A corridor linking protected forests; meeting conservation and livelihood expectations

The Mngeta corridor: linking the Kilombero Nature Reserve and the Udzungwa Scarp Catchment Forest Reserve, Morogoro Region, Tanzania

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Abstract

The Udzungwa Mountain forests of the Eastern Arc Mountains of Tanzania are globally recognised as a centre of outstanding biological diversity. In addition the continued existence of forest cover upon these mountains is critical in maintaining ecosystem services. The Udzungwa Scarp Catchment Forest Reserve which displays unique levels of species endemism risks becoming an isolated patch of forest. Should this happen forest dependent species are more likely to face extinction. As such a corridor linking the Udzungwa Scarp Catchment Forest Reserve to the contiguous forest made up of the Kilombero Nature Reserve and the Udzungwa Mountains National Park has been proposed. This study examines demographic characteristics, livelihood strategies, and dependencies upon natural resources of households inside the proposed corridor area and outside the corridor area upon village land. The results show that an estimated 90 households depend upon natural resources particularly agricultural land and open access forests inside the proposed corridor area. Demographic characteristics and livelihood strategies of households within the corridor area do not differ greatly from households located upon village land outside of the corridor. As such given fair compensation that safeguards household livelihoods, resettlement upon village land is considered feasible, given a suitable political climate.

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Acronyms

a.s.l.	Above sea level
GoT	Government of Tanzania
HH	Households
HHH	Head of household
IRA	Institute of Resource Assessment
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goal
PFM	Participatory Forest Management
PRSP	Poverty Reduction Strategy Paper
VEC	Village Environment Committee
VLFR	Village Land Forest Reserve
URT	United Republic of Tanzania

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1.0 Background

1.1 Global biodiversity and ecosystem services

1.1.1 The importance of biodiversity and ecosystem services to human well-being

The importance that biological diversity plays in the well-being of human life is universally recognised; indicated by the near universal ratification of the Convention on Biological Diversity (CBD) (Secretariat of the Convention on Biological Diversity, 2006). In 2002 those countries who had ratified the CBD, adopted a Strategic Plan to;

> "*achieve, by 2010, a significant reduction of the current rate of biodiversity loss at the global, regional and national level, as a contribution to poverty alleviation and to the benefit of all life on Earth"* (Secretariat of the Convention on Biological Diversity, 2006).

Biodiversity loss is of global concern due to the ecosystem services that a biodiverse, healthy ecosystem provide. Such services include disease and climate regulation, food, water, aesthetic and cultural enjoyment (Millennium Ecosystem Assessment, 2005; hereafter MA, 2005). Ecosystem services can be split into four main categories (Table 1).

Table 1. Categories of ecosystems services

Ecosystem Service	Example
Provisioning	Those that provide food, water, timber, and fibre.
Regulating	Those that affect climate, floods, disease, wastes, and water quality.
Cultural	Those that provide recreational, aesthetic, and spiritual benefits.
Supporting	Those that affect soil formation, photosynthesis, and nutrient cycling.

After: MA 2005.

Human life is wholly dependent upon ecosystem services. For those ecosystem services that are relatively scarce, if they are depended upon by humans, even a small decrease in the provision of that service can deplete the quality of human well-being (MA, 2005). The global demand for ecosystem services has been reported to exceed the earth's capacity to renew the resources by some 20% (Secretariat of the Convention on Biological Diversity, 2006). The Millennium Ecosystem Assessment (2005) highlighted that 15 of the 24, or 60%, of ecosystem services assessed have been degraded over the preceding 50 years. For example, demands made upon capture fisheries and fresh water ecosystem services were considered unsustainable given the levels of extraction at the time of the study, let alone future ones. That is not to say that all ecosystem services have declined. Indeed some have increased, these include: crop production; livestock production; aquaculture; and the net source of global carbon sequestration since mid century. However, the increase of one ecosystem service has often been to the detriment of another, this is particularly true of food production.

The expansion of agricultural lands has resulted in reduced forest cover; a decrease in biodiversity; and in some instances an increase in the magnitude of floods and erosion resultant of land use change (MA, 2005). However the Secretariat of the Convention on Biological Diversity (2006) notes that whilst on all levels and geographical scales biodiversity is in decline, actions can be taken to reverse the trends. One such action includes the establishment of an ecologically representative network of terrestrial protected areas by 2010; and marine protected areas by 2012. Protected areas now cover 12% of the earth's terrestrial service and the number of protected areas is increasing. However, the protected area covered per ecoregion still falls short of the 10% surface cover per ecoregion target required to achieve the 2010 Biodiversity Target (Secretariat of the Convention on Biological Diversity, 2006).

1.1.2 Drivers of ecosystem change

Over the last 50 to 100 years habitat change, climate change, over-exploitation, invasive species and pollution by nitrogen and phosphorus are considered to be five of the main drivers of ecosystem change and biodiversity loss on our planet. Habitat change and over-exploitation have been the main drivers of biodiversity loss for tropical forests over the last century and the impact of both is predicted to continue (Secretariat of the Convention on Biological Diversity, 2006). Whilst the literature supports the view that a comprehensive network of protected areas contributes to the decrease in biodiversity loss (Secretariat of the Convention on Biological Diversity, 2006; MA, 2005; Rodrigues *et al* 2004), the design and distribution of protected areas is critical. Following the Fifth World Parks Congress in 2003, a gap analysis of protected area coverage revealed that whilst the target of ensuring that 10% of earth's terrestrial surface was designated as protected areas had been exceeded, a considerable number of threatened species were not found within protected areas (20% of analysed species). In addition, of the species that were found within protected areas, 1,423 were only represented in protected areas of ≤ 1,000 ha, a size that may not be able to support viable populations (Newmark, 1996). The gap analysis highlights that due to the non-universal distribution of biodiversity, if the conservation goal is species representation, it is not the region with the lowest percentage cover of protected areas that must increase protected area coverage, but more typically the regions with higher degrees of endemism (Rodrigues *et al*, 2004).

1.1.3 Habitat fragmentation

Simberloff and Abele (1976) vied that the application of island biogeography to conservation practice was premature and through the establishment of conservation programmes covering large areas, could prove costly. Recent history has seen a rapid increase in the human population with an associated expansion of land use which has resulted in the fragmentation of natural

habitat. As fragmentation proceeds in time, fragment size becomes smaller; as such each fragment becomes more insular; the result is an overall decline in biodiversity (Wilcox, 1980). Long-term studies in central Amazonian forests indicate that sample, area, edge, matrix and isolation effects all influence the biota of forest fragments (Laurance *et al*, 2002). To understand the influence of each of these effects upon forest fragments each one will be looked at in turn:

- Sampling effect: Smaller patches sample fewer species. A forest fragment will only represent a proportion of the regional biota compared to a larger forest area. This is of particular importance to tropical forests where species distribution can be patchy, and there are high degrees of endemism.

