



**HUMAN-WILDLIFE CONFLICT FROM THE EDGE, OF YAYU  
COFFEE FOREST BIOSPHERE RESERVE ALONG DISTANCE  
GRADIENT, SOUTHWEST, ETHIOPIA**

**M. Sc. THESIS**

**BY**

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**FEBRUARY, 2020**

**JIMMA, ETHIOPIA**

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**M.sc. Thesis**

**By**

**Alemayehu Mamo Haile**

**Msc. Thesis**

*Submitted to the School of Graduate Studies Jimma University, College of Agriculture and Veterinary Medicine in Partial Fulfillment of the Requirements for the Degree of Master of Science in Natural Resource Management Specialization in (Wildlife and Ecotourism Management)*

**Advisors:**

**Major Advisor:** Debela Hunde (PhD, Professor)

**Co-Advisor:** Debissa Lemessa (PhD)

**February, 2020**

**Jimma, Ethiopia**

## **DEDICATION**

I dedicate this thesis manuscript to the whole family members especially to my father Mr. Mamo Haile and my mother Mrs. Tejitu Tadesse, for growing me up with love and being a constant source of inspiration as without their effort and encouragement the thesis work would not be completed.

## STATEMENT OF AUTHOR

First of all I would like to announce that this thesis is my original work and that all sources of materials used in this thesis have been duly acknowledged. This thesis will be submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University College of agriculture and veterinary medicine and will be deposited in the university library to be made available to borrowers under the rule of the library. I solely declare that this thesis will not be submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Request for permissions for extensive quotation from manuscript in whole or in part may be granted by the head of department of Natural resource Management or the dean of the school of graduate studies based on his or her judgment when the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

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## **BIOGRAPHICAL SKETCH**

The author, Alemayehu Mamo Haile, was born on 9 January, 1988 in Hamuma kebele, Halu Woreda, in Illubabor Zone of Oromia National Regional State. He attended his elementary school at Hamuma higher primary school and secondary school at Gore higher and preparatory school. Following the completion of his Secondary education, he joined Nedjo ATVET College of Agriculture and Natural Resource Management on September 11, 2007 and graduated with Diploma in Natural resource management on 30 June, 2009. After graduation, he was employed by Halu woreda Agriculture and Natural Resource management office. Later he joined Jimma University College of agriculture and Veterinary medicine on 5 September 2015 and graduated with B.Sc. Degree in Natural resource Management with great distinct, on June30, 2017. After graduation from Jimma University, he worked Halu Woreda Agriculture and Natural source Management office, as Natural resource management department coordinator until he joined the graduate studies program of Jimma University College of Agriculture and Veterinary Medicine to pursue a graduate study leading to a Master's of Science degree in Wildlife and Ecotourism Management.

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## **LIST OF ACRONYMS AND ABRIVETIONS**

ANRMO	Agriculture and Natural Resource Management Office
DA	Development agent
GOVT	Government
HWC	Human-wildlife conflict
HG	Homegarden
HH	Household
ILAGNRMO	Illubabor zone Agriculture and Natural Resources Management Office
IUCN	International Union for Conservation of Nature
NGO	Non-Governmental Organization
NRM	Natural Resource Management
WWF	World Wide Fund of Nature
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
YBR	Yayu Biosphere Reserve
YCFBRR	Yayu Coffee Forest Biosphere Reserve

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## ABSTRACT

*Human-wildlife conflicts undermine human welfare, health, safety, conservation efforts and have economic and social costs. This study was conducted to assess human-wildlife conflict and crop raiding in relation to distances from forest edge, to surrounding the agricultural landscape of Yayu coffee forest biosphere reserve, southwest Ethiopia. A total of thirty transects each 1km long, with 200m interval between transects, were laid out from forest edge towards agricultural landscape and 124 HHs were randomly selected for questionnaire survey. Data, on type of major crop raiders, level of crop raiding; traditional crop protection methods and attitude of farmers towards wildlife were collected using questionnaire survey and focus group discussion. The data on types of crop raiders, level of crop raiding, traditional crop protection methods and response of farmers on attitude towards wildlife, were tested with Pearson's Chi-square test and the mean species richness in homegardens was tested with One-way ANOVA. All data were analyzed by R-statistical program (version 3.6.2.). The study result indicated that, four wild animals; Olive Baboon, Vervet monkey, bush pig and, crusted Porcupine were identified as major crop raiders. There was a significant spatial variation of crop raiding across the landscape ( $p=0.000$ ), frequency of crop raiding shows decreasing trend with increasing distance from the forest edge, and it was severe close to forest edge. Farmers were used traditional crop protection methods like; guarding, chasing, live fencing, scarecrow and smoking. Majority of the farmers close to forest edge have negative feeling to wildlife's, due to heavy crop loss and permanent guarding the crop. To mitigate heavy crop loss caused by wildlife, farmers nearest to the forest edge should change their farming practices. Further study is needed to find alternative crop species, which is less palatable to crop raiders and could grow in the agro climatic condition of the area.*

**Keywords:** Biosphere reserve; Close to forest; Crop raiding; Ethiopia; Forest edge; Yayu

# 1. INTRODUCTION

## 1.1. Background of the study

Human-wildlife conflict(HWC) is any interaction where there is an overlap between wildlife needs and human needs that resulted in costs to residents or their resources and wild animals or their habitats (World Park Congress, 2003). “Crop raiding” refers to wild animals damaging plant crops cultivated by humans, by either feeding on or trampling, them (Hill, 2017).Human-wildlife conflict has been in existence for as long as humans and wild animals have shared the same landscapes and resources. Nowadays it exists in one form or another all over the world (FAO, 2009). Human-wildlife conflicts around protected areas continue to be a growing challenge in contemporary conservation, especially when attempts are made to balance global environmental goals with local residents’ livelihood activities (Dolbeer *et al.* 1996).As a result, several previous studies have indicated that human-wildlife conflict has become sever across the globe and need an in depth analysis to understand the socio-ecological system related to this human-wildlife interaction in the way that such understanding will support the conservation of threatened and potentially endangered species (Hill, 2000).

Developing effective human-wildlife conflict mitigation strategies requires an understanding of the conflict patterns, species involved and attitudes of local people living along protected area boundaries, because the conservation of wildlife and their habitats requires giving priority for reducing conflict between wildlife and humans mainly in agricultural landscapes where people are densely populated and wildlife co-occur(Megaze *etal.*,2017). The transforming of natural landscapes to predominantly human modified landscapes triggers the competition between humans and wildlife for space and resources and this has exacerbated the severity of the human-wildlife conflict that has now-related at the unprecedented levels(Kate,2012). In spite of diverse and unique nature of the Ethiopian landscape and ecological diversity, the natural resources of the country are declining by human activities. This has increasingly restricted wild animals’ movement of the country to a few protected areas/habitats (Bekele *et al.*, 2011).

Crop-raiding is a form of human-wildlife conflict which directly affects local people's perception towards wildlife's and support for conservation initiatives (Hill, C.M., 2004).

According to Quirin, (2005) Wildlife ranging from invertebrate insect pests to vertebrate such as small mammals, birds and large mammals are reported to raid agricultural crops in different parts of Ethiopia. Asmamaw and Verma,( 2013) were reported that warthog and mountain nyala raid agricultural crops such as barley (*Hordeum spp*), linseed (*Linum usitatissimum*), vegetables including; potato(*Solanum tuberosum*) and cabbages in Bale Mountain National Park. In Illubabor zone; olive Baboon, vervet monkey, and Bush pigs were reported to be the primary pests responsible for crop damage (Dixon, 2008). In Gera district southwest Ethiopia, Olive baboons, bush pigs, giant forest hogs, vervet monkeys, porcupines, warthogs, Colobus monkeys and blue monkeys were reported as major crop raider wildlife species and a large proportion (79%) of the annual crop, home garden, and coffee fields were raided by at least one of these mammals during the cropping season (Ango *et al.*2014).

Etissa *et al.*, (2016) were indicated that crops damage due to wild animals is number one problem in transitional area of Yayu coffee forest biosphere reserve. The frequency of crop damage due to wildlife crop raiders varies with distance from wild nature to human modified landscapes (Madden,2008;Lemmesa *et al.*,2013).Moreover, the intensity and types of damage caused by wildlife vary with crop raider species, time of the year and type of crop species grown (Mwamidi *et al.*, 2012).

## **1.2. Statement of the problem**

One of the main challenges facing wildlife conservation in the twenty-first century concerns the increasing interaction between people and wildlife and the resulting conflicts that emerge (Sillero and Switzer, 2001); particularly, the encroachment of wild habitats in Africa is increasingly leading to conflict. Subsistence farmers living in developing countries of Africa and Asia are suffering from the negative impact of human-wildlife conflict because,

crop raiding by baboons, elephants and other herbivores seriously affect poor farmers (Teshome and Girmay, 2017).

As in other parts of the world, in Ethiopia, there are wide varieties of wildlife species causing damage to crops. These wildlife species cause serious damage to agricultural crops in different parts of the country (Datiko and Bekele, 2011). Crop raiding is a serious problem especially in situation of those who share the immediate boundaries with protected areas. Human population growth, less public understanding and the negative perception of local community towards wildlife and their conservation generally increase conflict between humans and wildlife (Teshome and Girmay, 2017). Crop-raiding animals may cause substantial damage to agricultural crops, and this has always been a major issue of contention throughout the world. Due to the expansion of cultivated land into previous wildlife habitat, it is becoming one of the most common conflicts antagonizing human-wildlife relationships (Sillero and Switzer, 2001).

The current study area, food items such as Maize, Sorghum, Teff Potato, Avocado, Mango, Beans and Haricot bean are damaged by wild animals like baboon, vervet monkey, Bush pig and Crusted porcupine. However, still the issue of human-wildlife conflict and crop raiding is not adequately assessed in the study area so far and adequate development enhancing information is lacking. Therefore, this study was designed in view of bridging this gap and to generate basic scientific information on human-wildlife conflict from the edge, of yayu coffee forest biosphere reserve along distance gradient, to contribute for future informed management of the conflict.

### **1.3. Objective**

#### **1.3.1. General objective**

The general objective of this study was to assess human-wildlife conflict from the edge, of yayu coffee forest biosphere reserve along distance gradient and understand sustainable agricultural production and biodiversity conservation



### **1.3.2. Specific objectives**

✚ The specific objectives of this study were to assess ;

- Types of major crop raiding wildlife species around YCFBR
- The level of crop raiding a long distance gradient from the edge of YCFBR to surrounding agricultural landscape
- Homegarden crop composition and level of their susceptibility to crop raiders across spatial distance from the forest edge
- Traditional crop protection methods used by local farmers
- Local farmers attitude towards wildlife conservation

### **1.4. Research questions**

- What are the major crop raiding wildlife species in the agricultural landscapes surrounding Yuyu coffee forest biosphere reserve?
- What is the level of crop raiding from the edge of the Yuyu coffee forest biosphere reserve to surrounding agricultural landscape?
- What is the homegarden crop composition and level of their susceptibility to crop raiders across spatial distance from forest edge to agricultural landscape around YCFBR?
- What are traditional crop protection methods used by farmers to reduce crop raiding in the study area?
- What is the local farmers' attitude towards wildlife conservation in the study area?

