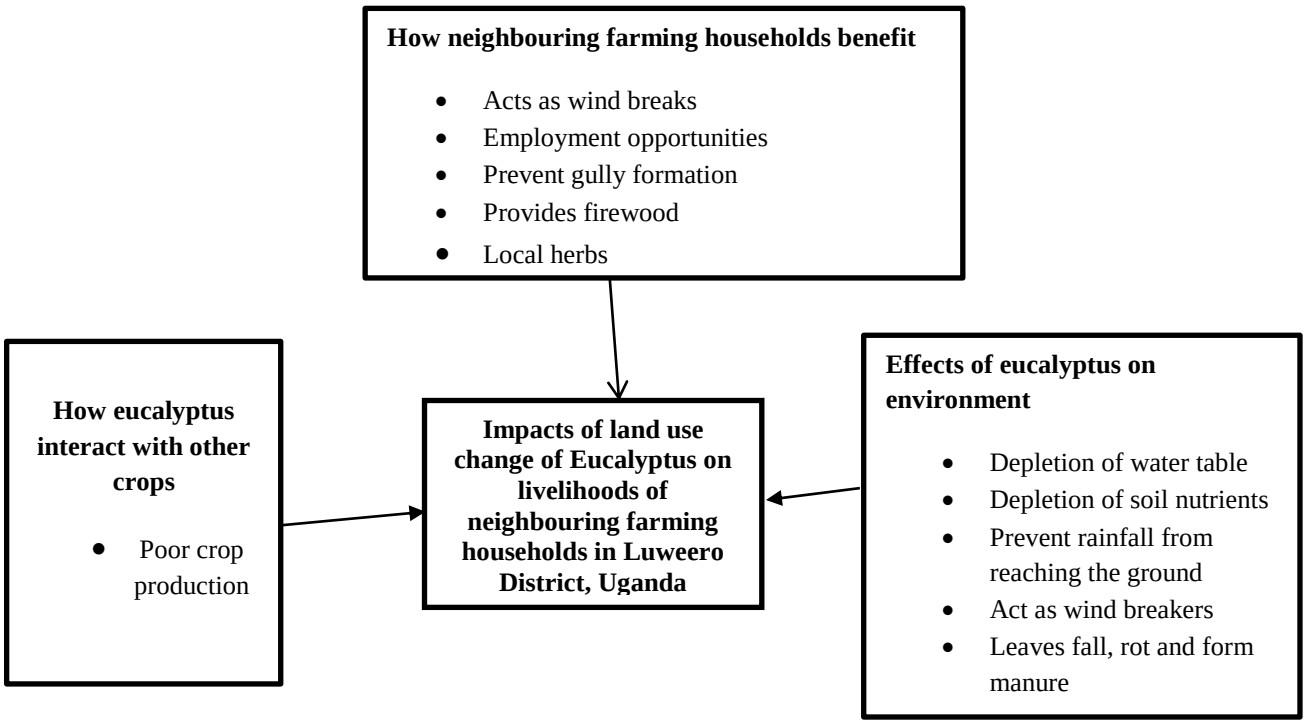
1.3.3. Hypotheses

1. The farming households living adjacent to Eucalyptus plantations in Luwero district are homogenous with at least 80% similarity based on their socioeconomic variable
2. The opportunities accessed by the diversity of farming households in the vicinity of Eucalyptus plantations in Luwero district is not of importance to their livelihoods.
3. The 'opportunity cost' incurred by the diversity of farming households living adjacent to Eucalyptus plantations in Luwero district is not of major importance to their livelihoods.
4. There are no threats to the livelihood of the diversity of farming households borne out of living adjacent to Eucalyptus plantations in Luwero district.

1.4 Significance of the study

This study assess the positive and negative impacts of eucalyptus growing on the neighbouring farming households' livelihoods. In this way, it illuminates other impact pathways of Eucalyptus that have hitherto not been studies on the livelihoods of agro-based livelihoods, which can inform policy advocacy and formulation for sustainable intensification of rural land use systems. This is crucial in the face of increased challenges from accelerated land degradation and climate change challenges to resource-poor farming households in Africa that depend on natural resource integrity for their livelihood.

Conceptual framework 1



CHAPTER TWO: LITERATURE REVIEW

2.0 Overview

Eucalyptus is the most widely planted hardwood in the whole world Albaugh, Dye et al. (2013). People within East Africa have grown it for over a century and the rate at which it's grown gradually increases since the population has developed important local knowledge, skills and methods of eucalyptus management. However, the growth of eucalyptus trees has impacts on the neighbouring farming households and environment at large (Kluthe, 2016).

To any farmer, environmental conservation is key in this era, and this is partially played by planting of tress like Eucalyptus. The tress are planted for stabilization of gullies, road strengthening embankments and conservation of the soil (Dessie, 2011). However, when the neighbouring farmers grow eucalyptus in rotation with crops, soil nutrients are depleted at a rapid rate. It has also been reported that where Eucalyptus has been grown for a long period, soil fertility has been improved, leading to no adverse effect on crop productivity (Mbugua, 2009). There are both positive and negative impacts of Eucalyptus on aspects of livelihood, which have not been verified with farmers that make a living in the vicinity of Eucalyptus plantations.

2.1 Contribution of Eucalyptus to farming households' livelihood

The farming households around eucalyptus plantations usually benefit like the eucalyptus farmers themselves. Wood products like poles for construction, wood for fuel and other uses like lighting can be got from eucalyptus trees (Mekonnen, Kassa *et al*., 2007). Given the fact that eucalyptus trees consume a lot of water, (Zegeye 2010), they are important in draining of marshy lands (Chowdhury, Kumar *et al*., 2011), which could harbour mosquitoes and lead to malaria infections in the neighbouring farming household members. Similarly, the drained marshy lands can be used for agriculture. Economic diversification is paramount and therefore eucalyptus growing has created a vast range of job opportunities to various people including the locals and mostly the uneducated people and farming household members near these plantations (Dessie, 2011). Some of the work these people may be required to do includes weeding in the tree plantations, spraying, watering, harvesting the tree products, loading onto vehicles for onward transportation etc.

The tree products like leaves, barks and roots can be used in the of local medicines which help to keep the members of the community healthy e.g. In Ethiopia leaves of *E. globulus* are

commonly used to treat flus and common cold (Dessie, 2011). Wind especially strong winds are some of the natural hazards in agriculture, however, the neighbouring farming households have added advantage as the eucalyptus trees act as windbreaks hence prevent the destruction of their crops by the winds (Smith, Jarvis et al. 1997). Studies show the vast reasons and benefits of the community around the eucalyptus plantations including the farming households in the community among these include, it's important in soil conservation and gully stabilisation (Mbugua, 2009). In recent years, many farmers now rear cattle in forest environment in order to make full use of the land resource (Pottier, 1984) and so Eucalyptus plantations can offer fodder to the neighbouring communities. However, these opportunities come at an opportunity cost, which has also been contested in the literature.

2.2 Negative impacts on rural livelihoods associated with Eucalyptus land use

Given the facts that eucalyptus has got a vast advantages like fast growing habits and rapid rate of adaptation to various climates, its water consumption rate is high and is known to lead to loss of a lot of ground water (Joshi and Palanisami, 2011). This is further explained in the context that when it comes to water adaptability, eucalyptus is unique compared to other perennial trees. It efficiently adjusts to additional water situations, that is to say, when there is a lot of water equivalent to 90 litres per plant per day. Similarly, it can as well grow successfully in environments of water scarcity that is when the water availability is between 40-50 litres per plant per day. This is possible by its ability to draw water from large area in the vicinity of its root system. In such water stress situation, its roots grow up to longer (6-9 m) and extract more water (Joshi and Palanisami, 2011). This eventually reduces the yield of nearby crops due to water stress (Kidanu, Mamo *et al*., 2005). According to Gombya-Ssembajjwe (1999), many crops that were planted within the width of about 2 to 10 metres near the tree line of the eucalyptus plantation remained weak and poor and this resulted to poor crop production. Never the less, this isn't only an effect of eucalyptus trees as other exotic trees also impact the same effects (Dessie 2011). Furthermore, the impact of Eucalyptus on the hydrology of a catchment has been contested (White *et al*, 1995) with the argument that in areas where rainfall exceeds 1200 mm per year, Eucalyptus is not expected to impact negatively on the hydrological cycle. Luwero district receives more than 1200 mm per year and therefore it is not clear if Eucalyptus has had a negative impact on availability of water and crop yields and if this can be a source of conflict between the growers and the neighbouring farming households.