- Area effect: Species richness has been positively correlated with area, whilst species extinction rates have been negatively correlated with fragment size.

- Edge effect: Microclimatic changes at the edge of fragments include reduced humidity, increased light and increased temperature variability. These microclimatic changes negatively impact on forest adapted species. Increased tree death on edges of fragments contributes to an alteration in canopy structure. Edge effect is typically negative for deep forest adapted species but other species may benefit; for example birds that forage in tree gaps.

- Matrix effect: the matrix habitats between fragments influence fragment ecology with fragments surrounded by re-growth forest experiencing less changes in microclimate than fragments surrounded by all too different habitats e.g. pasture. Matrix habitat influences fragment connectivity, matrix avoiding species are more likely to decline or disappear from

fragmented forests than species that will utilise the matrix habitat. Typically the more alike the matrix habitat to that of the fragments the more likely it is to be used by species sensitive to fragmentation (Laurance *et al*, 2002).

With respect to tropical forests, habitat fragmentation has been seen to: reduce above-ground tree biomass (Laurance *et al*, 1997); cause species abundance differences between intact and fragmented forests, with some species becoming hyper-abundant and others declining (Laurance *et al*, 2002); to cause faunal relaxation with a half life of approximately 50 years for a 1000 ha area (Brooks *et al*, 1999); and to alter microclimate, particularly within 100m of the edge of a forest fragment (Laurance *et al*, 1997).

1.1.4 Corridors: a way to link refuges

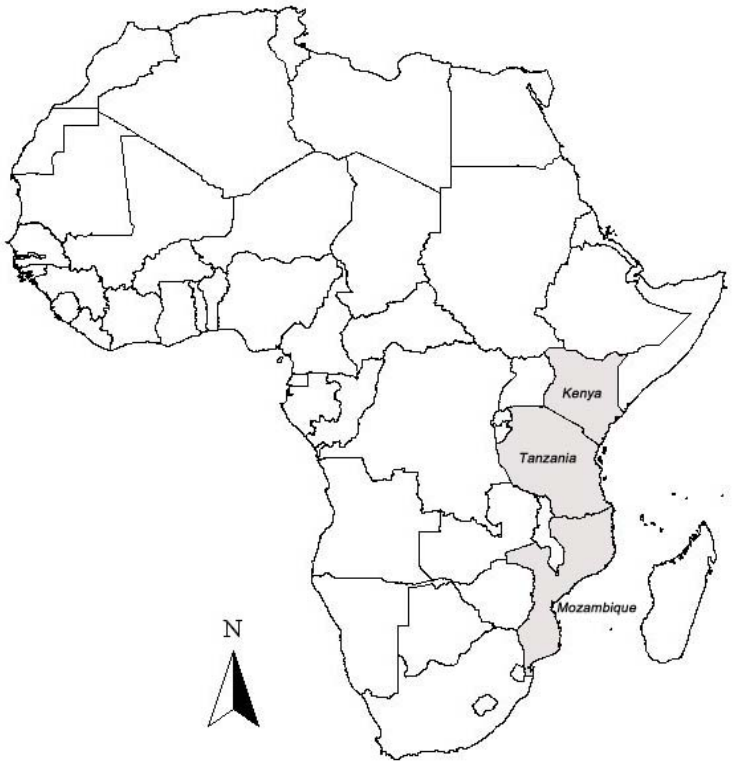
One solution to habitat fragmentation is the establishment of 'corridors' between refuges or more isolated patches of particular habitats and ecotones. Corridors have the potential to facilitate the movement of genetic material between otherwise disconnected areas, thus alleviating the threat of inbreeding depression and demographic stochasticity brought about by isolation. However, the establishment of corridors may also present risks to the fauna and flora of particular conservation interest, for example corridors linking refuges may serve to transmit disease or fire between areas; or increase the exposure of fauna to poachers. In addition to this there may also be significant economic and financial costs, where the economics of constructing any required infrastructure; may also be more expensive than, for example, relocating keystone fauna from one refuge to another (Simberloff & Cox, 1987). There is a complex nexus of ecological and socio-economic issues connected with corridor design that are often difficult to disaggregate and to achieve the desired conservation or ecosystem service outcome. With shape; area; composite species within the corridor (matrix habitat); and habitat dependencies of the target species that one wishes to utilise the

corridor; all playing important roles in the success or failure of a corridor in linking refuges (Laurance, 2002; Hess & Fischer, 2001; Fleury & Brown, 1997; Simberloff & Cox, 1987).

1.2 The East Africa Region

1.2.1 Ecoregions and protected areas

Coastal East Africa encompassing Kenya, Tanzania and Mozambique (Map 1) has a long history of allocating land for protective purposes through the gazettment of national parks, forest reserves and marine protected areas; for example, Kilimanjaro National Park in Tanzania, was gazetted in 1910. Using the IUCN categories of protected areas I - V, 12.3%, 39.6% and 5.7% of Kenya, Tanzania and Mozambique's total land area are protected. These figures are exclusive of marine and littoral protected areas which total 2,579 ha across the region (Earthtrends, 2003a; 2003b; 2003c).



Map 1. Country map of Africa showing Kenya, Tanzania and Mozambique shaded in grey

Globally the region is recognised as a centre of biodiversity acknowledged by: the Eastern African Coastal Forests Global Ecoregion; the Eastern Arc Montane Forest Global Ecoregion (Olson & Dinerstein, 1998) and; the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya biodiversity hotspot (Myers *et al,* 2000). Whilst these facts are impressive to, it is important to note that people in 16 out of the 25 biodiversity hotspots are facing malnutrition and depend to some degree directly upon natural resources to sustain themselves (Scherr & McNeely, 2001).

1.2.2 People and protected areas

The protection of areas, by its very nature depends upon the enforcement of rules governing access to resources, in Africa this has resulted in conflict between short-term individual interests and long-term communal interests (Bell, 1987). Indeed, when assessing who bears the costs of conservation Balmford and Whitten (2003) drew attention to the undesirable situation where the opportunity costs of conservation are often borne by local communities. Such passive costs are incurred frequently by the rural poor through; restricted or denied access to natural resources, or the lost opportunity to convert land. This situation was noted to be particularly true in the tropics where threatened species and habitats are more prevalent than in other parts of the world.

In the mid 1990's decentralisation of protected forests was piloted in northern and eastern Tanzania. Following the success of these projects and a review of Tanzania forest policy and legislation Participatory Forest Management (PFM) was developed. PFM allows for communities alone (through Village Land Forest Reserves) or together with government authorities (Joint Forest Management) to manage forests for sustainable use or conservation purposes (Blomley *et al,* 2008). To date 3.6 million ha of forest in 209 forest reserves are managed under PFM agreements. A review of 13 PFM forest reserves have provide evidence that such management arrangement can be

a success with lower levels human disturbance (cut poles and timbers) found in PFM forests compared to those managed solely by the state (Blomley *et al,* 2008).