### **1.5. Research hypothesis**

Ho: There is no association between the two variables

Ha: There is an association between the two variables

## **1.6. Significance of the study**

In the present study area the majority of the land is covered with forest and farmers who are nearest to the forest are the main victims of crop damage by wildlife crop raiders' species. Most of their agricultural products are exposed to the damage caused by these wildlife crop raiders and their seasonal or yearly crop yields from their agriculture are less when compared to those located far away from the forest edge.

Therefore, the present study can provide information about the specific species of wild animals crop raiders , crops mostly damaged by it, maximize the understanding of farmers towards the wild animal conservation. Moreover, it can be used for farmers to get awareness about forms of the HWC and mitigation strategy ,used for Agriculture and natural Resource Management offices and development agents to give awareness for farmers and also provides baseline data on human wildlife conflict. Hence, this study can paramount important in assessing human wildlife conflict on crop raiding along distance gradient from the forest edge to agricultural landscape in the study area.

## **2. LITERATURE REVIEW**

### **2.1. Biodiversity conservation**

Nature conservation has the capacity to significantly reduce the rate at which diversity is being destroyed (IUCN, 2010). There are many reasons why biodiversity conservation is important; the most importantly are the ecosystem services that the natural environment provides, processes such as water purification, formation of soils, and the growth of food, fuel and products are driven by the activities of wild species (Jeffries, 2006). The benefits humans gain from ecosystem services have only recently been acknowledged and are still poorly understood. However, we do know that these services are not only vital to humans; they are also freely provided where ecosystems remain healthy.

### **2.2. Human-wildlife conflict**

Human-wildlife conflict is a term commonly used by conservationists to describe the interaction between wild animals and people. It exists in different forms all over the world and is experienced more in developing countries (Blair, 2008). Various definitions about the term have been forwarded by different researchers and organizations working on the area. The World Wide Fund for Nature (WWF, 2006) defined it as any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations, or on the environment. Similarly, the United States Geological Survey (2003) defined it as: Human-wildlife conflict occurs when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife. Human responses to the interaction are the most decisive factor for the outcomes of the conflicts between humans and wildlife (USGS, 2003). The International Union for Conservation of Nature (IUCN, 2005) defined HWC as a conflict occurring “when human population requirements overlap with those of wildlife, resulting in costs to both residents and wild animals,” or a negative impact of the needs and behavior of the goals of both wildlife and humans, as such human-wildlife conflict can have negative impacts on both the humans and wildlife.

### **2.2.1. Human-wildlife conflict in and surrounding protected areas of Ethiopia**

Protected areas are designated areas that are protected due to their ecological, cultural, or other values. It plays a vital role in biodiversity conservation. Ethiopia has over 55 protected areas which cover 17.1% land area of the country, ranked third in African countries next to Tanzania and Uganda, these areas protected in order to gain benefits for livelihoods at local, regional and country level but the value obtained from the protected areas is very low when it is compared to other African countries like Kenya, Tanzania and South Africa (Getahun, 2017). Human-wildlife conflict is a major concern of most people living next to protected areas in developing countries due to their subsistent live (Reddy & Workneh, 2014).

Ethiopian protected areas face many challenges due to growing populations, border conflicts, and recurring drought (Ashenafi and Leader-Williams, 2005). Human-wildlife conflict is a serious problem in Ethiopia especially in situation of those who share the immediate boundaries with protected areas. Human population growth, less public understanding and the negative perception of local community towards wildlife and their conservation generally increase conflict between humans and wildlife (Teshome and Girmay, 2017).

The study conducted in Chebera Churchura National Park, southern Ethiopia showed that (98%) of the respondents responded that competition over resources between human and wildlife was the cause of human-wildlife conflict around the park ,only 2% of the respondents noted competition was not a source of conflict between human and wild-animals (Girma,2016). In Ethiopia, most of the people whose farming activities are poor, local subsistence farming communities, and in some cases, commercial farms adjacent to wildlife habitats often impacted by the presence and abundance of wild pest animal species. It is also expected to observe the spatial pattern of wildlife crop raiding incidences in farms located near wildlife habitats or within wild animal species foraging range (Ashenafi and Williams, 2005).

In the country Elephants reported as crop raiders and given more attention (Kumssa and Bekele, 2013). In the Babble elephant sanctuary, crops such: sorghum, maize, mango, papaya, pumpkin, sweet potato and ground nut raided by elephants were reported ( Biru and

Bekele, 2012). Cultivated crops such as maize (*Zea mays*), potato (*Solanum tuberosum*) and haricot beans are major crops raided by wildlife in Swayne's hartebeest sanctuary (Tekle, 1996). The study conducted surrounding Yayu biosphere reserve showed that wildlife damage was an important challenge for growing fruits and vegetables. Monkeys and birds feed on fruits and cause physical damage to fruit trees, which in turn causes a yield reduction for the following years (Mathewos *et.al*, 2018).

### **2.2.2. Human-wildlife conflict in southwest Ethiopia**

The studies in Kafa Zone, Southern Nations Nationalities and Peoples Region (SNNPR), Ethiopia, have shown that the presence of high conflict between pest primates (Anubis baboon and vervet monkey) and farmers in all of the study sites (Debalke, 2016). The conflict between wild animals and farmer's around Chato forest Horo Guduru Wollega Zone, Western Ethiopia, involved crop raiding and livestock predation. Out of the total expected yield of maize; 28.1% was lost due to crop raiding by wild animals. Maize damaged by Anubis baboon was 16.96%, Vervet monkey 8.72% and other wild animals was 2.42% and this showed that there was strong conflict between them (Regassa ,2017). Geleta *etal.*, (2019) reported that in Jorgo-Wato Protected Forest western Ethiopia, Cape buffalo, olive baboon, grivet monkey, bush pig, giant forest hog and crested porcupine are common crop pests and Buffaloes were observed and reported to cause damage on seven cultivated crops belonging to the family Poaceae and Fabaceae such as; *Zea mays*, *Sorghum bicolor*, *Triticum aestivum*, *Hordeum vulgare*, *Eragrostis Teff*, *Pisum sativum* and *Vicia faba*.

The study conducted in Gambella National park reported that; the major human activities that impacts on the Nile Lechwe (*Kobus megaceros*) were agricultural investment and illegal hunting. The large scale agriculture activities close to the protected area produce effect to the wildlife resource in the area (Legas andTaye, 2017).The study conducted in Jimma zone, Gera district southwest Ethiopia also showed that; Baboons, bush pigs and vervet monkeys caused damage by eating and trampling a variety of crops, including maize, sorghum, finger millet, tubers, vegetables, field beans and peas. Warthogs fed on cereals, mainly teff; olive baboons in addition to crop raiding also fed on lambs and poultry; giant forest hogs damaged crops in homegarden and open fields, mainly by trampling; porcupine's mainly raided enset, vegetables and tubers; and olive baboons and blue monkeys damaged coffee berries. Olive

baboons, vervet monkeys and Colobus monkeys also caused damage by eating fruits (Ango *et al.*, 2014). Crop damage by mammals is an obvious problem in many places. Baboons and bush pigs are often considered as the worst crop pests. Many crops are affected and even coffee is raided by baboons (Hylander *et al.*, 2014). Rural subsistence farmers in Illubabor Zone, western Ethiopia, have long experienced agricultural losses due to crop-raiding by wild animals (Quirin and Dixon, 2012). Homegarden horticultural and other crops productions in the area are facing many challenges, due to crop damage by wild animals, in the transitional area of Yayu Coffee Forest Biosphere Reserve, Ethiopia (Etissa *et al.*, 2016).

### **2.3. Causes of human-wildlife conflict**

The main cause of human-wildlife conflict worldwide is the competition between growing human populations and wildlife for the same declining living spaces and resource (Madden, 2008). The transformation of forests, savannah and other ecosystem in to agrarian areas or urban agglomerates as a consequence of the increasing demands for land, food production, energy and raw materials has leads to dramatic decrease in wildlife habitat. The major causes of human-wild animal's conflict could be attributed to many factors ranging from wild animals population increase to human population increase (Edward and Frank, 2012). More peoples means more cultivated land and hence a greater interface between people and pests, the increment in both pests and human population create competitions on fixed natural resource which leads to conflict (Sillero-Zubiri and Switzer, 2001). The study conducted in Gera district south- west Ethiopia showed that human population growth and anthropogenic effect such as deforestation, inappropriate site selection for investment (coffee production) in forested area and expansion of subsistence agricultural activities have led to increase in HWC. However, habitat disturbance was the major causes identified as HWC in Gera district (Gobosho *et al.*, 2015).

#### **2.3.1. Human population growth**

According to Musyoki (2007) almost all human societies lived by hunting and gathering around ten thousand years ago. Co-existence between humans and animals was never strained as natural resources were abundant in terms of quality and quantity. When people started cultivating land for agricultural purposes and tamed animals, reliable food resource base was gained throughout the year but this faced new threats of crop damage by wild

animals. Humans have suffered losses in crops and livestock ever since there has been agriculture (Naughton-Treves, 1998). A rise in human population, the subsequent demand for settlements and socio-economic activities has led to expansion of human activities up to the edges of conservation areas and marginal land that were animal dispersal ranges (Musyoki, 2007).

### **2.3.2. Expansion of agriculture in to protected area**

Since the dawn of agriculture, people and wild animals have been in conflict because, agricultural crops generally offer a rich food source for wild animals as well as for people. Large, wild herbivores compete for pasture resources with livestock and can act as reservoirs of livestock diseases. Furthermore, livestock form a concentrated and vulnerable food source for predators. As a result, humans have extirpated many native animal species from agricultural areas, either directly or indirectly through modifications in habitat availability or structure resulting from land use changes. As human populations have expanded in developing countries they have caused loss in biodiversity and species extinctions, and will continue to do so. The two principal threats to African wildlife are agricultural expansion and hunting. Increasing human populations are associated with greater conversion and fragmentation of wild habitats, and more intense hunting pressure on remaining wildlife stocks. Increased human encroachment in formerly wild habitat also sets the stage for conflicts between humans and wildlife, with casualties on both sides. Perhaps the most common cost imposed on humans by wildlife is damage to agricultural output, where a significant share of agricultural production near the extensive margin of human-nature interface can be destroyed by wildlife (Deodatus, 2000).

In recent decades there has been a significant shift towards the intensification of agriculture, and the resulting large monoculture can be very attractive to animals. Some animals are naturally pre-adapted to take advantage of these opportunities. Omnivorous species like Anubis baboons will take a wide range and diversity of foods, including many crop species and often utilize several different parts of these plants, rendering them vulnerable throughout their life cycle (Sillero-Zubiri and Switzer, 2001). Due to the availability of food resources in agricultural crop field's wildlife population is increasing outside of protected areas and

their crop raiding activities is affecting life of poor rural farmers (Asmamaw and Verma, 2013).Landscape patterns are the structural and functional arrangements of landscape elements (Patch, corridor and matrix) across landscapes. These arrangements develop continuously in space and time (Sih *et al.*, 2000).