2.3 Change in productivity of cropping systems adjacent to Eucalyptus land cover

Many farmers assert that in the process of getting trees that can be used to be used for intercropping, eucalyptus is the worst choice (Pender, Nkonya *et al*., 2006) This is because the eucalyptus species of trees don't fix nitrogen in the soil which is a very important nutrient in the development of many crops mostly legumes. Being a non-leguminous tree, instead they compete with the planted crops for the little nutrients in the soil and for this among many reasons, there will always be a change (decrease) in crop yields adjacent eucalyptus plantations (Zerga, 2015). This calls for monoculture of only the tree species without intercropping. Nevertheless, monoculture forestry has its disadvantages, these include; nutrients are depleted from the soil into the tree components, and it also changes the chemical status in the soil surface as only the litter layer and organic matter becomes dominated by one species. In many cases due to the high adaptability of the eucalyptus tree species to a widely varying eco-systems, (Joshi and Palanisami, 2011) afforestation programmes of government lands, marginal lands and even fertile lands are widely practiced on individual farms which has replaced food, fodder and fuel crops. Due to the allopathic activities of the some eucalyptus spp , selective growth of the crops is practiced by farming households next to these plantation and perhaps this effect limits intercropping of crops with the trees, the allele chemicals produced by the eucalyptus had effects on the proper growth of some crops like maize and beans (Alemie 2009)

CHAPTER THREE: METHODOLOGY

3.0 Overview

The primary data for this study was collected during the months of April and May in Luwero district of Uganda, I interacted with various farmers living near eucalyptus plantations and data were collected using the questionnaire designed to achieve the set specific objectives of the study.

3.1 Study Area

Luwero is a district that is found in Central Region of Uganda. Its bordered by different districts like Nakasongola to the north, in the East Kayunga District, Mukono District in the southeast, Wakiso District to the south, and finally to the west Nakaseke District. According to a daily Monitor article dated March 8, 2018, many districts including Luweero district have resorted to growing eucalyptus as alternatives to reduce the pressure on natural forests, never the less, and a lot of agriculture is practiced in this district.

3.2 Data Collection

Using questionnaire methods, data was collected. Using a questionnaire, different questions were asked from the farmers neighbouring the tree plantations and their answers were noted which data was later analysed. The study was conducted between the months of April and May, 2019.

3.3 Study Population

The population under this study were farmers in Luwero district, particularly those that were near eucalyptus plantations.

3.4 Sample size determination

In order to determine the sample size needed in the study to assess the impacts of land use change to eucalyptus on livelihoods of neighbouring farming households in Luwero district, Uganda, a standard formula given by (Kish,1985), was used to calculate the sample size as being 50.

3.5 Selection, Inclusion and Exclusion Criteria

I considered all farmers nearby eucalyptus plantations. I excluded out other farmers that were not growing their crops near eucalyptus plantations or those that were established near other tree *spp* like pine trees.

3.6 Sampling method

Radom sampling was used to reduce on bias. As long as the farmer met the inclusion criteria, had equal chances of being enrolled into this study.

3.7 Data processing, management and analysis

Data were entered into MS Excel whence they were imported to GenStat15 for multivariate analysis and SPSS 17 for non-parametric statistical analysis. The variables age, sex, duration of residence in village, farming experience, education level and primary occupation of household head were subjected to non-hierarchical clustering of the cases in the study using the complete link function in GenStat 15 and a dendrogram generated to test Hypothesis 1. The resulting clusters were regarded as farm types. Chi Square Test in SPSS17 were used to measure hypotheses 2 to 4. This was done for all respondents in general and also with respect to the clusters or Farm types generated in testing Hypothesis 1 to see if any specific group was favoured or disfavoured. All significant effects are reported at 95% confidence level.

CHAPTER FOUR: RESULTS

4.1. Diversity of households in Eucalyptus farming communities in Luwero

A wide range of households were involved in this study with respect to the household demographic information collected for characterization purposes. However, these were clustered into two farm types at 0.5 coefficient of similarity (Fig 1).

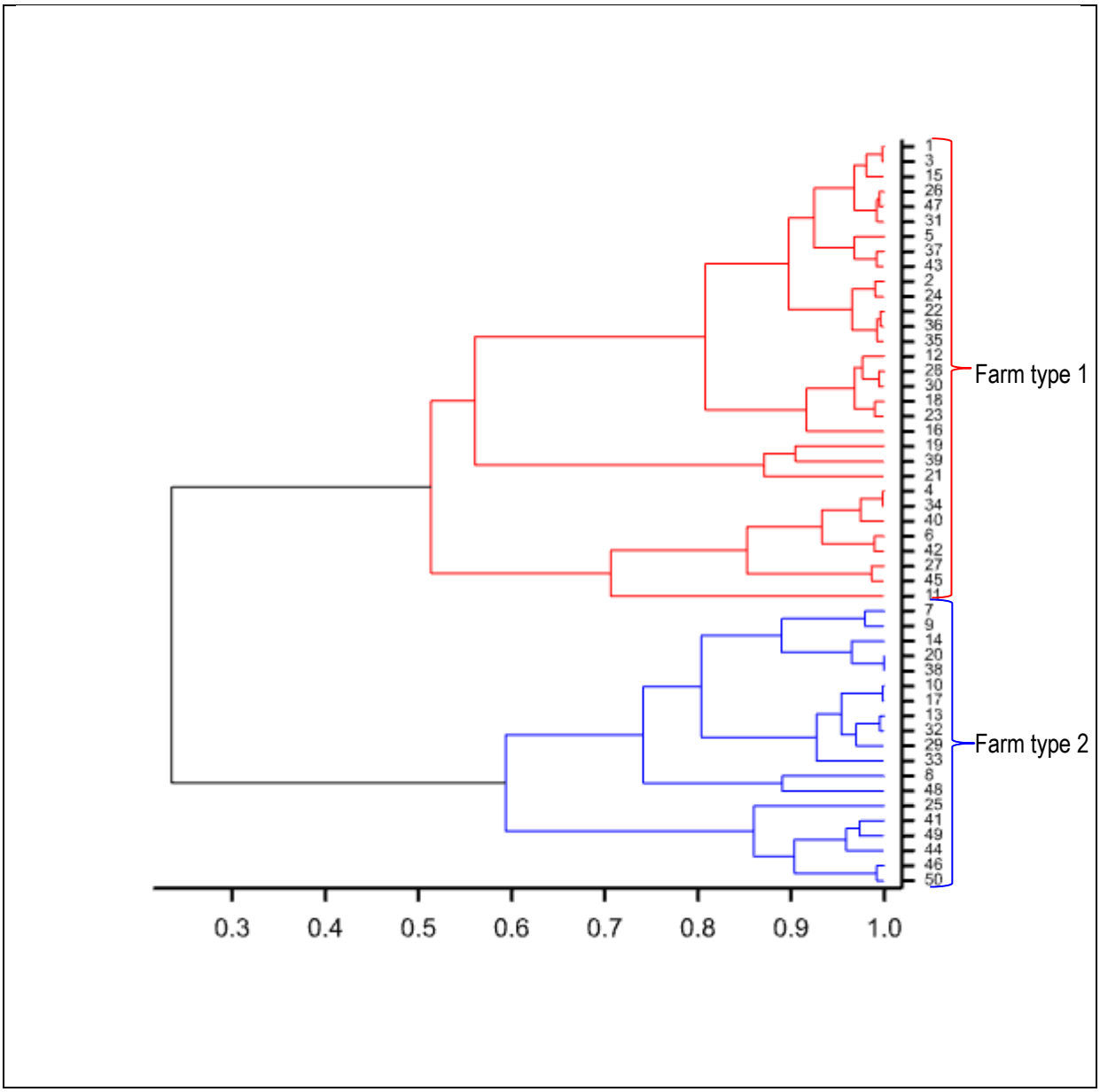
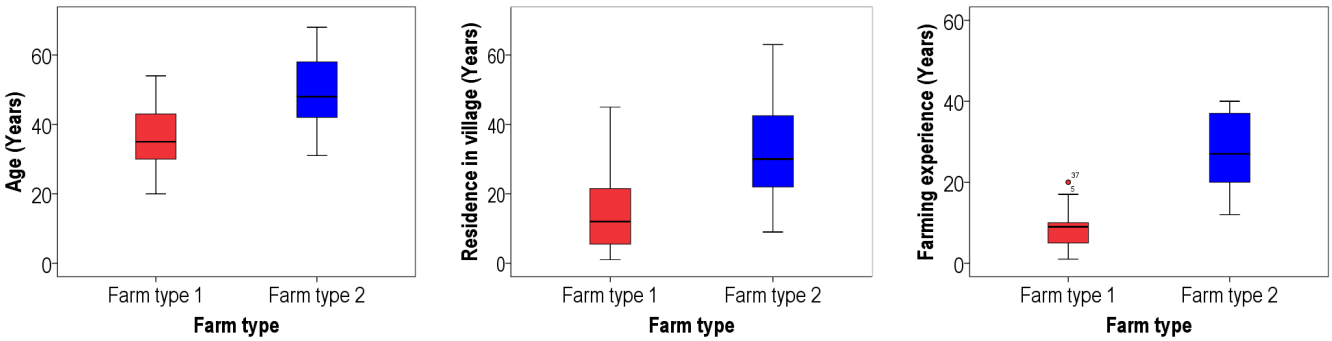