1.2.3 Natural resource dependency

Throughout the region there is a high dependence upon natural resources, with a considerable proportion of the region still depending upon fuel wood as the main source of energy. This has obvious consequences for the regions forests, for example the Eastern Arc Mountains of Tanzania have lost 12% or 42,330 ha of forest cover between the 1970s and 2000s years (Mbilinyi & Kashaigili, 2005).

With the population in the region growing, pressures upon natural resources are only set to increase. In a region dominated with households dependent upon subsistence farming and natural forest, marine and freshwater resources it is indeed the case that the consequences of biodiversity loss and ecosystem disruption will impact negatively upon rural households because of the intrinsic dependency that such households have upon ecosystem services for their livelihoods (The Secretariat of the Convention on Biological Diversity, 2006)

1.2.4 National development and environmental sustainability

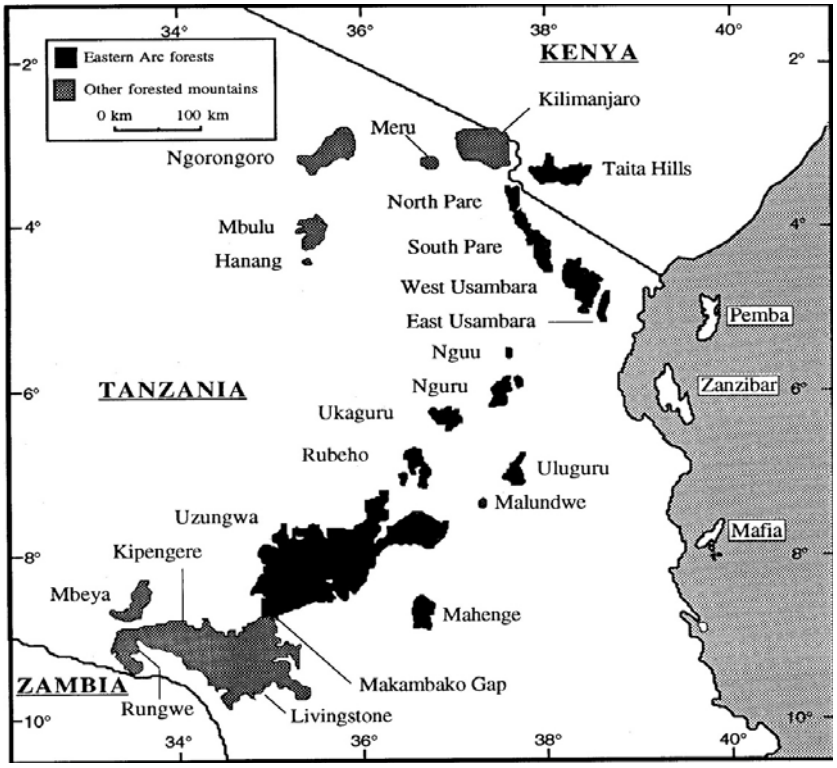
Governments in the region are committed to achieving the Millennium Development Goals (MDGs) with their aims set down in Poverty Reduction Strategy Papers (PRSP). However, achievement of environmental sustainability is afforded less attention in the PRSPs than the achievement of other MDGs. This is of significance to budget allocation, with lesser resources being allocated to, for example, the protection of catchment forests. Whilst this bias in priority may be understandable given the higher priority to achieve a minimum standard of well-being for the human populous, the delayed response in addressing environmental sustainability may be detrimental to

the overall development strategies of the country, and thus the attainment of the MDGs. Indeed the failure of Tanzania's hydropower stations to provide a reliable supply of electricity due to failing rains; which may be linked to a loss in forest cover; has already proved costly to industry in Tanzania (Mtalo *et al*, 2005)

1.3 The Eastern Arc Mountains of Kenya and Tanzania

1.3.1 Biological Importance

The Eastern Arc Mountains, estimated to be 30 million years old are made up of 13 mountain blocks stretching from the Taita Hills in southern Kenya to the Udzungwa Mountains in south-central Tanzania (Map 2). They are listed as one of the worlds 25 Biodiversity Hotspots, home to 96 endemic vertebrate species and at least 800 endemic vascular plant species (Myers *et al,* 2000). An estimated 70% of the original forest cover has been lost; today all these endemic species exist in just 3,300 square kilometres of fragmented forests (Burgess *et al,* 2007).



Map 2. The thirteen mountain blocks of the Eastern Arc Mountains of Kenya and Tanzania which support moist forest (shown in black)

Source: Lovett & Wasser (1993).

This study will focus on an area within the largest of the mountain blocks found within the Eastern Arc Mountains; the Udzungwa Mountains. The Udzungwa Mountain block has an estimated 1,353km^2 of forest habitat at an altitudinal range of 300 – 2580 m above sea level. The catchment forests of the Udzungwa Mountains are home to 96 endemic and near-endemic vertebrate species; including two endemic monkeys the Udzungwa Red Colobus *(Procolobus gordonorum)* and the Sanje Mangabe *(Cercocebus sanjei*); two endemic shrews; three endemic birds; six endemic reptiles; and seven endemic amphibians (Burgess *et al,* 2007). In addition a new species of monkey *(Rungwecebus kipunji)* has been found in just one forest of the Udzungwa Mountains; this new species is only found at one other location;

the Rungwe-Livingston Mountains of the Southern Highlands of Tanzania (Davenport *et al,* 2007).

1.3.2 Economic Importance

Ecosystem services provided by the Udzungwa Mountain forests contribute considerably to the countries economy, particularly through the provision of water. Water originating in these mountains supplies the Kihansi hydropower plant which in 2005 produced 35% of Tanzania's hydroelectricity (GoT, 2006, in Rovero, 2007). Water from these forests can also be linked to the livelihoods of agriculturalists and fishers in the Kilombero Valley and Rufiji River Basin which support an estimated 3.2 million people. In 1999 rice production in the Kilombero Valley alone exceeded 40,000 metric tonnes, estimated to be worth TSh 4 billion[1] (IRA 2000 in Rovero, 2007).

1.3.3 Protective Status

To date 1,990 kilometres square of the Udzungwa Mountain forests are afforded considerable protection within the Udzungwa Mountains National Park, managed by the Tanzania National Parks Authority. However:

> *"an equal amount of forest containing many species not found in the park, is essentially unprotected and currently threatened with degradation and total loss by illegal activities"* (Rovero, 2007).

Rovero (2007) is referring to a number of gazetted Catchment Forest Reserves which surround the Udzungwa Mountains National Park. These are the West Kilombero Scarp, Matundu, Iyondo and Udzungwa Scarp Catchment Forest Reserves.