The establishment of National parks and reserves has been seen as a central point in conservation of natural environments. However, according to Musyoki (2007), their absolute value has been put into question when compared to the benefits which the local communities accrue from conservation activities. In scenario where wildlife induced damages to human property or life are neither controlled nor compensated, negative attitudes become entrenched with the locals and they therefore regard wildlife as a livelihood threat.

### **2.3.3. Lack of clear responsibility on wildlife management**

Ownership and control over wildlife areas and resources is contested in all wildlife rich areas. While states have taken over vast areas for conservation purposes, indigenous residents have not given up claims for rights to benefit economically from these areas. In some situations, local communities have been evicted to establish protected areas. Under such circumstances, traditional rights over wildlife resources are lost and become an issue of contention to the local community (Naughton-Treves, 1996).

### **2.3.4. Competition for resources between people and wildlife**

Crop raiding is on the increase and people are competing with wildlife for resources.The development of small scale farming in areas that have historically been known to be prime wildlife habitats, or migration corridors. In Kenya for example, the remarkable transition from semi nomadism to semi agricultural and settlement. Most natural wildlife buffer zones have led to competition for food, water, habitats, and space for both humans and wildlife hence resulting in a conflict for survival (Kagiri, 2000)

## **2.4. Crop raiding**

Crop raiding is a major form of human- wildlife conflict, and its mitigation has become crucial to realize long-term wildlife conservation. It can be defined as wild animals moving



from their natural habitat into agricultural land to feed on the crops that humans grow for their own consumption and trade (Sillero-Zubiri and Laurenson, 2001). It is a serious source of conflict between local communities and the management of adjacent protected areas (Malugu, 2010). Crop raiding is becoming a worldwide and complex problem (Nyahongo, 2007). It affects subsistence farmers directly through the loss of their primary food and cash resources and indirectly through a variety of social costs (Marchal and Hill, 2009).

Crop raiding by wild animals is caused by several species ranging from large mammals to smaller animals, such as birds, rodents and insects. Crop raiding may peak during the harvest season when the crop is mature (Gunn, 2009) but it commonly occurs throughout the year. Mature crops may offer a high nutritional benefit to the raiding wild animals and are also the most palatable and contain most calories, reducing herbivore feeding time (Ntalwila *et al.*, 2011). Crop raiding by wild animals is a problem of most rural Africa which has led to incidences of loss of human life, injury to humans, destruction of crops and farm infrastructure (Naughton-Treves, 2001).

#### **2.4.1. Factors for crop raiding**

Farmers planting and growing patterns subsequently make food available to wildlife, especially during times of natural food scarcity (Lee and Priston, 2005). Therefore Crop raiding is certainly intensifies when natural forage is limited (Lemessa *et al.*, 2013) and raiding intensity has also been linked to peaks in crop production-occasionally despite natural food availability. Crop raiding is therefore an adaptation by wildlife to both natural habitat loss and increased availability of alternative food resources (Hockings *et al.*, 2009). Conversely, analysis of crop raiding in Uganda (Linkie *et al.*, 2007) suggested that decisions to raid crops were not based on reduced availability of forest forage but on the increased availability of preferred crops along the forest's margins. In other words, animals may simply prefer the forest agricultural boundary over areas deeper into a protected area, where natural forage may be more readily available than crops (Butynski, 1984).

A number of other factors affect the frequency of crop raiding. These include the species involved (Nijman and Nekaris, 2010), farm location and size, crop type (Priston, 2008 and

Underdown, 2009), number of neighboring farms surrounding land use (Hill, 2000), and mitigation methods employed by the farmers (Priston, 2005). The study conducted in Gera district, south west Ethiopia, shows that not all crops were equally affected by crop raiders. Maize was the most vulnerable crop to crop raiders followed by sorghum, and potato was the least vulnerable crop to damage caused by wild animals (Gobosho *etal*, 2015). The damage can occur seasonally or year round. Anubis baboons are likely to visit fields all year round, thus farmers, whose farms are close to the forest boundary, are potentially at risk of losing staple crops year round. A point to notice is that crop raiding activity, especially by Anubis baboon occurs at day, so fields have to be protected at day (Hill, 2000).

Many different crops are targeted by animals, these includes cereals, fruits, vegetables and trees. Crop raiding may be greatest during harvest season, but it does occur throughout the year. In particular maize seems to be targeted and damaged throughout its growing cycle, from the newly sown seed to the time the cobs are mature. Damage sustained at any stage can cause severe crop losses, but these are most serious when crops are mature (Sillero-zubiri, 2001).

#### **2.4.2. The impacts of crop raiding on household livelihoods**

The major types of human- wildlife conflict in many parts of Africa and Asia is crop loss caused by large mammals near to protected areas and forests among agriculturalists. The extent of damage is almost significant when it is considered at the global level as compared to the damage caused by invertebrates and rodents. However in the area where large number of animals occurs, the whole season production may be lost in a single night (Naughton-Treves, 1997). Wildlife damage varies considerably from site to site and farmers have unequal capacity for preventing losses. Farmers themselves are sometimes, the cause for crop loss because they continuously change the vegetation structure of the land closer to the protected areas. This changed vegetation probably become attractive to wild herbivores (Messmer, 2000). Crop raiding and hunting may be closely linked and crop raiding can reduce farmers' tolerance towards wildlife. Despite high population density in rural areas and more rapid conversion of forest to farmland, much less is known about crop raiding in Asia and Africa (Linkei, 2007). Damiba and Abes (1993) noted that production of highly

palatable and nutritious seasonal crop such as maize, which attracts primates and other wild-animal involve heavily losses and therefore high guarding investments. Farmers' loss a whole garden particularly in areas highly infested with Baboons, Vervet monkeys, Bush pig and Porcupines, which inflict heavy and potentially catastrophic losses.

Nchanji (1998) reported that crop raiding is a serious problem as crop raiding animals can have a devastating impact on the standard of living of peasants whose entire survival is dependent on subsistence agriculture .He estimated that in situation where farmers guarded their crops, the loss incurred was 30% and where there was no guarding at all it was 90%. There was severe food shortage, high food price, malnutrition and morbidity increased besides the rural agricultural society becoming poorer and poorer. Majority of children not going to school and in situations where farmers guarded their crops, children were forced to absent from school to guard crops (Chambers, 1992). Crop damage affects farmers directly through loss of their primary food and cash resources, and indirectly through a variety of social costs such as costs for school and hospital. Due to these losses, rural people express their fear of development projects that deal with wildlife conservation (Hill *et al.*, 2000).

## **2.5. Traditional methods to protect crop damage from wildlife**

People can prevent crop damage by using different methods such as guarding, chasing, fencing, scarecrows and trapping to control their crop damage. Guarding was the most familiar methods. Most farmers guarded their crops especially during the harvest season. Chasing and fencing were also the second and the third important methods respectively. Yelling and throwing stones were the other methods used to chase wild animals away from the farmland (Adem, 2009). Gobosho *et al.*, (2015) were reported that respondents used different traditional methods to defend crop raider from their crop and include guarding, chasing, live fencing, scarecrow and smoking.

## **2.6. The impacts of human-wildlife conflict on wildlife conservation**

Human-wildlife conflict is an increasingly significant obstacle to the conservation of wildlife and hence may result in radical decrease in the number of wildlife population. This

was reported by various scholars who conduct a research in the area. Gobosho (2015) states that human-wildlife conflict is among the most important threats to the survival of many wildlife species. Development including construction of roads, dams and utilities support human beings to accomplish the daily activities. But, these activities weaken the long term sustainable development by propagating unintended environmental impacts. Human-wild animal conflict is an increasingly significant obstacle to the conservation of wildlife (Madden, 2008). Human being can be developing a range of options for attempting to lessen conflict with wildlife. By using different options includes reducing the livelihood of attacks through livestock guarding dogs, electric fencing, improved construction of livestock enclosure, toxic collars, disruptive stimuli and other aversive techniques. All these can have substantial impacts on the wild-animal populations (Eyebe *et al.*, 2012). The intensity of conflict that frequently arises when people and wildlife exist in close proximity to one another, concentrating on maintaining wildlife largely within the world's current protected areas may seem like an obvious solution (Baldus, 2004).

## **2.7. Attitude of local peoples towards wildlife**

Social and environmental conditions are deeply and inextricably linked (Adams and Hutton 2007). An important component of conservation, and the management of human-wildlife conflict, is therefore the examination of people's behavior and perceptions regarding wildlife and the factors that influence these perceptions (Riley and Priston, 2010). Conservation can no longer be considered in isolation from the economic and social interests of people (Keller, 1985). Perceptions influence attitudes towards wildlife (Hill, 2004) and (St John *et al.*, 2012) attitudes can be useful indicators of behavioral. As such, people's perceptions and expectations underpin human-wildlife interactions and shape their responses to conflict with wildlife (Hill, 2004). If local people attach a negative value to wildlife they will not support its continued existence in the region (Gillingham and Lee, 2003), and conservation depends on local community support. A number of studies have revealed that age, gender, ethnicity, level of education, political attitude, landholding size, period of residency and religion all influence attitudes towards wildlife (Gifford and Nilsson, 2014)

Nowadays the conflict between local people and wildlife is taken as the major conservation issue (Newmark *et al.*, 1993). The conservation attitude of rural people living near to the protected area is highly influenced by the problem associated with wildlife people living surrounding the protected areas who are unable to control the losses caused by wildlife are likely to develop negative attitude toward wildlife (Newmark *et al.*, 1994). Human attitudes and values about wildlife vary both among and within different sectors of the society. The views of rural residents about wildlife may not differ from urban residents' except that they personally experience more of the benefits and problems caused by wildlife. However farmers are one sector of the society whose attitudes about wildlife continue to differ from other stakeholders. They continue to view in terms of its importance and tend to be more concerned about how wildlife affects them economically (Messmer, 2000).

The most common attitude of people towards wild animals is the utilitarian one, with little consideration of the consequences. In South Africa, for example, some species of reptiles are more intensively used by traditional healers (Smart *et al.*, 2005). Birds can be important for seed dispersal, biological control of pests and aesthetic values; which leads to positive attitude towards some bird species. Concerning snakes, the majority of local people showed low knowledge in believing that most snakes are non-poisonous, so local people perceived snakes as being dangerous animals (Lopez-del-Toro *et al.*, 2009). For non-flying mammals, attitudes were in general different. However, the perception of local people has been positive towards those species used as food and negative towards those species that cause some level of damage. Negative attitudes also revealed towards rodents that damage crops. In Indonesia and India costs associated with wildlife have a negative impact on local perceptions, while the benefits have positive effects (Sekhar, 2007). Animals that cause higher levels of damage are disliked and when the damage is small or moderate, the attitudes of people are more positive (Kaltenbornet *et al.*, 2006). Whatever the case, public understanding of the general environment and population related issues is critical for successful conservation efforts.