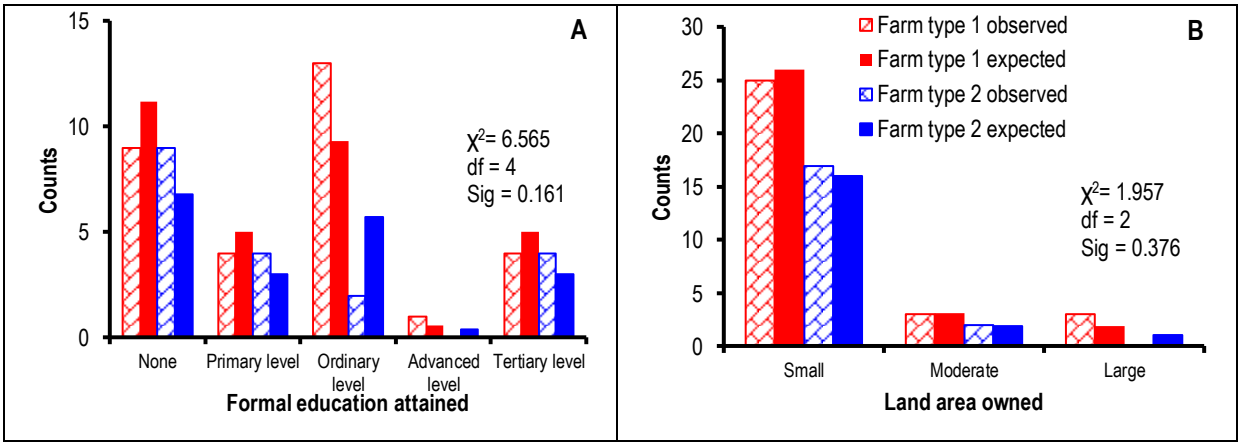
Figure 1: **Dendrogram showing the diversity of surveyed households in Luwero district (Central Uganda) with respect to biographic information**

Farm type 1 were the majority (62%) of the sampled households (Fig. 2). They were significantly younger in age by about 10 years, lived in the village by about 20 years fewer, and their farming experience shorter by about 20 years than for farm type 2 (Fig 2).



1Figure 2: Box plots for age, duration of residence in study village and farming experience of respondents in Luwero district, central Uganda

Farm type 1 respondents were slightly better educated than their farm type 2 counterparts at ordinary and advanced levels (Fig 3A) though the differences were not statistically significant at 95% confidence level. Farm type 1 tended to own the large tracts of land compared with farm type 2, but this difference was not significant at 95% confidence level (Fig 3B).



1Figure 3: Variation in formal education attained by respondent (A) and total acreage owned by the household in Luwero district, central Uganda

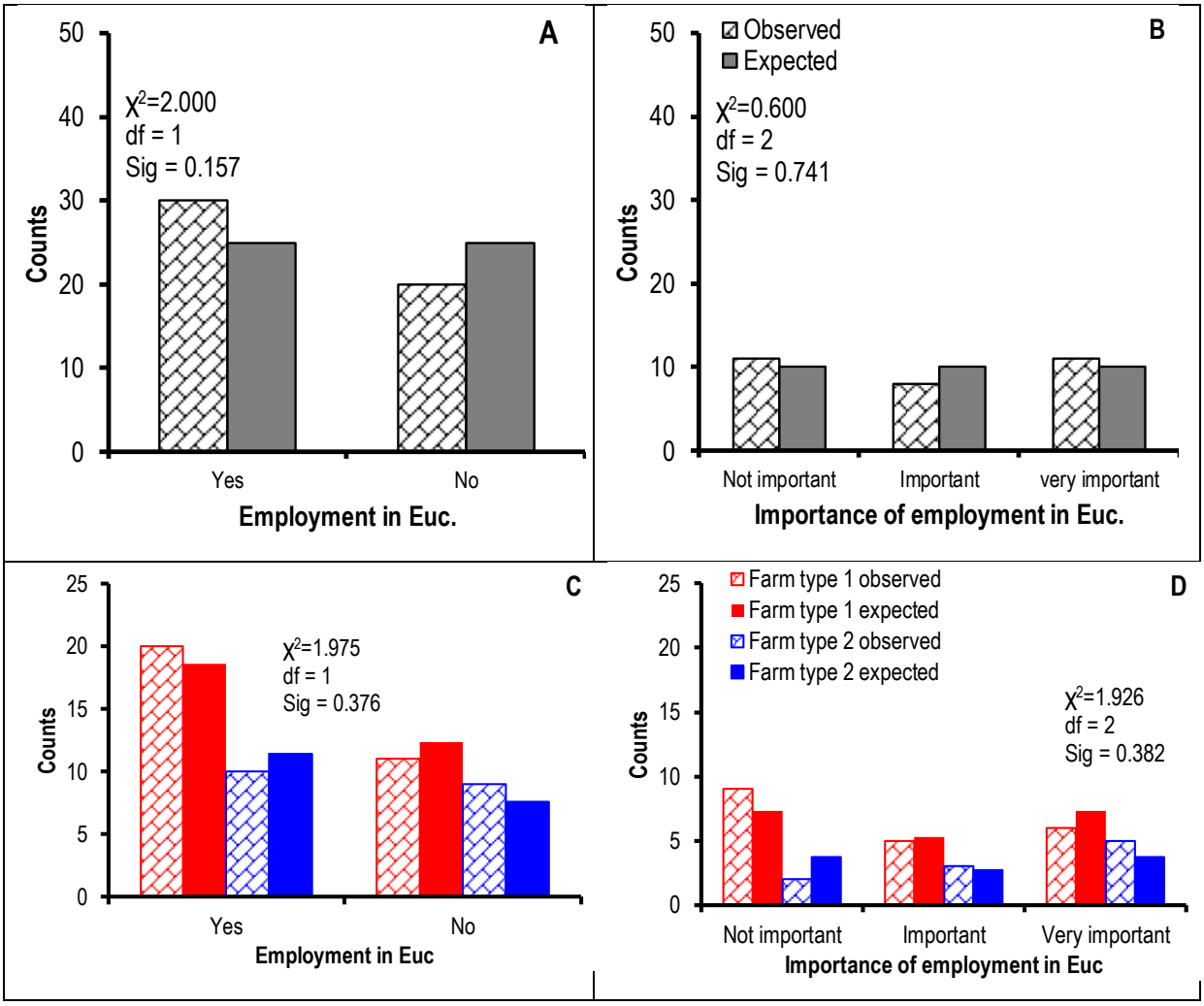
'Small' is equal to or less than 5 Acres owned; 'moderate' is 6-10 Acres owned; Large is greater than 10 Acres owned

4.2. Eucalyptus' opportunities to farming communities in Luwero district

4.2.1. Job creation

This was assessed with respect to job opportunities in the Eucalyptus plantations, access to land in the Eucalyptus plantations for cultivation of food crops, harvesting or purchasing firewood and building poles and use of the Eucalyptus plantations as grazing area for domestic livestock. The number of respondents who reported getting jobs in the Eucalyptus plantations was similar to that reporting never getting jobs in the Eucalyptus plantations. In each category ('Yes' or 'No'), the observed counts were similar to the expected counts as per

the Chi Square Test (Fig 4A) and this was the same across the farm types (Fig 4C). Those who got jobs in the in the Eucalyptus plantations were also not certain if the jobs were important to their livelihoods or not (Fig. 4B) regardless of the farm type (Fig 4D).