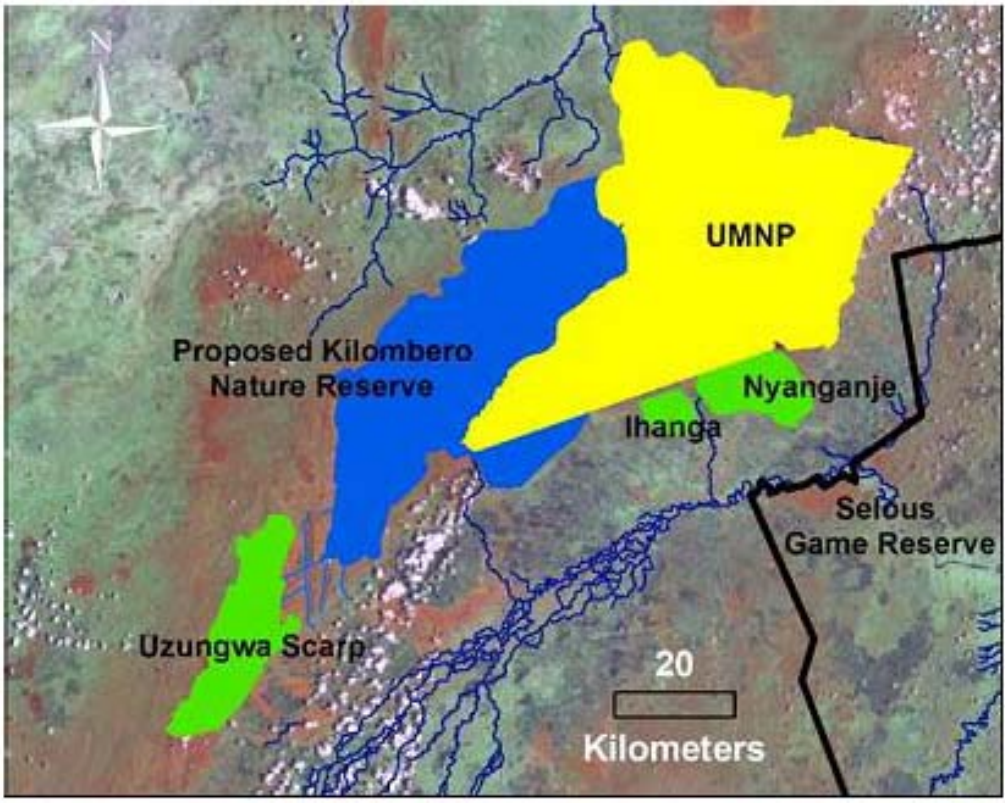
[1] Exchange rate: US$1 = TSh 1,153

The designation of any type of forest reserve in Tanzania is supported by the National Forest Policy of 1998 and the Forest Act (no. 14) of 2002 (Forest & Beekeeping Division, 2006). Catchment Forest Reserves are managed by the Forest and Beekeeping Division of the Department of Natural Resource and Tourism of the Government of Tanzania – i.e. the Central Government. Catchment Forest Reserves are protected principally for the protection of water sheds; soil conservation; and the protection of wild plants (GoT, 2002). The protective status of gazetted Catchment Forest Reserve makes any form of resource extraction and / or clearing of forest within the boundaries illegal.

Despite being gazetted as Catchment Forest Reserves, Iyondo (280 km^2 gazetted in 1958) and Udzungwa Scarp (207 km^2 gazetted in 1929) Catchment Forest Reserves experienced higher levels of illegal human resource extraction than Udzungwa Mountains National Park. Resource extraction includes pole and timber extraction; charcoal making; and hunting for bush meat. The pressure on both of these Catchment Forest Reserves is exacerbated by a growing human population, as migration to the area in search of arable land is high (Rovero, 2007).

1.3.4 Declaration of Kilombero Nature Reserve

On 17 August 2007 West Kilombero Scarp Catchment Forest Reserve, together with Matundu and Iyondo Catchment Forest Reserves become part of the Kilombero Nature Forest Reserve (Government Notice no. 182 JB no. 2525), (Marshall et al, 2007) (Map 3).



KEY
Yellow: National Park
Blue: Nature Forest Reserve
Green: Catchment Forest Reserve

Map 3. Protected areas of the Udzungwa Landscape

(Source: Rovero, 2007)

Declaration of Nature Forest Reserve status is enabled through Part V of the Forest Act 2002, whereby the Minister may declared, by order published in the Gazette, any area of land to be a Nature Forest Reserve (GoT, 2002). A Nature Forest Reserve is considered:

> *"(c) an area of land covered by forest reserve, used principally to protect nature and scenic areas of national or international significance and to maintain and enhance bio-diversity and genetic resources in an undisturbed, dynamic and evolutionary state known as a nature forest reserve"*. (GoT, 2002)

Nature Forest Reserve is the highest order of protective status that the Forest and Beekeeping Division can bestow upon a forest. Subject to provisions within the Forest Act 2002, designation as a Nature Forest Reserve prohibits;

- *rights to occupancy of any area designated as a national forest reserve;*
- *extractive activities of any kind, whether that be timber or non-timber forest products; and*
- *clearing of vegetation, cultivation, grazing, fishing or hunting.* (GoT, 2002).

The increased protective status of these three Catchment Forest Reserves affords them the same status as a National Park administered by the Tanzania National Parks Authority. This elevated status should increase resources available to the Forest and Beekeeping Division of the Government of Tanzania to manage and protect these forests. However, Udzungwa Scarp Catchment Forest Reserve, due to an oversight has not been included within the Kilombero Nature Forest Reserve. As such, Udzungwa Scarp Catchment Forest Reserve will remain as an isolated forest fragment.