### 3. MATERIALS AND METHODS

#### 3.1. Description of the study area

The Yayu Coffee forest Biosphere reserve (Fig. 1) is located at about 560 km from Addis Ababa in southwest Ethiopia within the Illubabor Zone of Oromia National Regional State ,within altitudinal range from 1140 to 2562 m a.s.l.(Gole *et al.*,2008). It lies between 8°10'0"N-8°20'0"N Latitude and 35°40'00"E-36°0'00"E Longitude. Yayu forest was designated as Yayu coffee forest biosphere reserve in 2010 by United Nations Educational, Scientific and Cultural organization (UNESCO) for the in-situ conservation of wild *Arabica Coffee* (Gole *et al.*, 2009).

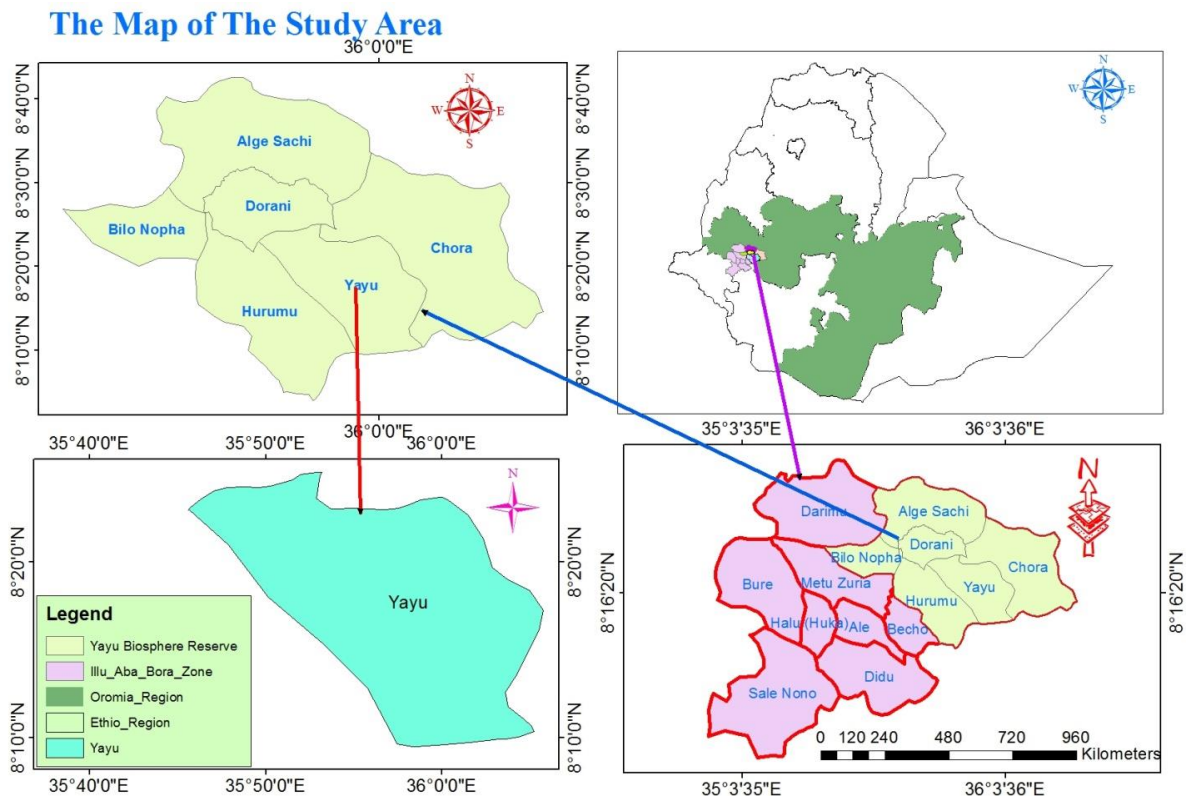


Figure 1: Map of the Yayu coffee forest biosphere reserve

The total area of YCFBR is about, 167,021ha and the area forms the dispersal area for agriculture and most conducive to livestock grazing, wild animal conservation and tourism. The YCFBR consists of three zones including core zone amounts to 27,733 ha-is undisturbed natural forest area, buffer zone (21,552 ha)-consists of mainly semi-forest

coffee and where controlled use of forest resources is exercised by local communities and transitional zone-covers the area 117,736ha which is comprised different land use types, such as, crop land, plantations, grasslands, wetlands, managed coffee forests, and settlements (Fekensa *et al.* 2016).

The YCFBR has bordering with six districts namely; Yayu, Hurumu, Doreni, Bilo-nopha, Alge-sachi and Chora. From these six districts found in the reserve, based on the preliminary information gathered during scoping survey on the level of human-wildlife conflict, from (ILAGNRMO), Yayu district was purposively selected for the study, because of the presence of serious HWC in the area. Correspondingly, out of five kebeles included into YCFBR, from the district two kebeles, namely, Bondao-magela and Geci were selected. In the next Villages found in the selected two kebeles were categorized (stratified) into three groups based on their proximity to towards to forest edge as -Bondao and Dogi-villages close to forest edges (<0.5km), -Magela and Geci-Intermediate villages (0.5-1km) and Agaro and Leku- villages far from the forest edges (>1 km) following the method used by (Gobosho *et al.*, 2015; Girma *et al.*, 2019). In total, six villages were selected.

The area is crossed by three major rivers, i.e., Geba, Dogi and Sese (Gole *et al.*, 2008). The dominant soil of the area includes nitosols, acrisols, vertisols, and cambisols (Tafesse, 1996).It has hot and humid climate, with the mean annual temperature of around 20°C oscillating between the average extremes of 12°C and 29°C. The area exhibits a uni-modal rainfall pattern with mean annual precipitation of 2100 mm, with high disparity from year to year, and ranging from 1400 to 3000 mm (Gole *et al.*, 2008). It is rich in flora, avifauna and mammal species. There are, about, 450 higher plant species, 50 mammals, 200 birds and 20 amphibian species, of which over 100 species of plants, birds and mammals are only found in this reserve area (Gole *et al.*, 2009).

About 154, 300 permanent residents live in the transition areas of YCFBR, and mainly relying on agriculture (Fekensa *et al.*, 2016). For more than 90% of the population of the study area agriculture is considered to be main source of livelihood and it is characterized by mixed farming systems run by smallholders (Gole *et al.*, 2009). The mixed farming system comprises coffee and cereal crop production, animal husbandry, beekeeping and spices. The

major cereal crops include; maize, sorghum, teff, wheat, burley and millet. Coffee is the major cash crop accounting for over 60% income (Gole, 2003).

The agricultural landscapes of surrounding Yayu Biosphere reserve, is of mosaic type and forests cover most of the area, and consist of four major variations, namely undisturbed natural forest, semi-forest coffee systems, fully managed forest for coffee production, and old secondary forests (Gole *et al.*, 2009).

## 3.2 . Method

### 3.2.1 .Sampling design

To study the crop damage in relation to distances from the forest edge to surrounding the agricultural landscape of Yayu coffee forest biosphere reserve, transects were laid out from forest edge towards agricultural landscape and three complementary data collection methods namely questionnaire survey, focus group discussion and direct observation were used along the transects.

### 3.2.2. Sample size determination

The sample size of the households to be taken was calculated using the formula (Cochran, 1977) based on the total numbers of household head living in the two kebeles which is 1265 according to the kebele administration offices.

$$n_o = \frac{Z^2 * (P)(q)}{d^2} \quad n_1 = \frac{n_o}{(1 + n_o / N)}$$

**Where:**  $n_o$  = desired sample size when population greater than 10000

$n_1$  = finite population correction factors less than 10000

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.1 (proportion of population to be included in sample i.e. 10%)

q = is 1-P i.e. (0.9)

N = is total number of population

d = is degree of accuracy desired (0.05)



$$n_1 = \frac{(1.96)^2 * (0.1)(0.9)}{(0.05)^2} = 138.29$$

$$n_1 = \frac{138.29}{1 + \frac{138.29}{1265}} \rightarrow = 138.29 / 1.11 = 124$$

Based on Cochran (1977) population correction factors, a total of 124 (61 from Bondaomagela and 63 from Geci) sample household were selected for questionnaire survey, using simple random sampling techniques from the total population of 1265 (625 from Bondaomagela and 640 from Geci) for present study. Then after the HHs were proportionally selected from each stratified villages, as village (close to forest edge 48, intermediate 38 and far from the forest 38).

### 3.2.3. Data collection

A total of thirty transects each 1km long with 200m interval between transects (ten close to forest, ten intermediate and ten far from the forest edge) were laid out from the forest edge towards agricultural landscape and all of the data were collected by walking along these transects. Farmers were randomly selected from each of the transects and questionnaire survey were held along the transect.

#### *Questionnaire survey*

Questionnaire survey were used to acquire information on demographic aspects of the respondents, types of wildlife crop raiders, types of crops prone to crop raiding, frequency of crop raiding, extent of crop damage by wildlife crop raiders, amount of crop yield loss, traditional crop protection methods used by farmers and attitudes of farmers towards wildlife conservation (Appendix II). Questionnaire were prepared in English language and translated into Afan Oromo since the majorities of the respondents were Afan Oromo speakers.

#### *Homegarden crop species composition assessment*

On each of the transect three to four homegardens were randomly selected to assess homegarden crop species composition. Here, in total, 90 homegardens (i.e., thirty home

homegardens from each location,) were used for the crop composition assessment (Appendix VI).

#### *Focus group discussion*

To explore the spatial extent of crop damage due to crop raiding, or to debate, share and verify the study subjects' responses and to obtain deep and validate data, focus group discussion was held with 8-12 households selected from each village using the checklist prepared for open discussion (Appendix III).

#### *Direct observation*

In addition, direct observation and assessment were made on the extent of crop damage to identify the types of crops damaged by crop raiders (Appendix V). To identify the type of crop raiders based on the different signs of attack marks from damaged crops and foot marks of these crop raiders were used, the method used by (Strum, 1994).

#### *Estimation of amount of crop damage*

To estimate the amount of crop damaged along the distance gradient; twenty-four farmers were randomly selected from three locations and five plots of 4m x 4m were placed randomly within the crop stands of four farmers in each sites and crop damage from 0.5ha of the four farmers in each sites was measured.

### **3.3. Data analysis**

The frequencies of occurrence, i.e., number of days baboons, bush pigs, vervet monkeys and porcupines occurred in field crops and homegardens were arranged (0, 15–100 and 100–300 days) in relation to the transects (along distance gradient) and the differences in distributions were tested with Pearson's Chi-square test. If the crops mean species richness

in homegardens differed by the distance from forest edges (i.e., among the three locations ) was tested with One-way ANOVA. Moreover the occurrence of the different types of crop raiders among the surveyed villages, types of crops most prone to crop raiders, the difference in the response of farmers on types of traditional crop protection methods used by farmers and response of farmers on attitude towards wildlife was tested using the Pearson's Chi-square test. The data on the amount of crop damage was analyzed using descriptive statistics, while the relationship between distance from the forest edge to agricultural landscape and crop raiding( to test if it is positive or negative relationship) was tested with Pearson correlation test. All data were analyzed using R-statistical program (version 3.6.2).

## **4. RESULT AND DISCUSSION**

### **4.1. House hold characteristics of the respondents**

The general information about the demographic data obtained from the respondents which include the gender, age and education level was identified before conducting the research.