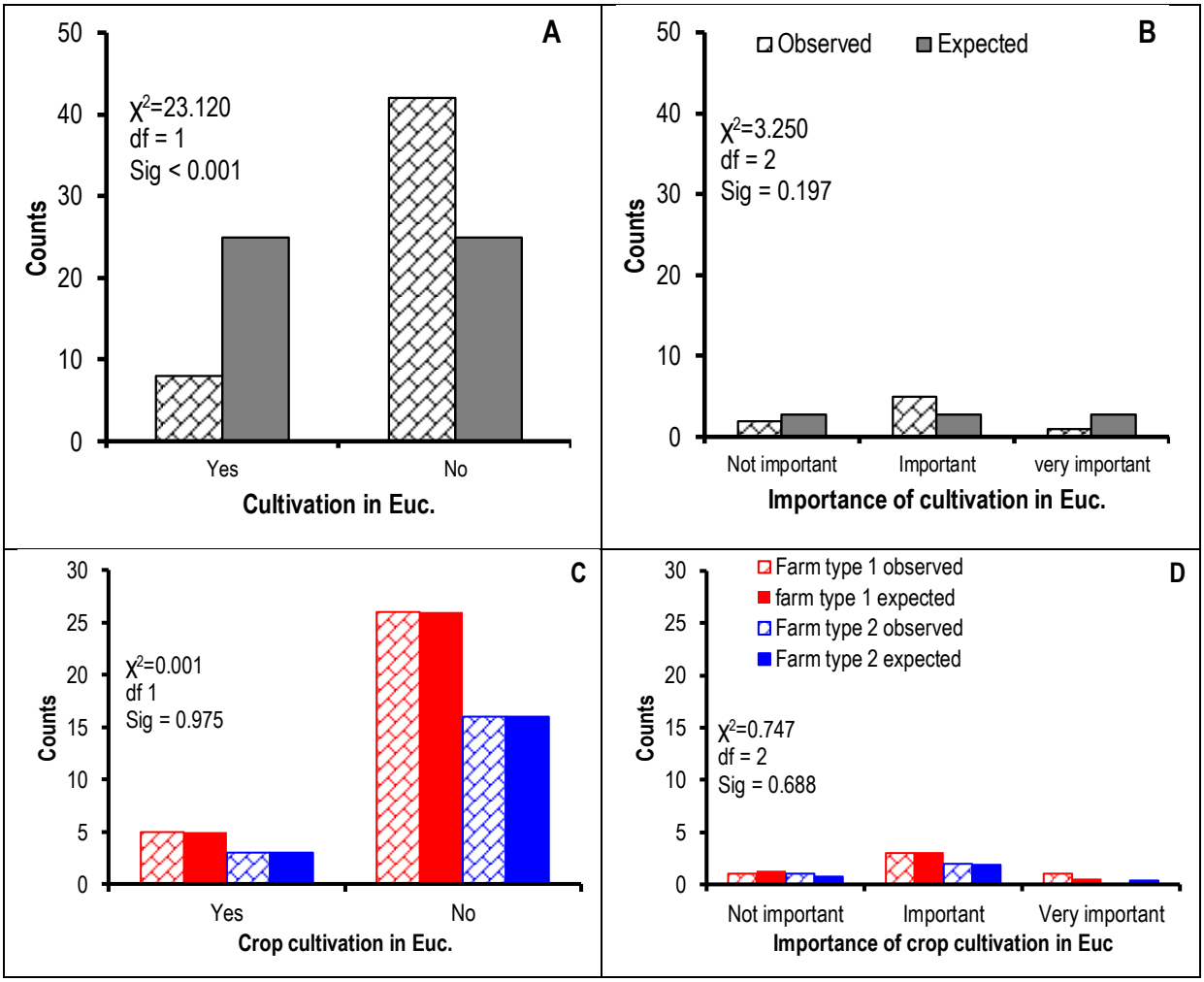
1Figure 4: Access to employment opportunities in Eucalyptus plantations in general (A), specific to farm types (C), ranking of the jobs to household livelihood in general (B) and across farm types (D)

Yes = accessed jobs in Eucalyptus (Euc.) plantations; No = did not access jobs in Eucalyptus plantations; not important = household could meet their livelihood needs without the jobs in Eucalyptus plantations; Important = household could meet a portion of their livelihood needs without the jobs in Eucalyptus plantations but struggle to survive; Very important = the household entirely depended on the jobs in Eucalyptus to meet their livelihood needs.

4.2.2. Production of food crops

Over 80% of the respondents did not get access to the Eucalyptus plantations to grow their own food. This was significantly higher than the expected 50% (Fig 5A). Of the few who got access to the Eucalyptus plantations to grow their own food, the majority (n=5) considered

the opportunity important to their livelihood though the association was not significant at 95% confidence level (Fig 5 B). There was no significant difference in access to the Eucalyptus plantations for crop cultivation across farm types (Fig 5C) and ranking of its importance of the food crops produced this way to the livelihood of the households (Fig 5D).



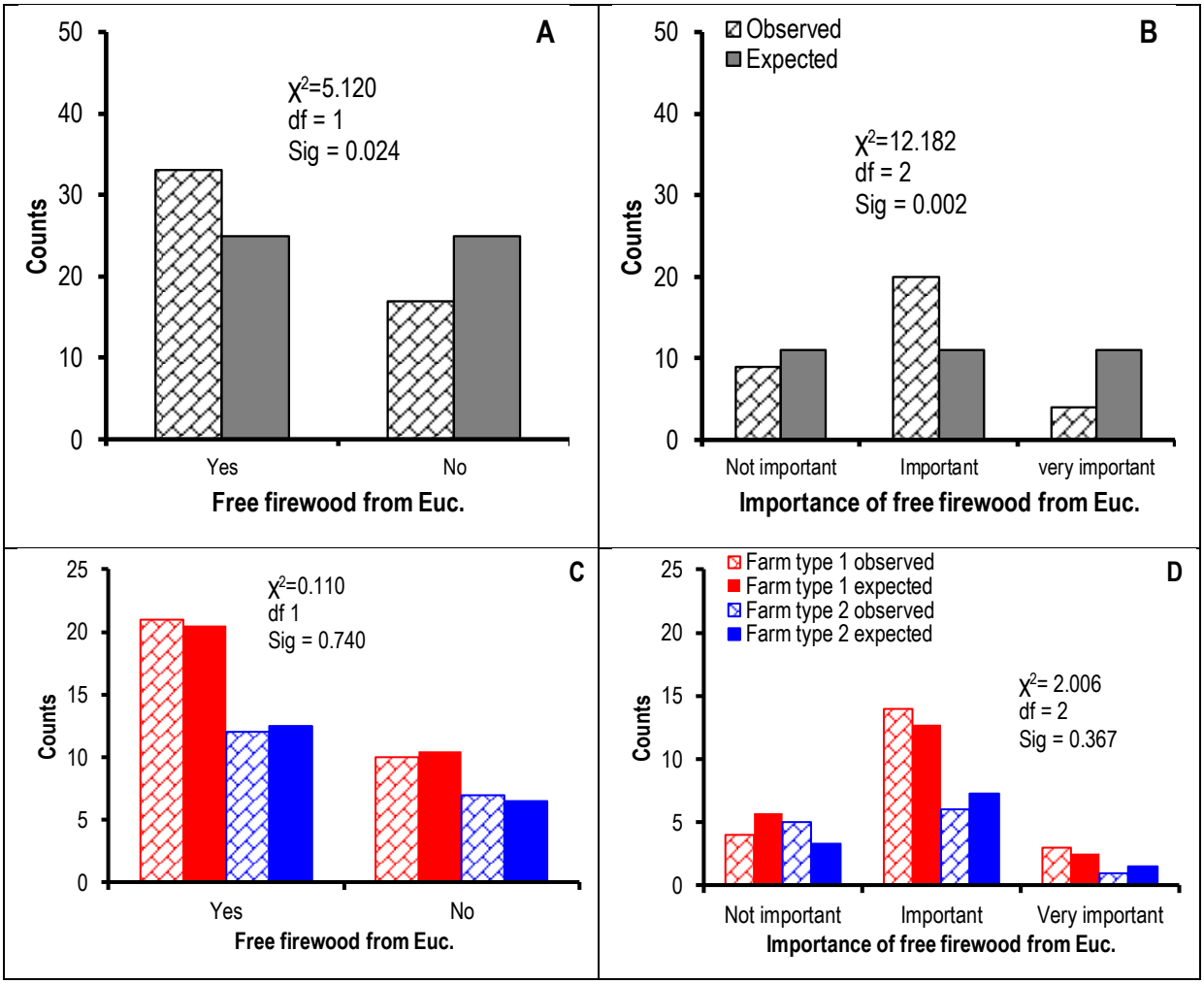
1Figure 5: Access to Eucalyptus plantations in general to grow food crops (A), specific to farm types (C), ranking of the food produced in Eucalyptus plantations to household livelihood in general (B) and across farm types (D)

Yes = accessed Eucalyptus (Euc.) plantations for crop cultivation; No = did not access Eucalyptus plantations from crop cultivation; Not important = household could meet their food needs without the food production in Eucalyptus plantations; Important = household could meet a portion of their food needs without access to the Eucalyptus plantations; Very important = the household entirely depended on the food from the Eucalyptus plantations.