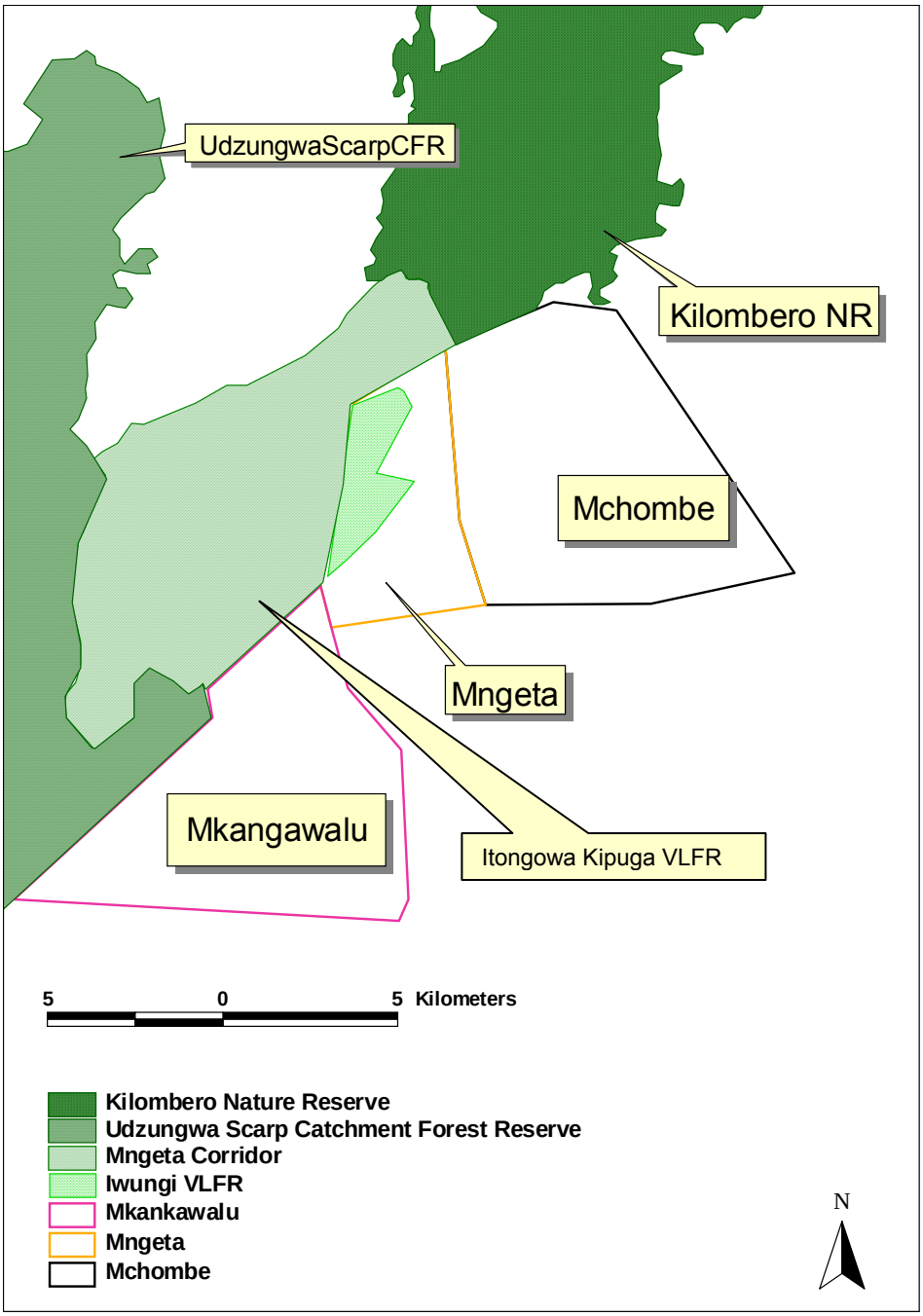
The Udzungwa Scarp Catchment Forest Reserve has a density of endemic vertebrate species far greater than that of the whole of the Eastern Arc Mountains (30.8 species per 100 km^2 versus 4.5), yet it is isolated from neighbouring forests.

1.3.5 The proposed Mngeta corridor

As discussed in section 1.1.3 above, fragmented forest habitats are less effective for the long-term conservation of biodiversity than larger forest areas; or a forest patches within a matrix where the matrix habitat permits movement of species between isolated forest fragments. In order to

safeguard the long-term survival of biodiversity of the isolated Udzungwa Scarp Catchment Forest Reserve Rovero (2007) proposed that the 'Mngeta corridor' be established between Kilombero Nature Forest Reserve and Udzungwa Scarp Catchment Forest Reserve (Map 4).

The proposed Mngeta corridor measures 9.2 to 15.2 km between Udzungwa Scarp Catchment Forest Reserve and the Kilombero Nature Reserve. Corridor width ranges from 2.1 to 6.8 km. The total area encompassed by the corridor is 63 km^2. By analysing aerial digital photographs and conducting ground surveys Rovero (2007) estimated that as much as 80% of the corridor area was covered by natural vegetation (grass, shrubs, woodlands or forest). Approximately 25% of which was considered to be natural forest and woodland. Rovero (2007) also noted that parts of the corridor are very steep and covered with mixed grassland, shrubs and low-canopy forest. Rovero (2007) estimated that 20% of the corridor area, or 12.6 km^2 were occupied by recent farms.



Map 4. Proposed Mngeta corridor and surrounding environs[2]

[2] Map 4 shows polygons made from 1:50000 digitised topographical maps; and polygons developed from boundary beacon GPS coordinates collected during fieldwork and built into ArcView 3.3. Coordinates were not available for Itongowa Kipuga Village Land Forest Reserve (VLFR); the arrow on the map is an indication of the location of this VLFR only and is not based on official data.

The proposed Mngeta corridor is situated entirely upon public (Government) land and does not fall within the boundaries of the three neighbouring villages Mkangawalu, Mngeta and Mchombe. Rovero (2007) estimated that the corridor area supports less than 100 households who mostly utilise the area for seasonal farming. In addition Rovero (2007) highlighted the need for further studies into the human population size and resource utilisation within the corridor, should the corridor be considered for implementation.

1.4 Project rationale

The Udzungwa Mountain forests are globally recognised as a centre of outstanding biological diversity and the continued existence of forest cover upon these mountains is critical in terms of ecosystem services.

Rovero (2007) notes that a contiguous forest block would serve conservation targets better than the current situation of fragmented forest patches. This is in respect of both permitting genetic transfer between areas; and in terms of one contiguous forest being a more easily manageable unit than multiple patches of forest. Yet the feasibility of establishing a corridor between the Udzungwa Scarp Catchment Forest Reserve and the Kilombero Nature Reserve is currently unknown. This is due to the lack of social data from the research area that can inform a sound conservation recommendation that will be both socially and ecologically sustainable. Specifically the level of human dependency upon the corridor area is unknown. Research is needed to fill this knowledge gap.

1.5 Research aims and objectives

The aim of this study is to provide social data from households residing in the three villages of Mchombe, Mngeta and Mkangawalu which boarder the corridor area; and from households residing inside the corridor area. These data will help describe the research population's demographic characteristics, livelihood strategies, and dependencies upon natural resources. These data

will contribute to existing biological data from the area in order that a recommendation based on the concept of double sustainability as described by Cernea and Schmidt-Soltau (2003) may be offered for the Mngeta corridor.

The objectives of the study are:

- Collect demographic and socio-economic data from households within the research area;
- To approximate how many households utilise natural resources, including farm land, within the proposed corridor area;
- To establish the main drivers causing households to utilise natural resources within the proposed corridor area; and
- To asses whether households outside of, and inside the proposed corridor area differ in natural resource dependency; and
- To provide quantitative data of livelihood strategies of the research population.