#### 4.1.1. Gender

From the data collected of 124 respondents, the finding, indicated that 98(79%) of the information were received from males and 26 (21%) of the response were received from females as indicated in (Figure2).

#### 4.1.2. Age

As indicated in (Figure3); the respondents were classified in age range of 18-30 years with 24 (19.4%), followed by age groups of 31-45 years with 51 (41. %), 46-60 years with 40 (32.3%) and above 61 years were 9 (7.3%).The majority of the respondents were living along the forest edge and who were living for a long period of time in the study area. Respondent farmers for the administered questionnaire survey were in the maturity age and they had an experience in agricultural activities and also trained in the challenges and crop raiding activities.

#### 4.1.3. Educational background

Educational background of the respondents of the study area were classified as; 32(25.8%) Cannot read and write, 51(41.13%) were able to read and write, 24 (19.4%) attended primary level (1-8) and 17 (13.7%) those who had attended secondary level (9-12) (Table 1).

## 4.2. Type of wildlife crop raiders

In the study area Olive baboon (*Papio Anubis*), vervet monkey (*Chloroethiops*)(L.), Bush pigs (*Potamochoerus larvatus* and Crusted porcupine (*Hystrix cristata* )(L.) were identified as being the most problematic crop raiding wildlife's (Table 2) and the questionnaire survey were also focused on these species to understand the spatial distribution of problems respondents are facing in terms of damage caused from these wildlife's. The occurrence /coming/ of the different types of crop raiders from forest to the farmland was significantly differed among the surveyed villages (Pearson's Chi-squared test:  $X^2 = 27.467$ ,  $df = 15$ ,  $p\text{-value} = 0.02$ , Figure 4). Fifty six percent of the respondents affirmed that Olive baboon is the top crop raider followed by, vervet monkey (23%) and Bush pig(13%),crusted porcupine was ranked as the last wildlife crop raider (8%) (Figure4). The result is in line with Quirin (2005) who was reported that the top 4 crop foragers on upland and wetland maize in Illubabor zone metu woreda which include baboons, vervet monkeys, porcupines and Bush pigs.

Table 1: Types of wildlife crop raiders in the study area

Crop raiders	Villages						Total
	Bondao	Magela	Agaro	Dogi	Geci	Leku	
Olive baboon	18	8	13	13	8	9	69
Vervet monkey	3	7	3	3	8	8	32
Bush pig	1	4	0	5	0	3	13
Crusted porcupine	2	0	2	3	3	0	10
Total	24	19	18	24	19	20	124

Most of these wildlife crop raiders caused damage by eating and trampling a variety of crops (in open fields and homegarden). Baboons damage maize at all growing stages, in villages nearest to the forest edge and damaged crops in homegarden and open fields; porcupines

mainly raided maize at (seedling, flowering and maturity stage), Taro, Potato, Enset, etc. vervet monkeys caused damage on maize and fruits in all sampled locations in different degrees. Bush pig mainly caused damage maize (at flowering and maturity stage) no one reports crop damaged by Bush pig at seedling stage in the present study area. The result was agreed with Kate (2012) who was reported that baboon were ranked number one crop raiders in Uganda; and responsible for 70% of all damage events and caused a much greater degree of crop losses locally than any other species of wildlife .In other study area Baboons were reported as the most destructive and ranked number one crop raiding wild animals in Africa (Datiko and Bekele, 2013; Joseline, 2010).

### **4.3. Level of crop raiding from forest edges to agricultural landscape**

The response of farmers from questioner survey showed that all of their farms were experienced crop raiding by wildlife crop raider's in different amount depending on; location of the field with respect to the forest edge, types of wildlife crop raiders' species and type of crops grown.

#### **4.3.1. Frequency of crop raiding**

During the questionnaire survey farmers were asked the occurrence of number of days in a year wildlife crop raiders come and visit their farm land in both (open fields and homegardens) at different distance from the forest edge to agricultural landscape and their answers was summarized in (Table 3 and 4). There were a more visits by all major crop raiders identified in the study area (i.e., Olive baboon, vervet monkey, Bush pig and Crusted porcupine) in both home-garden and field crop distances close to forest edge.

According to response of farmers the frequency of number of wildlife crop raiders come in to their farm land and damage the crops in a year was indicates decreasing trend with increasing distance from the forest edge and vice versa. The crop damage is more sever around the buffer zone, because crop raiders frequently raids the crops which are nearest to the forest edge through year round. Similar study was conducted by Ango *et al.*, (2016) who were reported that the proportion of fields raided by mammal pests was significantly higher in villages near forests compared to those located away from forests.

Table 2: Frequency of crop raiding by wildlife's in open fields across spatial gradient.

Crop raiders	Frequency classes of occurrence (days)									X <sup>2</sup>	Df	p-value
	0-0.5km			0.5-1km			>1km					
	0	15-100	100-300	0	15-100	100-300	0	15-100	100-300			
Baboon	0	17	31	6	32	0	33	5	0	102.7	10	0.000
Monkey	0	14	34	0	13	25	26	7	5	117.05	10	0.002
Bush pig	7	15	26	13	16	9	24	12	2	3.873	10	0.001
Porcupine	0	16	32	7	30	1	32	6	0	83.859	10	0.001

(0, 15-100,100-300) indicates; 0days, 15-100days and 100-300days

0days means not occurred at all

Table 3: Frequency of crop raiding by wildlife's in homegardens across spatial gradient

Crop raiders	Frequency classes of occurrence (days)									X <sup>2</sup>	Df	p-value
	0-0.5km			0.5km-1km			>1km					
	0	15-100	100-300	0	15-100	100-300	0	15-100	100-300			
Baboon	0	26	22	11	27	0	36	2	0	108.71	10	0.000
Monkey	0	33	15	0	21	17	23	11	4	113.12	10	0.003
Bush pig	3	18	27	9	23	6	31	7	0	96.886	10	0.000
Porcupine	0	28	20	2	33	3	34	4	0	105.36	10	0.002

(0, 15-100,100-300) indicates; 0days, 15-100days and 100-300days

0days means not occurred at all

The response of farmers shows that; the pattern of crop damage by wildlife was a significant spatial variation in different parts of the landscape from the forest edge to different distance in agricultural landscape (Table 3 and 4). The result was similar with the study conducted in Jorgo-Wato forest western Ethiopia by Geleta *et al.*, (2019) who were reported that Variation in crop damages between villages in the study area could be associated with the distance of cultivated land from the forest. Farmers those who are settled surrounding the forest edge faced great problems by crop damage and other associated problems than farmers who are settled at far away from the forest edge. This is because of the buffer zone forest edge is nearest to the habitat of wildlife crop raiders and other wildlife's, so crop raiders and others visit the farm land nearest to the buffer zone more frequent than the sites far from the buffer zone forest edge. The result is in line with Lemessa *et al.*, (2014) who was reported that the farming communities dwelling close to the forest edges are more prone to the crop raiding by baboons and bush pigs than those farmers situated at far away from forest edges and they face severe crop raiding problem almost throughout the year.

The study result revealed that there was a significant negative correlation between the mean frequency of crop raiding and the distance of the study villages from forest edge ( $p=000$ , Pearson Correlation value =- 0.887).As the distance of study sites from the forest edge decreased, frequency of crop raiding or/and pattern of crop raiding was increased and vice versa. The distance between the farm land and the forest edge was the most important indicator of the expected level of destruction of the crops observed on the farms surrounding YCFBR. When there was only a short distance between the farmland and the forest edge, crop raiding by wildlife's occurred frequently. As this distance was increased, the frequency and the magnitude of crop raiding events decreased. A farm land located at >500m from the forest edge, was less suffered to crop raiding. The finding is in line with Hill, (2000) who was reported that, the close proximity between farms and the forest ecosystem resulting in high level of conflict and the forest edge were most frequently raided by wild boar, pig-tailed macaque and porcupine individually and all species combined.



In other case Parts of plant damage were associated to wildlife species involved in crop raiding and type of the crop species. Olive baboons feed on maize throughout its life cycle i.e. seedlings, flowering and fruiting while vervet monkeys also eats through its life time but, more destroyed maize near maturation stage (flowering stage), Bush pig were observed causing damage on crops in the time of flowering to the maturation stage, porcupine affects crop early in the seedling and flowering stage, mainly destroyed maize near maturation stage. Additionally Monkeys and baboon feed on fruits in the homegardens and cause physical damage to fruits, like Avocado,Mango,Banana and the like, which in turn causes agricultural yield reduction for the farmers. These finding was similar with Mathewos *et.al*, (2018) who were reported, Wildlife damage was an important challenge for growing fruits and vegetables. Monkeys and birds feed on fruits and cause physical damage to fruit trees, which in turn causes a yield reduction for the following years.

#### **4.3.2. Types of crops prone to crop raiding wildlife's**

Farmers listed out that different kinds of crops including Maize, Sorghum, Teff, Potato, Beans, Peas ,Haricot bean and different kinds of fruits and vegetable crops were lost from their farm land by wildlife crop raiders in the study area although, not all crops were equally affected by these crop raider wildlife's. The types of crops damaged by wildlife crop raiders differed significantly among the surveyed villages ( $\chi^2=66.166$  df =25,  $p<000$ ,Table5). Maize was the crop with the most reported damage (57), followed by sorghum (18), potato (15), teff (13), avocado (12), and mango (9). Mango was the least susceptible crop to be damaged by wildlife crop raiders in the study area. The result was agreed with Warren (2008), who was reported that maize, banana and potato were the most frequently eaten crop by crop raiders in West Africa.

Table 4: Major crops raided in the study area

Types of crop raided	Villages						Total
	Bondao	Magela	Agaro	Dogi	Geci	Leku	
Maize	17	7	9	15	6	7	61
Sorghum	2	0	4	0	8	4	18
Potato	3	0	5	0	3	3	14
Mango	0	5	0	2	0	3	10
Avocado	2	3	0	5	2	0	12
Teff	0	4	0	2	0	3	9
Total	24	19	18	24	19	20	124

The respondent's response showed that wildlife crop raiders were influencing them damaging their agricultural production yield which farmers of the study area are dependent on for their livelihood and this condition intensified negative interaction between human and wildlife. According to answer from the farmer's and field observation maize was the type of crop mainly damaged by crop raiding wildlife's in the study area. The reason might be due to maize is sweet to feed, not difficult to handle and effortless to raid. The result was agreed with the study conducted in Uganda by; Hill (2000) who was reported that baboons appear to concentrate their crop raiding activities on maize throughout the year when the crop is present in the fields.

#### 4.3.3. The extent of crop damage by wildlife crop raiders

The result of focus group discussion and key informant interview shows that extent of crop damage by wildlife crop raiders were increasing from time to time; all of the respondents from, Bondao, Magela, Geci and Dogi reported that there was an increase of crop damage by wildlife crop raiders from time to time. However few respondents from Agaro and Leku were gave unknown response on trends of crop damage. The extent of crop damaged were significantly different among the sampled villages ( $\chi^2 = 67.009$ ,  $df = 10$ ,  $P < 0.05$  (0.000)). Majority 113(91%) of the respondents reported that it is increasing whereas 11(9%) of them

said it is unknown and finally the study result was showed that the trend of crop raiding is increasing from time to time (Table 5).