4.2.3. Production of fuel wood

At the community level, about 66% of the respondents reported being allowed to harvest firewood from the Eucalyptus plantations free of charge. This was significant at 95%

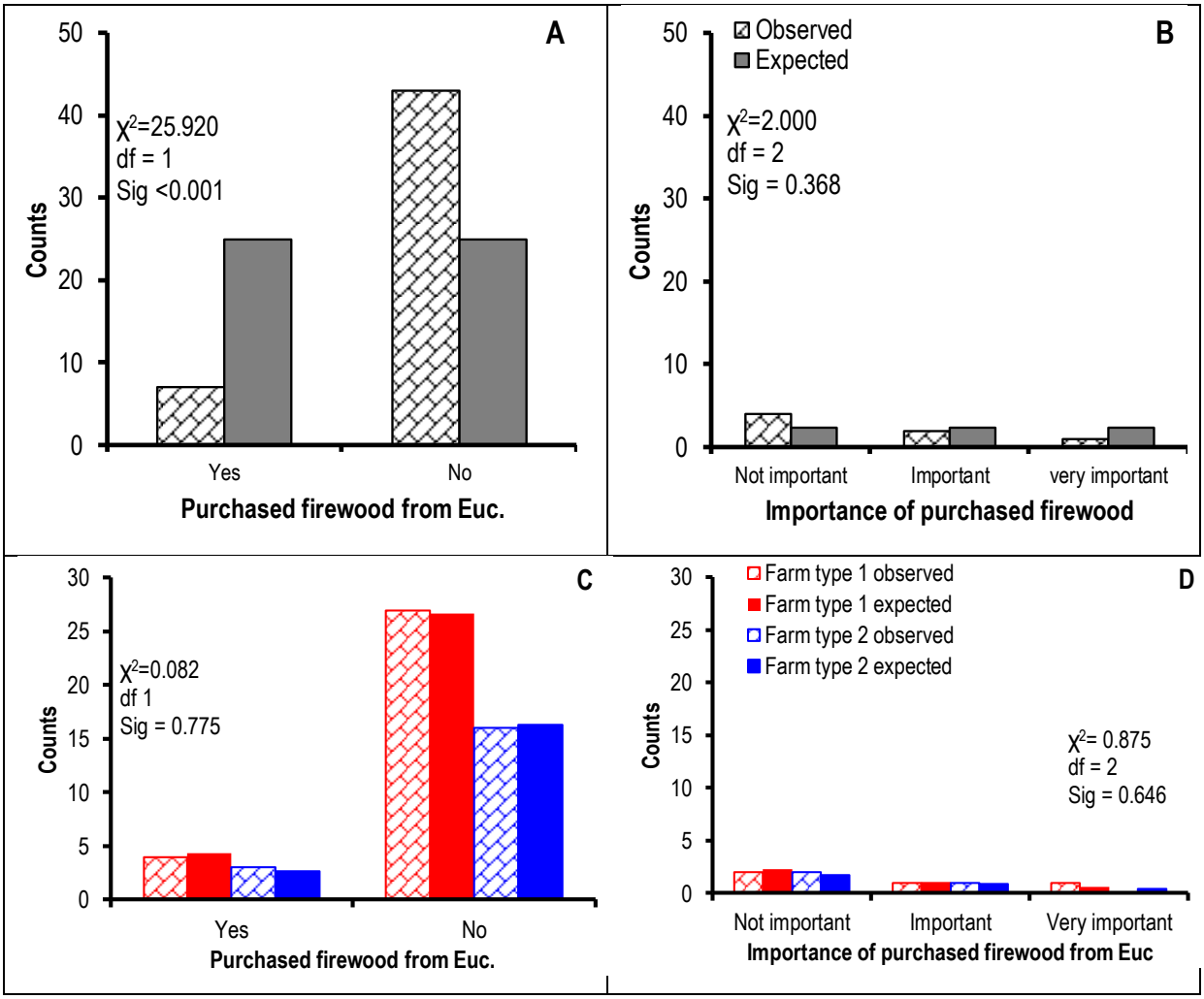
confidence level given that the expected frequency was only 50% (Figure 6A). The firewood freely harvested was important to the households and this was also significant at 95% confidence level given that the observed for the category 'Important' was 20 counts (60.6%) compared to the expected 11 counts or 33% (Fig 6B). There was no significant difference in freely harvesting firewood from the Eucalyptus plantations across farm types (Fig 6C) and ranking of its importance to the livelihood of the households (Fig 6D).



1Figure 6: Free harvest of firewood from Eucalyptus plantations in general (A), specific to farm types (C), ranking of the free firewood from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D)

Yes = Freely harvested firewood from the Eucalyptus (Euc.) plantations; No = did not freely harvest firewood from the Eucalyptus plantations; Not important = household could meet their firewood needs without the free harvests from the Eucalyptus plantations; Important = household could meet a portion of their firewood needs without free harvests from the Eucalyptus plantations; Very important = the household entirely depended on the firewood harvested freely from the Eucalyptus plantations.

Less than 15% (7 counts) of the respondents in general purchased firewood from the Eucalyptus plantations. Compared to the expected 50%, or 25 counts, this difference was significant at 95% confidence level (Fig 7A). Of the few (7 counts) who purchased firewood, the majority (4 counts or 57%) ranked the purchased firewood from the Eucalyptus plantations not important to their livelihood though this was not significant at 95% confidence level (Fig 7B). There was no significant difference in freely harvesting firewood from the Eucalyptus plantations across farm types (Fig 7C) and ranking of its importance to the livelihood of the households (Fig 7D).

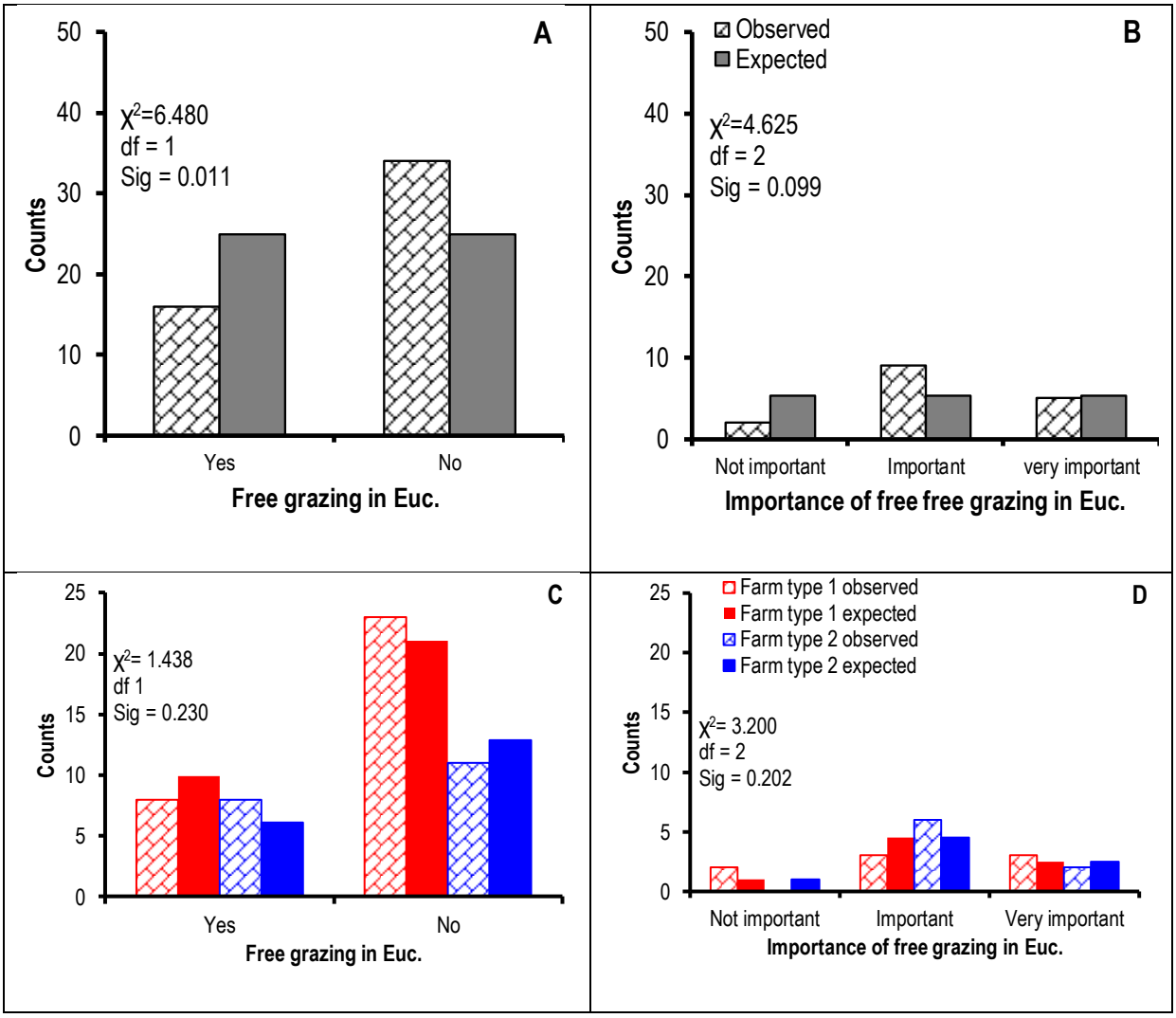


1Figure 7: Purchased firewood from Eucalyptus plantations in general (A), specific to farm types (C), ranking of the purchased firewood from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D)