2.0 Methods

2.1 Demographic, socioeconomic and natural resource dependencies of households in the research area

2.1.1 Household survey questionnaire

The objectives of this study were to assess land use, natural resource exploitation and livelihood strategies amongst people living within and close to the proposed Mngeta corridor. Research was conducted in three rural villages, which neighbour the corridor area. Quantitative data were obtained using a short questionnaire (Appendix 1). The construction of a sampling frame for the selection of a probabalistic sample was not possible as there were no lists to draw from and no time to determine household numbers and locations. The questionnaire was therefore administered using a purposive sampling strategy. The criteria for household selection were: location of village residence; household farming activity and location of plots within the proposed corridor area; availability to answer questions. Key informants (village leaders and Mngeta corridor residents) knowledge was used to guide the sampling process.

The aim was to interview 50 people in each of the three villages, thus ensuring that data were collected from each of the three villages in the research area. A sample of 50 people per village was considered realistic given the time available for conducting fieldwork. However, the identification of additional hamlets within the corridor area resulted in the completion of 165 questionnaires, thus ensuring that data on corridor residents were represented in the sample. Interviews were conducted in Swahili by trained and experienced interviewers with a scribe maintaining records. Following the definition of Laws *et al* (2003) quoting Bell (1993) a combination of open, quantity and ranking questions were included in the questionnaire to ascertain household information indicating: standard of living; resource ownership; livelihood strategies, including land-use practices; and

dependence upon natural resources. Specifically ranking questions were used to ascertain respondents' degree of dependence upon natural resource extraction.

Data were also collected on the perceived benefits of respondents' livelihood strategies. Having identified all of their household's livelihood strategies respondents were asked to rank the perceived value of each of their livelihood strategies with regards to: importance for household food; and importance for household income.

The household survey was designed to collect broad data of household socio-economics, resource use and demographics; it was introduced as being about land use upon the floodplain and land use up in the hills. The survey was designed on purpose not to interrogate people about resource extraction from protected forests, as this would not serve to meet the research objective of discovering how people utilise resources within the area. This approach was considered appropriate as the research population are suspicious of people questioning them about illegal activities e.g. timber extraction or poaching, and are unwilling to elicit information that may be detrimental to themselves or others.

Were required assumption could be met by the data, non-parametric statistical tests have been used to look for significant differences between respondents living inside and outside of the corridor area (Pallant, 2001). Both Chi-square and Mann Whitney U tests have both been used to interrogate survey data. The latter has been used applied in consideration of proxy wealth indicators.

2.1.2 Group meetings

Quantitative and qualitative data were gathered through group meetings held in each of the three research villages. So as not to end up with a group too

large for two facilitators to manage, every other questionnaire respondent was invited to attend the meeting. Ultimately attendees were self-selecting. Attendees participated in four activities: village mapping; seasonal calendar; livelihood scoring exercise and; a focus group discussion. With the exception of the latter, attendees were split by gender to complete the exercises. These participatory methods were used to gather viewpoints of different groups within the society (men and women). The methods collect data on the perceptions of the attendees, as such data may be subjective or factually incorrect but it nevertheless portrays the opinions of the attendees (Harrison, 2006).

2.1.3 Village mapping

Attendees were asked to draw a map of their village as recommended by Laws *et al* (2003) intervention from facilitators was kept to a minimum; only initiating the activity by suggesting that attendees start by drawing the village boundary and then perhaps the road or railway. Maps were initially drawn directly onto the ground. Once attendees had finished drawing their maps the facilitators asked each group to identify important resources or places within the village; each of these were marked with a labelled card placed on the map. Once attendees had finished identifying important resources or places within the village, the facilitators asked the two groups to rank the resources or places in order of importance to them. The rank number was written on a card and placed on the map. Again during both of these steps intervention by the facilitators was kept to a minimum with discussion amongst participants being allowed to reach a natural conclusion.

2.1.4 Seasonal calendar

Attendees completed a seasonal calendar answering questions including: when is men's / women's workload the hardest; when are the main crops grown and sold; when is household income and expenditure the highest? (See Appendix 2). Answers were recorded on a matrix drawn on the ground,

or on paper. The matrix had the months running across the top and the questions down the left hand side. Participants provided responses in the form of a score by month. To allow for comparison between groups the maximum score that a group could award was set at six.

2.1.5 Livelihood scoring exercise

Attendees were asked to list all the livelihood activities that they actively undertook. These were then ranked: first in order of importance for the contribution they make to household food security and; secondly in order of importance for the contribution they make in the form of household income. Results were recorded in the facilitators' note books.

2.1.6 Focus group discussion

The focus group discussion covered two themes: awareness and perceptions towards forest reserves and; attendee's knowledge of the Mngeta corridor area. Appendix 3 shows the questions asked during focus group discussion.

2.1.7 Social transect

In order to contact households within the corridor area key informants were asked to act as guides to facilitate a social transect. The social transect was designed to take in as many households as possible in the time available (total of four days) in order to gain a picture of the level of human occupancy within the corridor area. Whilst walking within the corridor household survey questionnaires where completed, mostly at homesteads but sometimes along pathways or upon farming land. In addition to household surveys the following data were also collected:

- GPS coordinates of houses;
- Photographs showing habitat and land use;
- GPS coordinates associated with photographs mentioned above.

GPS data were collected using a Garmin eTrex ® personal navigator set to collect data in UTM units. These data were collected as part of the GIS component of the project discussed in 2.2 below.

2.2 GIS analysis

In order to produce accurate maps of the research area GIS data were collected. These included:

- GPS coordinates for village beacon points of Mchombe, Mngeta and Mkangawalu villages supplied by the Land Office, Kilombero District Authority;
- GPS coordinates for beacon points of Iwungi Village Land Forest Reserve supplied by the Kilombero District Forest Office;
- digitised 1:50,000 topographical maps produced by the Surveys and Mapping Division, Ministry of Lands and Human Settlements Development, Tanzania;
- GIS layer of the Mngeta corridor supplied by F. Rovero; and
- various GIS layers provided by the core profile development group of the Critical Ecosystem Partnership Fund – Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya Hotspot.

Unfortunately GPS coordinated for beacon points of Itongowa Kipuga Village Land Forest Reserve of Mkangawalu village were not available. As such this forest has not been projected on maps included in this document.

GIS data were loaded into ArcView GIS 3.3 for the purpose of producing maps showing different types of land allocation and human settlements inside of the corridor area.

3.0 Results

3.1 Livelihood strategies in the research area: household survey

3.1.1 Geographical distribution of the sample

165 interviews, representing 4.8% of the population within the research area (i.e. households within the boundaries of Mchombe, Mngeta and Mangawalu villages and any households within the corridor area as depicted in Map 4, were conducted in three main villages. The three villages encompass 15 sub-villages and five hamlets, the latter are all positioned within the corridor area as shown in Table 2.