Table 5: Percentage of trend of crop damage by crop raiders based on farmers response

Distance from forest	Villages	N=(124)	Extent of crop damage					
			increase	%	Decrease	%	unknown	%
Close	Bondao	24	24	100	0	0	0	0
	Dogi	24	24	100	0	0	0	0
Intermediate	Magela	19	19	100	0	0	0	0
	Geci	19	16	100	0	0	0	0
Far	Agaro	18	15	83.3	0	0	3	16.7
	Leku	20	12	60	0	0	8	40

The result of this study shows that there was a strong conflict between wildlife and farmers living in the surrounding YCFBR, especially in villages close to forests than far away from the forests due to crop damage caused by wildlife crop raiders. The farmers revealed that these wildlife's cause significant crop loss on their production, and there is an increase of crop damage from time to time. The result was agreed with the finding of Gobosho *et al.*, (2015) who were reported that the trend of crop raiding was increasing from time to time and disagree with the finding of pandey *et al.*, (2015) who were reported that crop depredation has been reduced. Farmers were listed out the reason why crop raiding increases; according to their response; habitat degradation due to wild coffee production, expansion of subsistence agriculture around forest edge and increment of wildlife crop raider's population were the major reason. Before a few years ago when the forest were dense /intact /crop raider wildlife's can get easily their food from the natural forest, but nowadays these wildlife's can't get a enoph food from the forest because, the forest was degraded , as a result of this they find their food from agricultural landscape and compete with farmers.

#### 4.3.4. Estimation of crop loss to wildlife crop raiders and impacts on farmers

The yield loss to crops by wildlife crop raiders is the most important factors affecting the livelihoods of the farmers in the study area. During questionnaire survey farmers were asked

to estimate yield loss due to wildlife species crop raiders accordingly, majority of 54(43.6%) respondents were reported that about 20-40% of their total crop yield was lost by wildlife crop raiders, 12(9.8%) reported 10-20% yield loss, while 14(11.2%) reported 5-10% yield loss and finally 44(35.4%) were reported >5% yield loss to wildlife crop raiders.

Table 6: Response of farmers on crop yield loss to crop raiding wildlife's

Yield loss	Distance from the forest						Total Frequency (N=124)	%
	Close to forest		Intermediate		Far from forest			
	Frequency (n=48)	%	Frequency (n=38)	%	Frequency (n=38)	%		
20-40%	43	89.6	11	28.94	0	0	54	43.6
10-20%	5	10.4	7	18.42	0	0	12	9.8
5-10%	0	0	14	36.84	0	0	14	11.2
<5%	0	0	6	15.8	38	100	44	35.4
Total	48	100	38	100	38	100	124	100

From the (Table6) above it is clearly showed that most (43.6%) of farmers reported that the wildlife crop raiders are significantly contributed to the crop yield loss up to (40%) of annual crop yield in the study area. The result was close to the study conducted in Uganda by Wallace and Hill (2007) who were reported that crop damage by wildlife reduces yield up to 50%.

The spatial variation of crop yield loss was reported from different landscape (i.e., close to, intermediate and far from the forest), in areas close to forests about 89.6% of farmers were reported 20-40% yield loss, and only 10.4% of farmers were reported 10-20% yield loss, in the presence of guarding, but, without guarding they were reported up to 100% yield loss. *One amazing response was; during household survey one farmer said that; "at one day two baboons' damage 227maize cobs in the middle of my farm land which is approximately 200m from the forest edge"*. Similar study was conducted by Quirin (2005) in Illubabor zone metu woreda who was reported without guarding; all farmers reported 100% yield loss to raiding pests. Hill (2005) also reported that Crop raiding by wildlife can pose a significant threat to field crops and thus farmers' livelihoods, but not all farms are equally vulnerable.

However, in a site which is located at intermediate from forest edge 28.9% of farmers were reported 20-40% yield loss, majority (36.84%) of them were reported only 5-10% yield loss and 15.8% of them reported less than 5% yield loss. In areas far from the forest edge; the total yield loss reported was less than 5%. This report provides strong evidence that farmers settled nearest to the forest edge, in the surrounding of YCFBR, where the study was conducted, farmers perceived high crop yield loss by wildlife's as a great hindrance to their agricultural development, and crop losses varied from farmer to farmer depending on the distance from the forest edge.

The likelihood that the information received from the farmers may over estimate, maize farm was sampled and cross-checked. The maize yield lost by four wildlife crop raiders (i.e., baboon, monkey, bush pig and porcupine) in each sampled site was measured and calculated based on the yield obtained from one hectare taken from Yuyu district ANRMO and summarized in (Table7). The result showed that the yield lost estimated by farmers and field observation was similar.

Table 7: Maize yield lost by crop raiders in the sampled villages (kg)

Crop raiders	Villages						Total
	Bondao	Dogi	Magela	Geci	Agaro	Leku	
Baboon	272	298	91	129	59	30	879
Monkey	81	145	41	37	27	6	337
Bush Pig	20	29	26	16	0	13	104
Porcupine	16	20	15	11	2	0	64
Total	389	492	173	193	88	49	1384

Source: Field Survey from March 01-July 30/2019

The average maize yield lost to crop raiders estimated from field survey was 8.81qui/ha or 26.43% of the total expected yield at close to forest, 3.66 qui/ha or 10.98% of the total expected yield at intermediate, and 1.37qui/ha or 4.11% of the total expected yield at a site

far from the forest edge. The result was in line with Ango *et al.*, (2016) who were reported that the mean loss of maize yield to pests was 243kg or 34% of the total expected yield, in villages close to forest and 80kg, or 11.5% of the total expected yield in villages located away from forests.

The average estimated yield loss of maize due to crop raiding wildlife's in the sampled area was about 460kg (4.6 quintals) per hector in one crop growing season. In monetary term the loss covers 5286ETB per hector at village close to the forest edge, 2196 ETB per hector at intermediate village and 822 at villages far from the forest edge. The total average loss to farmers in the sampled area was estimated to be 2760ETB per hector. The loss covers 9.7% of the total annual production of the expected maize yield in the sampled area.

In the present study area most of the respondents close to the forest were mentioned that crop raiding to wildlife crop raiders was affecting their well-being and they were faced different socio-economic impact like; food shortage, severe economic loss, poverty, absence of children from school to guard the crop and poor social-relationship due to continues guarding the crop. The result of focus group discussion also revealed that: these wildlife's have made their living standard to be below that of other communities due to high damage of their main crops specially (Maize). The result was agreed with Mojo *et al.*, (2014) who were reported that almost all farmers blamed wild animals for making significant contributions to the shortage of food, low living standards, and poverty.

The yield loss due to wildlife crop raiders was identified the perceived direct and indirect economic, environmental, and social impacts. The result is agreed with Hill (2005) who was reported, crop raiding by wildlife can pose a significant threat to field crops and thus farmers 'livelihoods, but not all farms are equally vulnerable.

#### **4.4. Homegarden crop composition and level of their susceptibility to crop raiders**

Crop species ranging from fruits, vegetables, spices, root crops and cereal crops, totally about 54 crop species representing to 32 families with a maximum number of 24 and a minimum of 4 species were identified in the assessed homegardens (Appendix I). The mean

number of species per homegarden was 12.35 (range, 4–21) close to forest edges, 13.85, at intermediate (range 7–22) and 14.9 (range 8–24) far from forest edges. The result was in line with Lemessa *etal.*, (2013) who were reported that the mean number of species per homegarden was 10.9 (range, 5–22) close to forest edges and 12.3 (7–21) far from forest edges. The present finding showed that the distribution/diversity of homegarden crop species richness shows increasing trend with increasing distance from the forest edge (Figure 7). However, there was no significant difference among the sampled locations ( $F=3.042$ ,  $p= 0.08$ ), (Figure 8).

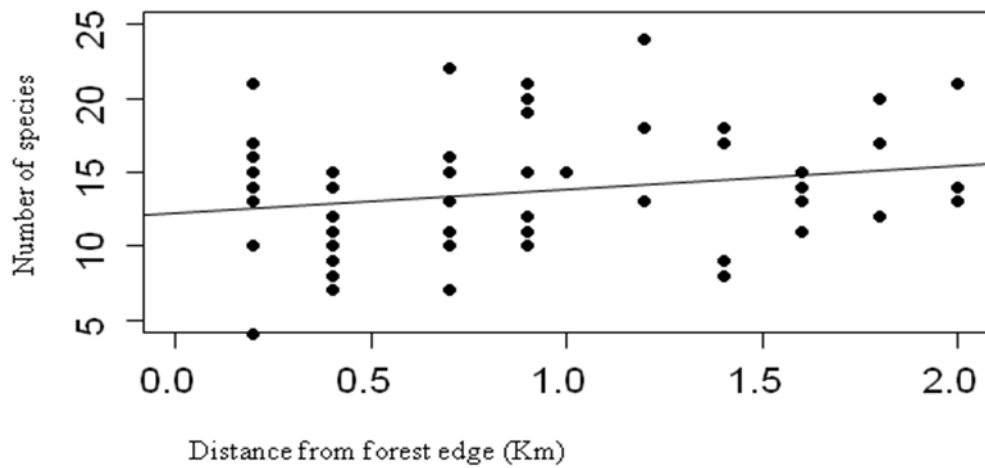


Figure 2: Homegarden crop species richness at different distance from the forest edge

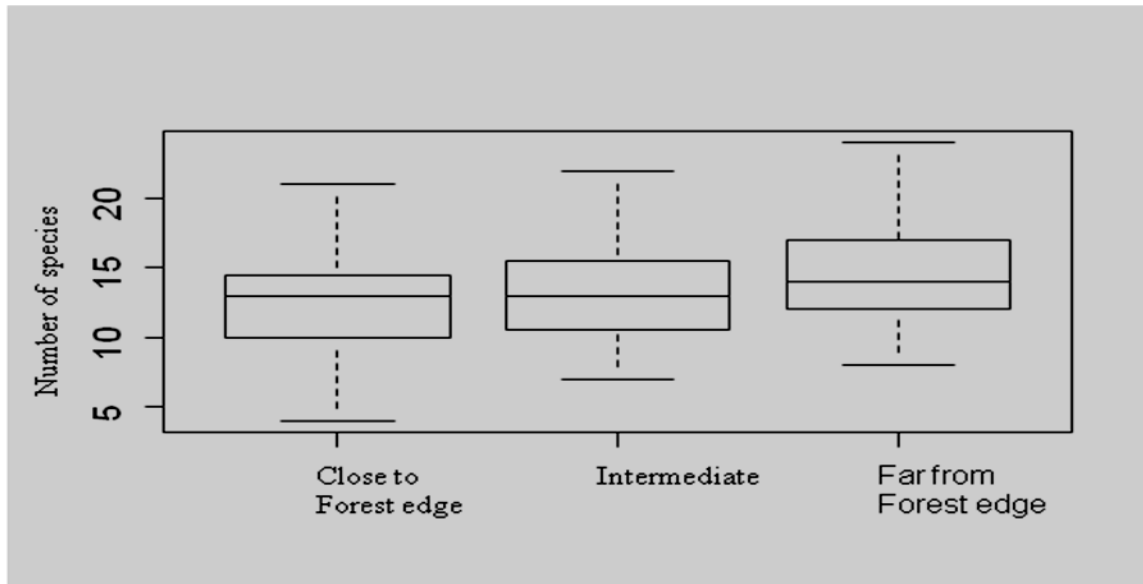


Figure 3: Homegarden crop species grown in the sampled locations across the landscape

The significant spatial variation of crop damage ( $p$ -value=0.001) by wildlife crop raiders at different parts of the landscape was found in the study area. Crop raiding frequency was showed that decreasing trend with increasing distance from the forest edge or increasing trend with decreasing distance from the forest edge (Figure9). However the distribution of the crops was observed that most homegarden crop species were grown with the similar frequency in all sampled locations or farmers' crop growing practices at different parts of the landscape was similar.