Yes = Purchased firewood from the Eucalyptus (Euc.) plantations; No = did not purchase firewood from the Eucalyptus plantations; Not important = household could meet their firewood needs without purchases from the Eucalyptus plantations; Important = household could meet a portion of their firewood needs without purchases from the Eucalyptus plantations; Very important = the household entirely depended on the firewood purchased from the Eucalyptus plantations.

4.2.4. Production of fodder

Free grazing in the Eucalyptus plantations seems to be rare in general. Only 16 respondents or 32% reported getting free grazing in the Eucalyptus plantations. This was significantly low compared to the expected 25 counts or 50% (Fig 8A).



1Figure 8: Free grazing livestock in the Eucalyptus plantations in general (A), specific to farm types (C), ranking of free grazing of livestock in the Eucalyptus plantations to household livelihood in general (B) and across farm types (D)

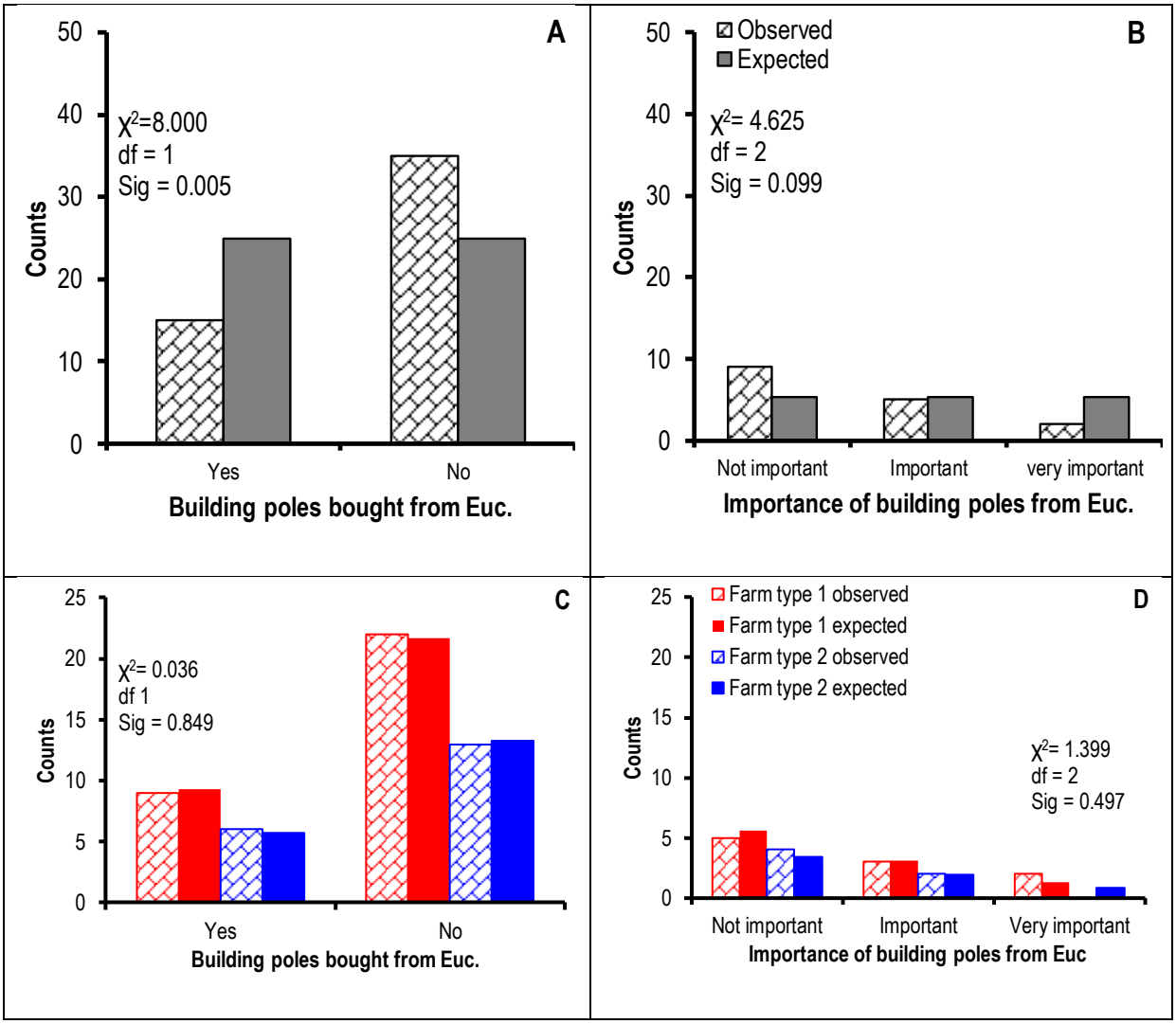
Yes = Freely grazed livestock in the Eucalyptus (Euc.) plantations; No = did not freely graze livestock in the Eucalyptus plantations; Not important = household could meet their livestock grazing needs without access to the Eucalyptus plantations; Important = household could meet a portion of their livestock grazing needs without free grazing in the Eucalyptus plantations; Very important = the household entirely depended on the freely grazing their livestock in the Eucalyptus plantations.

The majority (9 counts) of those that freely grazed their livestock in Eucalyptus plantations ranked the opportunity as important, but this was not significant at 95% confidence level

(Fig. 8B). There was no significant difference in freely grazing livestock in the Eucalyptus plantations across farm types (Fig. 8C) and ranking of its importance to the livelihood of the households (Fig. 8D).

4.2.5. Production of building poles

Only 15 respondents or 30% reported buying poles for construction from the Eucalyptus plantations in the village. This was low compared to the expected 25 counts or 50% and therefore the difference was significant at 95% confidence level (Fig. 9A).



1Figure 9: Purchase of construction poles from the Eucalyptus plantations in general (A), specific to farm types (C), ranking of purchasing building poles from the Eucalyptus plantations to household livelihood in general (B) and across farm types (D)

Yes = Purchased building poles from the Eucalyptus (Euc.) plantations; No = did not purchase construction poles from the Eucalyptus plantations; Not important = household could meet their building pole needs without purchase from the Eucalyptus plantations; Important = household could meet a portion of their building pole needs without purchase from the Eucalyptus plantations; Very important = the household entirely depended on the building poles purchased from the Eucalyptus plantations.