Table 2. Village population figures

Village	Sub-village	Hamlet in corridor area	Total No. HHs	No. of questionn aires completed (1 per HH)	% of population interviewed
Mngeta	Kiburubutu		137	5	3.6
	Mkula		128	6	4.7
	Mngeta		140	10	7.1
	Msesele		206	15	7.3
	Msesele	Mtogo	18	1	5.6
		Kilongo	30	10	33.3
		Kidete of Msesele	10	5	50.0
		Kivokoni	6	4	66.7
	Ikela		114	4	3.5
	Imwaga		210	6	2.9
		Sub total	999	66	6.6
Mchombe	Mchombe		539	10	1.9
	Zahanati		120	10	8.3
	Mlimani		166	10	6.0
	Mkusi		309	10	3.2
	Nakaguru		205	10	4.9
		Sub total	1,339	50	3.7
Mkanguwalu	Itongowa A		165	8	4.8
	Itongowa A	Kimbi	10	8	80.0
	Itongowa B		380	10	2.6
	Kidete		244	13	5.3
	Mkanguwalu		300	10	3.3
		Sub total	1,096	49	4.5
		TOTAL	3,437	165	4.8

Source: Village Government records

78.2% (129) of respondents reside and farm outside of the corridor area upon village land and 18.2% (30) of respondents farm and reside within the corridor area on a permanent basis. The remaining 3.6% (6) reside and farm within the corridor on a seasonal basis (Table 3).

Table 3. Sampling intensity of populations residing outside and inside the corridor area

	Frequency (n = 165)	Percent of sample	Percent of Outside / Inside corridor population interviewed
OUTSIDE CORRIDOR			
Reside outside of the corridor	129	78.2	3.8%
INSIDE CORRIDOR			
Reside permanently in corridor	30	18.2	48.6%*
Reside seasonally in corridor	6	3.6	

* The numbers of houses found in hamlets inside the corridor, totalling 74, were confirmed by local sources (Table 2). However, 22.2% (8 respondents) of the respondents farming within the corridor area were from Msesele (19.4%, 7 respondents) and Kidete (2.8%, 1 respondent) sub-villages. This means that the number of households utilising land within the corridor area is greater than the recorded number of households found within the hamlets of Mtogo, Kilongo, Kidete of Msesele, Kivokoni, and Kimbi. The considerably higher sampling intensity of households within the corridor area means that the data provides a clear picture of household demographic and socioeconomic characteristics inside of the corridor area.

3.1.2 Demographic characteristics

Data discussed in this section are summarised in (Table 4). The total sample was made up of 85 men (51.5%) and 80 women (48.5%) with the majority of respondents (62.4%, 103) being aged between 27 – 46 years of age (mean 38 years). The majority of heads of households (58.8%, 97) also fall within the age ranges of 27 – 46 (mean 42 years).

Table 4. Demographic profile

	Overall frequency (n = 165)	Overall percentage (n = 165)	Percentage of out-corridor respondents (n = 129)	Percentage of in-corridor respondents (n = 36)
RESPONDENTS				
Male	85	51.5	46.5	69.4
Female	80	48.5	53.5	30.6
Age range				
Unknown	5	3.0	2.3	5.6
17 – 26	25	15.2	14.7	16.7
27 – 36	65	39.4	38.8	41.7
37 – 46	38	23.0	24.0	19.4
47 – 56	15	9.1	10.1	5.6
57 – 66	12	7.3	7.8	5.6
67 +	5	3.0	2.3	5.6
HEADS OF HOUSEHOLDS				
Male	151	91.5	89.1	100.0
Female	14	8.5	10.9	0
Age range				
Unknown	14	8.5	6.2	16.7
17 – 26	10	6.1	5.4	8.3
27 – 36	48	29.1	28.7	30.6
37 – 46	49	29.7	30.2	27.8
47 – 56	21	12.7	14.7	5.6
57-66	15	9.1	10.1	5.6
67 +	8	4.8	4.7	5.6
Status Female HHH (n = 14)				
Not yet married	5	35.7	35.7	0
Divorced	4	28.6	28.6	0
Widow	5	35.7	35.7	0

When compared to National Census statistics (2002) it can be seen that the sample has a bias towards respondents aged between 30 – 49 years of age (Figure 1). This bias may be the result of a sampling strategy targeting farmers, with the age range biased reflecting both the main economically active group, and those most likely to be working in land-based activities.