Similar study were conducted in Gera district southwest Ethiopia by, Hylander *et.al*, (2014) who were observed that farmers close to the forest grow the same crops in approximately the same frequency as farmers at some kilometers from the forest edge.



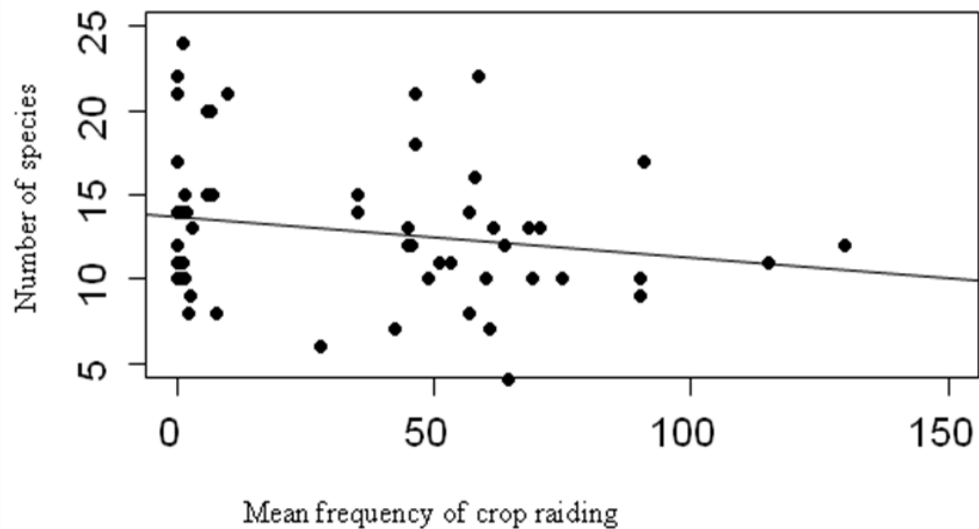


Figure 4: Frequency of crop raiding Vs crop species richness at different distance from the forest edge

This similar crop growing practice of the farmers at different distance from the forest edge, specially, farmers those who are settled nearest to the forest edge in study area might be they don't have alternative crop species which are less susceptible/palatable to these wildlife crop raiders. Lemessa (2014) was reported that the lack of differences in crop distribution between sites close to and far from the forest could be lack of alternative crop species that are not attacked and which could also grow in that agro-climatic condition. Although the farmers crop growing practice have similar distribution pattern at different locations in the landscape, wildlife crop raiders was significantly affected the crops which is found at a distances close to the forest edge than other sites. Crop species richness was observed increasing trend with increasing distance from the forest edge or it is higher at far from forest edge, this indicates, that crop species richness shows increasing trend with decreasing crop raiding frequency and vice versa. The result is in line with Lemessa *et al.*, (2013) who were reported that even if the farmers have not changed their crop growing patterns it is clear that crop raiders affect their daily life and especially farmers close to the forests have invented many ways of protecting their crops.

#### 4.5. Traditional methods of protecting crop raiding

In the present study area respondents were used different traditional methods to defend wildlife crop raiders species from their crop like; guarding, chasing, live fencing, scarecrow and smoking (Figure10). There was significantly difference between respondents among the study villages( $\chi^2 = 46.462$ ,  $df = 20$ ,  $P < 0.05(0.001)$ ) in using the different traditional methods in which 36.7% of the respondents were used guarding for their crop , whereas 21.7% were used chasing , 16.8% were used fencing ,15.6% and 9.2% were used smoking, and scarecrow respectively.

Table 8 : Rank of Crop protection methods used by farmers

Traditional methods	Villages						Total
	Bondao	Magela	Agaro	Dogi	Geci	Leku	
Guarding	12	6	6	13	7	4	48
Chasing	3	0	3	5	6	9	26
Smoking	7	3	4	0	4	2	20
Fencing	2	6	0	6	0	5	19
Scare crow	0	4	5	0	2	0	11
Total	24	19	18	24	19	20	124

Most of the respondents responded that they guarded their crops throughout crop growing season, because continuous guarding was the main strategy used to mitigate crop damage by wildlife crop raiders locally, Chasing and fencing were also the second and the third

important methods used respectively. Respondents revealed that during the day children and women participate in chasing raiders and vervet monkey from both homegarden and field crops. However, during the night, male households usually make patrol to protect the crops in homegarden and field crops from bush pigs and porcupine by shouting, using the torches and growing dogs. The respondents also revealed that, in most of the cases, they constructed live fences surrounding their homegardens and field crops to protect their crops from wildlife crop raider's especially nocturnal animals.

The current finding showed that permanent guarding was a method used by large number of farmers to protect their crop from damage of wildlife crop raiders and the effective method to protect crops from damage of wildlife's crop raiders throughout crop growing season, among the methods used (Figure11). Similar study was conducted by Hill, (2005) in Uganda, who was reported guarding crops against damage by wildlife is a common practice throughout the agriculture-wildlife interface. Farmer's expressed that, to compete with wildlife crop raiders the only preferable method was permanent guarding the crop especially maize throughout its developmental stages. Annual crops were guarded from the day of sowing until the crops were harvested day and night. Perennial crops was guarded year-round and this finding is similar with Etissa *et al*, (2016) who were reported that all farmers guard their farm fields and homegardens 24 hours a day from planting up to harvesting each crops from diversities of mammals, birds and other animals affecting the crops in the same study area.

#### **4.6. Attitude of the farmers towards wildlife conservation**

Understanding the interactions between human and wildlife is necessary to guaranty a better coexistence between human and wildlife and an improvement of wildlife conservation. The attitude of the respondents towards wildlife was assessed, depending on distance from the forest edge and it was showed that a significant difference ( $\chi^2 = 24.8$ ,  $df = 9$ ,  $p\text{-value} = 0.003$ ) among the sampled locations towards wildlife conservation. According to response from the farmers 81.25% from a villages close to the forest edge, 65.8% from an intermediate distance from the forest edge and 52.6% from a villages which are located far away from the forest edge have negative attitude towards wildlife conservation, On the

contrary, 18.75% from a villages close to forest edge,34.2% from intermediate distance from the forest edge and 47.4% from a villages which are located far away from the forest edge have positive attitude towards wildlife conservation in the present study area(Table 8). Majority of the farmers (67.7%) were argued that wildlife conservation had no importance. The main reason given for viewing wildlife conservation negatively was due to crop damage by wildlife crop raider species.

Table 9 : Attitude of farmers towards wildlife conservation

Location	n	Negative attitude	%	Positive attitude	%
Close to forest	48	39	81.25	9	18.75
Intermediate	38	25	65.8	13	34.2
Far from forest	38	20	52.6	18	47.4
Total	124	84	67.7	40	32.3

The result from the above table shows that the majority of the farmers close to the forest edge have negative feelings about wildlife conservation. The result is similar with Mackenzie (2012) who was reported that in many parts of Africa, the conflict between local people and wildlife is one of the most serious problems where villagers are located adjacent to nature reserves. FAO (2009) reported that the adverse negative perception is particularly strong near protected areas where the presence of wildlife populations inflicts daily costs on local communities, which can erode local support and tolerance. In turn, local people can develop a negative attitude towards reserves and wildlife, exacerbating conflict and undermining conservation efforts.

Due to negative feeling towards wildlife; farmers were undertook killing of wildlife's and some kind of vegetation clearing to decrease their habitat in the study area. Lemessa *et al.*, (2013) reported that the negative effects of crop raiders may affect the attitudes among farmers toward forests and thereby affect forest cover. As a result of clear-cutting of scattered trees (key-stone species), a lot of plants and animals become vulnerable to different factors: wild animals suffer from a lack of corridors, plants die due to lack of shade. This also has an adverse effect on the environment and wild animals, in turn loss of biodiversity. Tefera (2011) showed that some population of the endemic wild animals in the

protected areas are declining due to human interference; this can serve as a proxy to estimate how much wild animals in unprotected areas are being threatened.

In the other case the farmers response shows that there was a significant difference ( $\chi^2=14.782$ ,  $df = 3$ ,  $p\text{-value} = 0.002$ ) between educational level of respondents in their conservation attitude towards wildlife. Educated farmers have more positive feeling than an educated farmers, because they have some awareness about the benefits of wildlife or/and natural resource, this implies that educating the community about the potential benefits associated with a wildlife conservation can be an important tool in avoiding and resolving the conflicts caused between local community and wildlife. This finding is in line with Kumsa and Bekele (2014) who were reported that, Education is an important factor in understanding the role of protected areas and conservation in general.

## 5. CONCLUSION

Interaction between human and wildlife exists in different forms all over the world, particularly in developing country where people depend on substance agriculture. Crop-raiding by wild animals is well known to cause conflict between humans and wildlife's; and make communities intolerant towards wildlife protection .The present study has assessed human-wildlife conflict and crop raiding in relation to distances from forest edge to surrounding agricultural landscape of Yayu coffee forest biosphere reserve south west Ethiopia. Olive baboon, Vervet monkey, Bush pig and Crusted porcupine were the four most crop raiding wildlife's identified and reduced agricultural production in the study area. Olive baboon was the most commonly reported crop raider, Vervet monkey was the second problematic animals on crops damaged followed by Bush pig, and crusted porcupine was ranked as the last crop raider in the study area.

There was a significant spatial variation of crop raiding by wildlife's across the landscape. crop damage was sever at villages close to the forest edge than villages located at intermediate and far from the forest edge respectively .Among the damaged crops maize was the most crops which were cultivated by most of the farmers in the study area and it was the highest vulnerable crop damaged observed by crop raider wildlife's species.

The distribution of homegarden crop species richness was observed increasing trend with increasing distance from the forest edge or crop species richness was higher at distances far from the forest edge. This indicates distribution of homegarden crop species richness showed increasing trend with decreasing crop raiding frequency or decreases with increasing crop raiding frequency. Although there was a significant spatial variation in crop raiding by wildlife crop raiders, in different parts of the landscape, the most of crop growing practices of the farmers in different parts of the landscape was similar.

The farmers were used different traditional crop protection methods in the study area to defend crop raiders from their crop like; guarding, chasing, making scarecrow, fencing and smoking. Continuous guarding was the main strategy used by most of the farmers close to forest to mitigate crop damage by wildlife crop raiders.