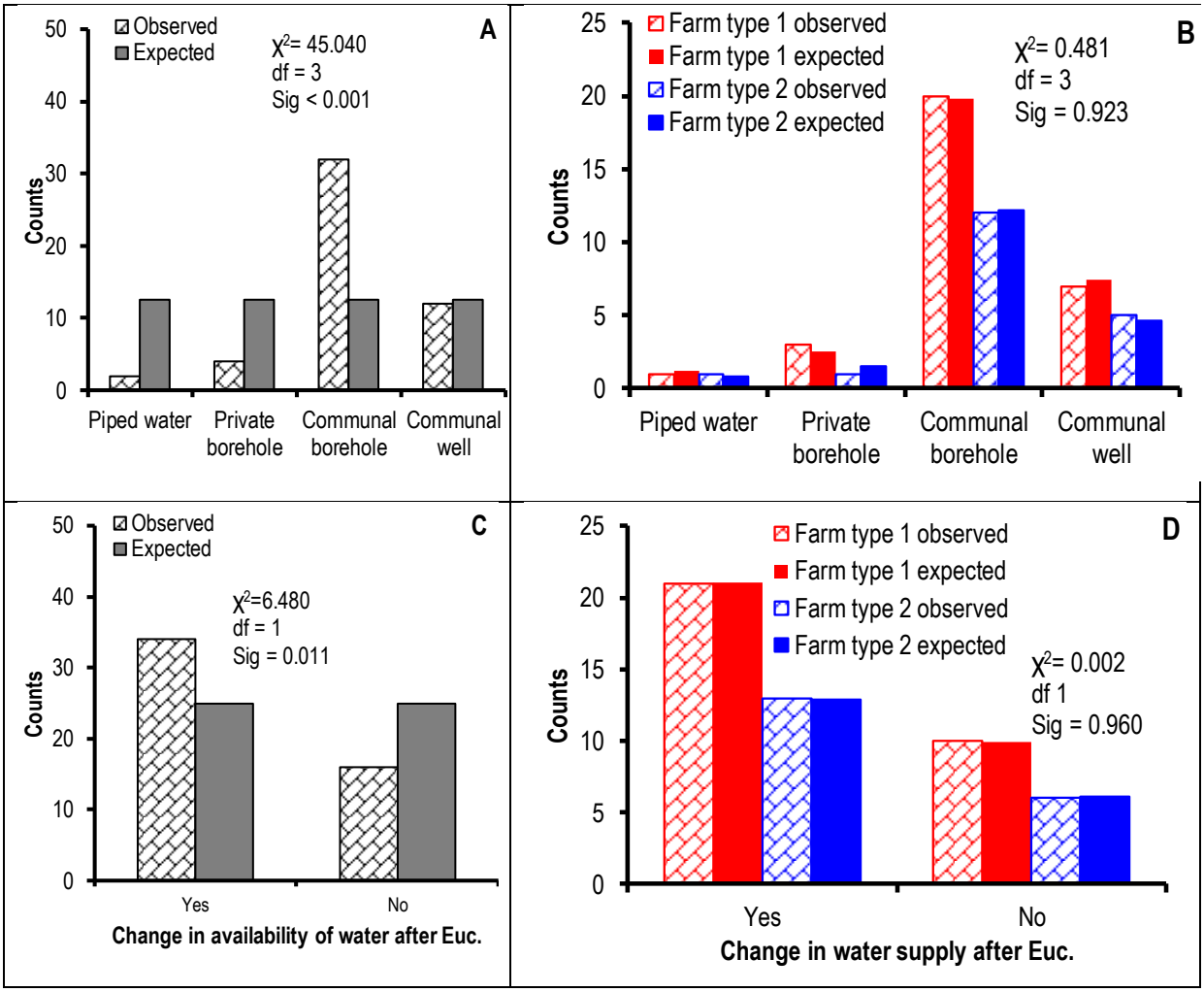
The majority (9 counts) of those that bought building poles from the Eucalyptus plantations in the village ranked the opportunity as being not important though this was not significant at

95% confidence level (Fig. 9B). There was no significant difference in purchase of building poles from the Eucalyptus plantations in the village across farm types (Fig. 9C) and ranking of its importance to the livelihood of the households (Fig. 9D).

4.3. Eucalyptus' 'opportunity cost' to farming communities' in Luwero district

4.3.1. Water for domestic use

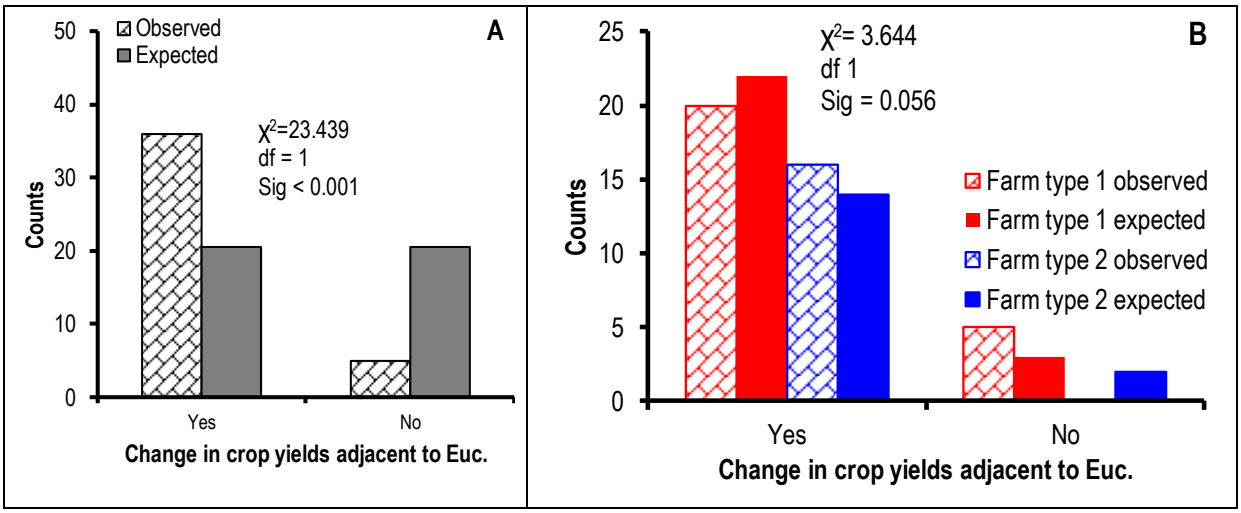
For domestic consumption, communal boreholes were used at a frequency that was three times that was expected (Fig. 10A) and therefore significant at 95% confidence level. There was no significant difference in source of water for domestic consumption between farm types (Fig. 10B). Significantly more respondents (34) than expected (25) reported a change in availability of water since the introduction of Eucalyptus to the area (Fig. 10C), regardless of farm type (Fig 10D). They all reported a reduction in availability of water for domestic use.



1Figure 10: Source of water for domestic consumption in general (A) and across farm types (B), and change in availability of water for domestic consumption since introduction of Eucalyptus (Euc.) in general (C) and across farm types (D) in Luwero district, Uganda

4.3.2. Change in crop yields adjacent to Eucalyptus

Over 70% of the respondents reported a change in crop yields adjacent to Eucalyptus, compared to an expected 41% in general and this was significant at 95% confidence level (Fig. 11A). However, only farm type 2 respondents were in agreement with this perception. Those from farm type 1 reported no change in crop yields adjacent to the eucalyptus though this difference was only significant at 94% confidence level (Fig. 11B).

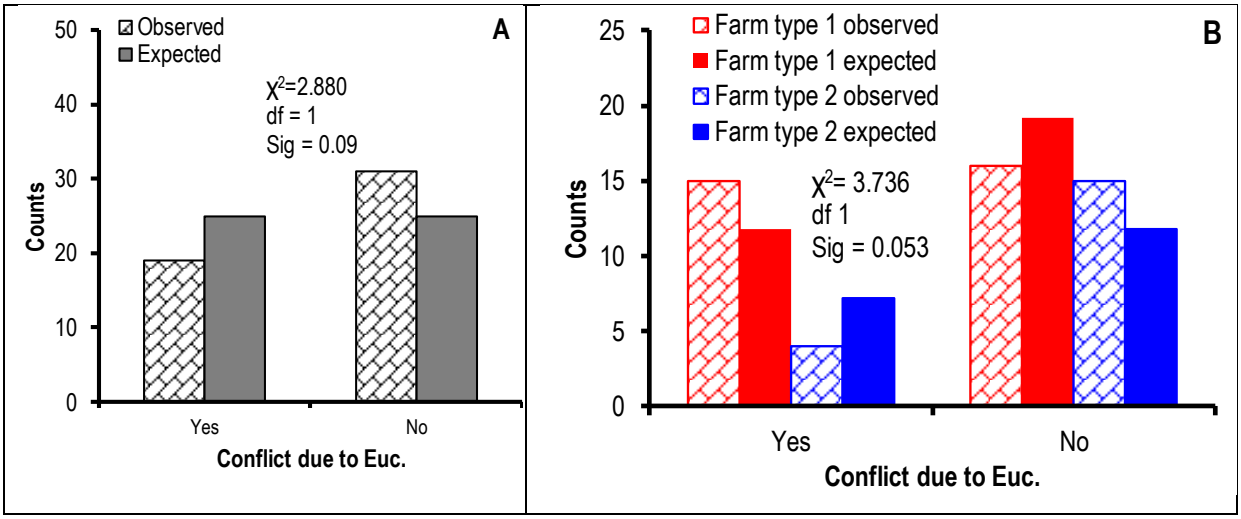


1Figure 11: Perceived change in crop yields adjacent to Eucalyptus (Euc.) in general (A) and across farm types in Luwero district, Uganda

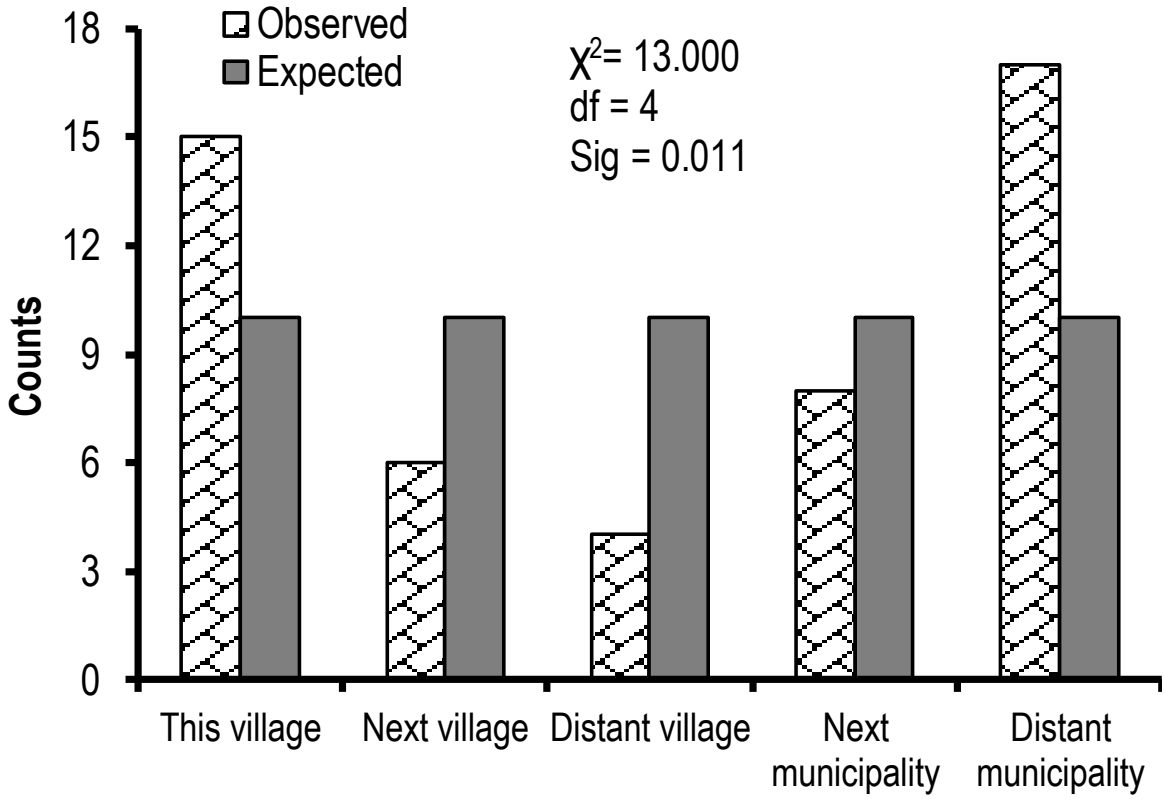
All who reported change in crop yields adjacent to Eucalyptus were of the view that the yields had declined (data not shown).

4.4. Eucalyptus' 'threat' to farming communities' in Luwero district

Fewer respondents (19 counts) than expected (25 counts) reported conflict with neighbours over the impact of Eucalyptus on their crops in general (Fig. 12A). However, this difference was only significant at 90% confidence level (Fig. 12A). The conflict was described as being mild or non-violent without any harm to body or property. It tended to be more prevalent in farm type 1 than in farm type 2 though this difference was only significant at 94% confidence level (Fig. 12B). However, it was also observed that the majority of Eucalyptus growers were non-residents in the villages where the study community lived (Fig. 13).



1Figure 12: Conflict over impacts of Eucalyptus (Euc.) on adjacent crops in general (A) and specific to farm types (B) in Luwero district, Uganda



1Figure 13: Residency of Eucalyptus owners in Luwero district, Uganda

CHAPTER FIVE: DISCUSSION

5.1 Eucalyptus' opportunities to farming communities in Luweero district

The opportunities to farming communities living in the neighbourhood of Eucalyptus plantations assessed in this study were jobs, food production, fuel wood, fodder and building poles from the Eucalyptus plantations. Only access to free firewood (Fig. 6A, B) turned out to be important to the farming households neighbouring Eucalyptus plantations regardless of the farm type (Fig. 6C, D). This finding is in line with reports from Leggat (1952), which indicates that eucalyptus has traditionally been used as source of freely harvested fuel wood in Uganda. The importance of Eucalyptus as a source of free firewood may be because it is recommended that growers prune all branches up to a height of 7m to prevent formation of knots, which degrade the resulting pole and timber quality. The knots are formed when branches die naturally (Kenya Forestry Services, 2009). Since the pruned branches are simply discarded in the plantation, farming communities that largely rely on biomass fuel for their household energy needs harvest these for the domestic consumption. In this regard, the Eucalyptus plantations were deemed to be an important source of fuel wood to the neighbouring farming households. However, this was not the case when it came to purchased fuelwood (Fig. 7). This may have been because the growers targeted the construction pole and timber market, which is more lucrative than the fuel wood market, since in the latter, only the small poor-quality products from the Eucalyptus plantations are sold as fuel wood.

Eucalyptus demands a lot of labour for land preparation, planting and weeding in the early part of its life cycle. However, this is over a limited duration of time after which canopy cover minimises the need to hire labour for management of the plantation (Kenya Forestry Services, 2009). This explains why Eucalyptus plantations did not significantly contribute to the job opportunities in the neighbouring farming communities (Fig. 4A). Eucalyptus also has allelopathic effects, which make other plant species intercropped with it to grow and yield poorly (….). This may explain why Eucalyptus did not significantly contribute to food production (Fig 5. A) in the neighbouring farming communities in Luwero district. It is likely that due to allelopathy, the contribution of Eucalyptus plantations to fodder for the neighbouring farming households was minimized.

5.2 Eucalyptus' opportunity cost to farming communities in Luweero district.

Just like (Joshi and Palanisami, 2011) **,** the commonest criticisms against plantations of eucalypts are that they lead to a change in the local climate. Well this isn't different from Luweero eucalyptus plantations as all the farmers that claimed to have noticed a change in the water availability say it was a decrease due to the trees. This is precisely due to their high evapotranspiration rate, this in turn drains water from the soil which leads to a lower water table. This high evapotranspiration rate is said to have highly contributed to poor crop yields just like noticed by (Jagger and Pender 2003)

This study just like (Dessie 2011) has shown that trees perform numerous important roles for the people for the surrounding communities. They are used for many purposes, these include among them, for fuel wood, poles for house construction. The firewood was mainly got for free and is used as a cheap alternative source of energy, only under a few cases did the owner sell the firewood to the neighbouring communities

Given the dangerous effects of eucalyptus to ground water availability, i.e. depletion of underground water, this has sparked conflicts between the eucalyptus plantations' owners and neighbours.

According to this research, bananas most grown crops near eucalyptus plantations with a percentage of 21% followed very closely with cassava at 20% while pines and yams got to be the least grown non-eucalyptus crops with 1% near eucalyptus trees and according to the data analysed, 72% of the neighbouring communities noticed a change in crop yield cultivated adjacent to the eucalyptus. This is in conformation with the research of (Zerga 2015)

This evident with all the yields in crop production dropping /decreasing at varying percentages, between 10-100% decrease. The reduction in crop yield is likely due to the effect of water, i.e. eucalyptus drained the land hence depriving the crops of water which is an essential element in their growth and productivity (Passioura 2002). However, about 32% of the neighbouring farmers confessed that they had noticed a change in pest prevalence as an effect of the eucalyptus. The change is both negative and positive depending on the type of crop grown. Never the less, the influence of eucalyptus on the pest and disease prevalence on the general scale is very little as many farmers actually didn't recognise it.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The only benefit that farming communities derive from the Eucalyptus plantations in Luwero district is free firewood regardless of Farm type. However, this comes at the cost of reduced water availability and crop yields regardless of farm type. There is also risk for conflict and social strife if business as usual continues, especially with the younger farmers.

6.2 Recommendations

There is need to zone out areas for cultivation of Eucalyptus where it is unlikely to negatively impact ground water recharge and crop yields in the surroundings.

Further studies should be conducted to establish alternative tree/shrub species that do not possess the negative effects observed with Eucalyptus.

APPENDICES

APPENDIX 1: MAP OF LUWEERO DISTRICT

FIGURE 1: Map of Uganda showing two study districts of Luwero and Nakasongola.

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