Understanding the attitudes of local people is critical for the success of wildlife conservation. Crop raiding can reduce farmers' tolerance towards wildlife. In the present study area attitudes of farmers towards wildlife was vary across the different parts of the landscape. Due to heavily reduction of crop loss and permanent guarding of the crop, majority of the farmers close to the forest have negative attitude towards wildlife conservation and their habitat. Majority of farmers those located far away from the forest have positive attitude towards wildlife's, because they don't faced heavy crop loss as farmers close to the forest edge. Human wildlife conflict and crop raiding issues must be treated with concern and placed in the context of local farmers. Farmers need to take responsibility for protecting their own crops and educating the community about the potential benefits associated with wildlife conservation can be an important tool in avoiding and resolving the conflicts caused between local community and wildlife.

## 6. RECOMMENDATION

Based on the findings of the present study, the following points are recommended:

- To minimize heavy agricultural yield losses, farmers who are located nearest to the forest edge, should be change their farming practices from highly susceptible seasonal crops such as maize to less susceptible perennial crops, as crops such as maize are more attractive to crop raiders than other crops, thus farmers should be encouraged to concentrate on crops which are not susceptible to wildlife crop raiders. Beekeeping, Ecotourism development and livestock raring are also suggested as alternative practice to the study area in this study.
- Encouraging farmers as they cooperate each other to keep cooperatively their crop farm from crop raiders to minimize crop heavy loss by using the most effective methods in the area.
- Farmers should sow similar crop at uniform time along side of their farm to keeping uniformly the farm to minimize the loss of crop damage caused by wildlife crop raiders.
- Educating the community of surrounding YCFBR regarding the benefit of wildlife conservation, the causes of human-wildlife conflict and strategies' for mitigating forms of the conflict.
- All stakeholders (GOVT, NGO and NRM experts) should need participate to reduce wild animal's habitat distraction and fragmentation and illegal settlement around buffer zone which forms a conflict between wild animals and human beings.
- To find sustainable solution to human-wildlife conflict or/and alternative crop species, which is less susceptible to crop raiders and could grow in the agro climatic-condition of the study area, a long-term study should be undertaken by scientists from different disciplines who need to work on the area of wildlife conservation and agricultural sustainability.



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## APPENDICES

Appendix. I: Homegarden crop species identified in the study area

No	Scientific name	Common name	Local name	Family name
1.	<i>Brassica carinata</i>	Abyssinian mustard	Abrango	Brassicaceae
2.	<i>Coccinia abyssinica</i>	Anchote	Anchote	Cucurbitaceae
3.	<i>Malus domestica</i>	Apple	Apple	Rosaceae
4.	<i>Persea americana</i>	Avocado	Avocado	Lauraceae
5.	<i>Ensete ventricosum</i>	Ensete	Qoccoo	Musaceae
6.	<i>Musa spp.</i>	Banana	Muzi	Musaceae
7.	<i>Brassicaoleraceavar.capitat</i>	White cabbage	Tikil Gomen	Brassicaceae
8.	<i>Brassica oleracea</i>	Cabbage	Gomen	Vegetable
9.	<i>Daucus carota</i>	Carrot	Carrot	Apiaceae
10.	<i>Annona cherimola</i>	Cherimoya	Gishta	Annonaceae
11.	<i>Beta vulgaris L.</i>	Beet root	Qey sir	Vegetable
12.	<i>Citrus medica L.</i>	Citron	Turungo	Rutaceae
13.	<i>Coffea arabica</i>	Coffee	Buna	Rubiaceae
14.	<i>Rhamnus prinoides</i>	Dog wod	Gesho	Rhamnaceae
15.	<i>Ruta chalepensis</i>	Fringedrue	Tena Adam	Ruta
16.	<i>Zingiber spp.</i>	Ginger	Zinjible	Spice
17.	<i>Capsicum annum</i>	Greenpepper	Qariya	Solanaceae
18.	<i>Psidium guajava</i>	Guava	Zeytuna	Myrtaceae
19.	<i>haseolus vulgaris</i>	Haricotbeen	Boloqe	Fabaceae
20.	<i>Curcuma longa</i>	Turmeric	Erid	Zingiberaceae
21.	<i>Phaseolus lunatus</i>	Lima bean	Adengure	Fabacea
22.	<i>Cicer arietinum</i>	Chick pea	Shimbra	Fabaceae
23.	<i>Vicia faba</i>	Faba bean	Baqela	Fabaceae
24.	<i>Catha edulis</i>	Khat	Khat	Celastraceae
25.	<i>Citrus medica</i>	Lemon	Lomi	Fruit
26.	<i>Zea mays</i>	Maize	Beqolo	Poaceae
27.	<i>Mangifera indica</i>	Mango	Mango	Fruit
28.	<i>Allium cepa</i>	Onion	Qey shinkurt	Amaryllidaceae
29.	<i>Citrus spp.</i>	Orange	Burtukan	Fruit
30.	<i>Ananas comosus</i>	Pineapple	Ananas	Fruit
31.	<i>Solanum tuberosum</i>	Potato	Dinch	Solanaceae
32.	<i>Carica papaya</i>	Papaya	Papaya	Fruit
33.	<i>Cucurbita pepo</i>	Pumpkin	Duba	Vegetable
34.	<i>Glycine max</i>	Soybean	Akurater	Pulse
35.	<i>Saccharum officinarum</i>	Sugar cane	Shenkora	Oil Crop

36.	<i>Helianthus annuus</i>	Sunflower	Sufii	Asteraceae
37.	<i>Ocimum basilicum</i>	Sweet Basil	Besobila	Lamiaceae
38.	<i>Colocasia esculenta</i>	Taro	Godere	Araceae
39.	<i>Nicotiana tabacum</i>	Tobacco	Tambo	Stimulant
40.	<i>Lycopersicon esculentum</i>	Tomato	Timatim	Vegetable
41.	<i>Eleusine coracana</i>	Finger millet	Dagusa	Poaceae
42.	<i>Dioscorea cayenensis</i> Lam.	Yam	yam	Root crop
43.	<i>Casimiroa edulis</i> La Llave	Kazmer	Kashmir	Rutaceae
44.	<i>Allium sativum</i>	Garlic	Nech Shinkurt	Spice
45.	<i>Lactuca sativa</i>	Lettuce	Selata	Asteraceae
46.	<i>Eleusine coracana</i>	Finger millet	Dagusa	Poaceae
47.	<i>Linum usitatissimum</i>	Flax	Telba	Linaceae
48.	<i>Citrus reticulata</i> Blanco	Mandarin orange	Mederin	Rutaceae
49.	<i>Coriandrum sativum</i>	Coriander	Dimblal	Apiaceae
50.	<i>Ipomoea batatas</i>	Sugar beet	Sukar dinich	Convolvulaceae
51.	<i>Aframomum corrorima</i>	Ethiopian cardamon	Korerima	Zingiberaceae
52.	<i>Artocarpus heterophyllus</i>	Jackfruit	Jackfruit	Moraceae
53.	<i>Pisum sativum</i>	Garden pea	Aatarii	Fabaceae
54.	<i>Plectranthus punctatus</i>	Potato Oromo	Dinicha romo	Solanaceae

**Appendix: II** Questionnaire for household's survey on spatial pattern of crop damage and other related crop raiding activities by wild mammal pests surrounding Yayu biosphere reserve, south western Ethiopia.

Name of data collector: \_\_\_\_\_ date: \_\_\_\_\_

1. Name \_\_\_\_\_

2. Sex [1] male [2] female

3. Age: \_\_\_\_\_

4. Educational back ground [1] Illiterate [2] read and writes only

[C] Elementary school [3] High school [4] other

5. Do you have your own farmland? [1] Yes [2] No

6. If your answer is „yes“ for question (Q 5) above, how much is its size?

[1] >0.5ha [2] 0.5-1 [3] 1-1.5ha [4] 1.5-2

7. How much is the distance of your farm land from buffer zone forest edge?

[1] Near [2] Medium [3] Far

8. What are your most livelihood activities?

[1] Crop farming [2] both crop farming and livestock rearing

- [3] Crop production and other income source [4] other (mention).
9. What type of crops do you grow in your farm land?  
 [1] Maize [2] sorghum [3] Teff [4] fruits [5] Other
10. Which type of crop is more attacked by wild animal?  
 [1] Maize [2] sorghum [3] fruits [4] Teff
11. To what extent wild animals cause damage to your crops?  
 [1] High [2] Medium [3] Low
12. Do wild animal cause damage to your crop? Yes / No.
13. If your answer yes for question (Q12) above, in what time more cause damage?  
 [1] Night [2] Day [3] both
14. Do you encounter any conflicts with wildlife? Yes or no
15. If your answer is yes for question (Q14), what kind of problems do you face because of wild mammal pests?  
 [1] Crop damage only [2] livestock predation only  
 [3] Both the crop damage and livestock predation [4] others
16. What is the major cause for the happening of HWC in your area?  
 [1] Expansion of subsistence agriculture around forest edge  
 [2] Wild animal habitat disturbance [3] proximity to forest  
 [4] Increment of wild animal's population
17. Which wild animal is more responsible for crop damage?  
 [1] Vervet Monkey [2] Anubis baboon [3] Bush pig [4] Porcupine
18. What control measures have been taken to protect you crops from crop raiders?  
 [1] Guarding [2] Chasing [3] Making scarecrows [4] Smoking [5] Others
19. At what stage wild animal more attack crops?  
 [1] Seedling [2] early maturation [3] Maturation [4] Other
20. What is the tendency of crop damage from time to time?  
 [1] Increasing [2] Decreasing [3] Unknown
21. How many crop yields can be lossed to mammal pests annually? estimate.
22. If your answer is yes for question (Q21), how many? And what is the species involved?
23. Which wild animals are more responsible for crop damage during day time?
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25. Which crop raiding wild animal is more responsible for crop damage during night time?

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26. Rank crop raiders according to the extent of crop damage.

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27. Estimate the frequency of wildlife species come and visit your farm land in a year in days (how many days wildlife species crop raiders come and visit your farm land in a year, Moth, weak and which season the become more frequent)?.

A. Baboon \_\_\_\_\_

B. V. monkey \_\_\_\_\_

C. Bush pig \_\_\_\_\_

D. porcupine \_\_\_\_\_

### **APPENDIX .III**

Check lists for Focus Group Discussion (farmers)

Discus the following points in context to your farm plot or locality

1. Is there any Human-wildlife conflict in your area?
2. What type of crops do you grow on your land?
3. What is the main deriving cause of HWC in your area
4. Which crop raiding wild animal is more cause crop damage?
5. Which wild animal species frequently attack your farm?
6. Do you think the presence of the Yayu biosphere reserve forest close to your area benefited the society? if benefited what are they?
7. In which season the crop damage is serious and what is the reason behind?
8. What are the major factors that cause Human wild animals conflict in the study area?
9. Is habitat of wild animal is fragmented due to human and natural causes in your area?
10. Why farmers in your area face human-wildlife conflict?

Appendix VI: Homegarden crop distribution assessment (inventory)

Home garden No(1-60)	Crop type(name)	No of each crop observed	Area(m <sup>2</sup> ) Occupied	Name of HH head	Altitude (m.a.sl)	N coordinate	E coordinate