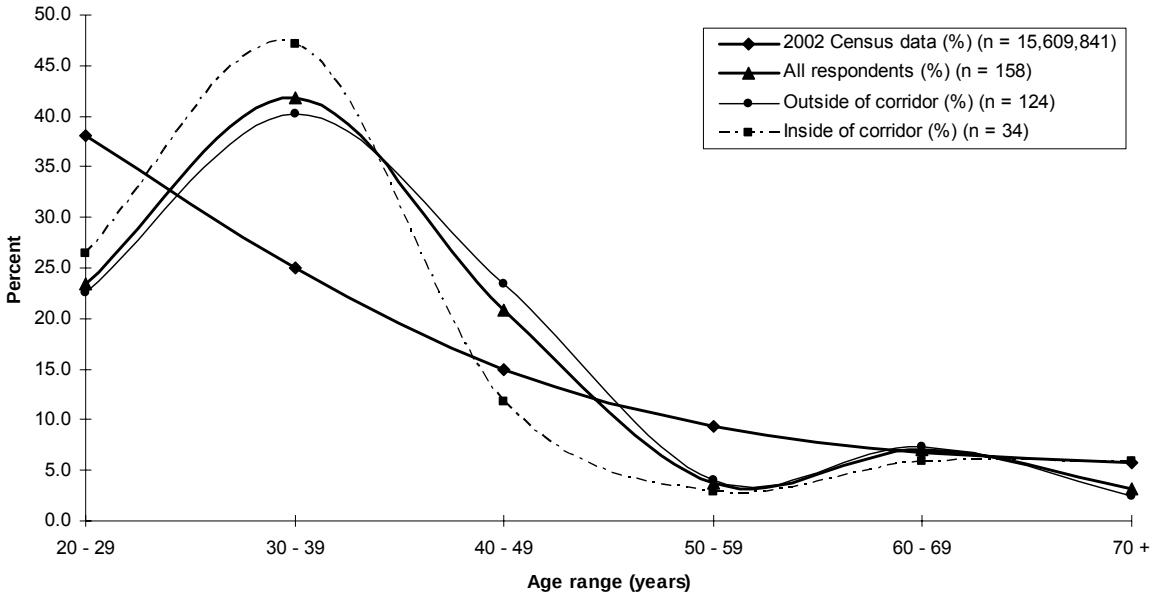


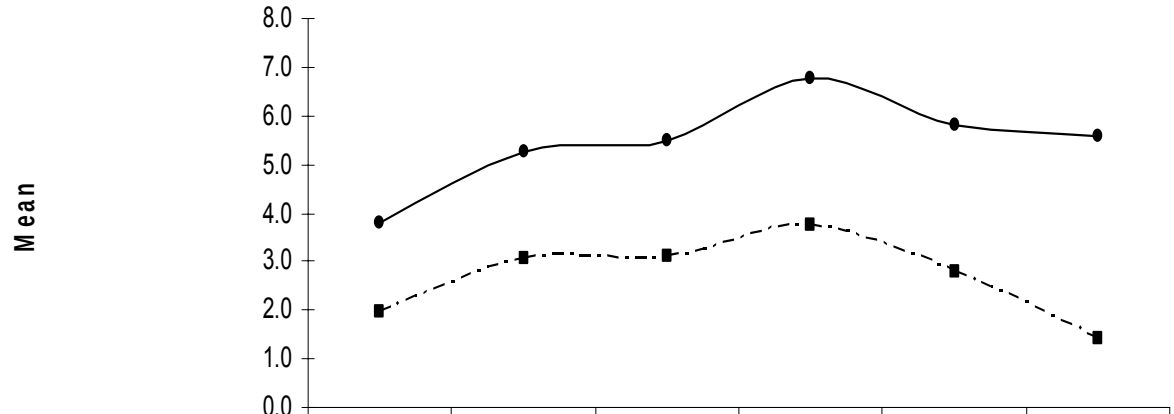
Figure 1. Age distribution of respondents compared to national census data of 2002 (URT, 2003)

The research highlights the male dominance over household hierarchy with an overall 91.5% of heads of households being male. When a couple are married it is typically the man who is the head of the household. Female heads of households are either women yet to marry, or those who are divorced or widowed.

The average household is made up of 5.3 people (typically representing husband, wife and children) with a mean of 2.4 adults and 2.9 children (individuals under 18 years of age). Figure 2 shows the household life cycle[3]; or the mean number of adults (parents) and children per household. The data shows a gradual increase in the mean number of children per household as

[3] Households can be distinguished by life-cycle stage; whereby the consumer (dependents) - labourer ratio is observed. Through the course of the household lifecycle, the ratio rose with childbirth then fell as children age and start to work (Thorner, Kerblay & Smith (1986), in Walker et al 2002),

parent's age, until parents reach their 50's, at which point the mean number of children decreases. The total number of people in the household decreases to a lesser degree reflecting that some young adults remain in the parental home beyond the age of 18 years.



	20 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 +
Mean no. people in HH	3.8	5.3	5.5	6.8	5.8	5.6
Mean no children in HH	2.0	3.1	3.1	3.8	2.8	1.4

Figure 2. Household lifecycle: mean number of people per household, distributed by age range of head of household (n = 151)

3.1.3 Ethnicity and in-migration

Two tribes which originate from the research area dominate the ethnicity of respondents. The Hehe of Iringa (50.9%, 84 respondents); and the Ndamba of Morogoro (19.4%, 32 respondents). The data do not suggest that these two ethnic groups use natural resource in different ways.

Across the sample 52.1% (86) of heads of households originate from one of the three research villages (from this point on referred to as 'residents') whilst 47.9% (79) of heads of households have migrated to, and settled in the area (from this point on referred to as 'migrants'. 54.4% (43) of migrants have

moved from the neighbouring region of Iringa, whilst 25.3% (20) have moved from neighbouring districts within Morogoro Region (Figure 3).

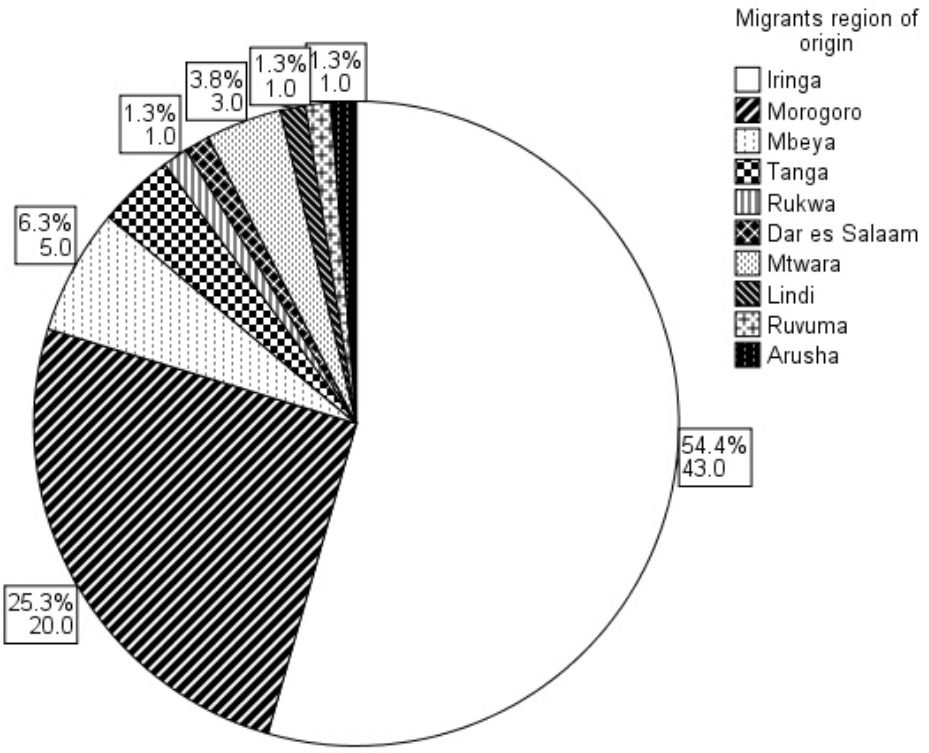


Figure 3. Migrant's region of origin (n = 79)

Regions of Tanzania are shown in Map 5 below. The research area sits on the border of Iringa and Morogoro regions.

Source of GIS layers: core profile development group of the Critical Ecosystem Partnership Fund – Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya Hotspot. Built into ArcView GIS 3.3.

Map 5. Tanzania regional map

A number of respondents, specifically within the corridor area, believe that they have migrated from Iringa Region to Morogoro Region when in fact, based on the 1:50,000 topographical map they still reside within the Iringa Region. This does not detract from the fact that such respondents migrated from one location to their current one, i.e. they were not native residents of the land where they were residing at the time of this study. Their status as migrants may affect their legal claim to land if resettlement and compensation are to be considered. In addition their perception that they are outside of their own region indicates the lack of clarity regarding regional boundaries.

When the data are split by households outside of, and inside the corridor area, the data shows that the proportion of migrants to residents is greater inside the corridor area than outside of the corridor area (Figure 4).

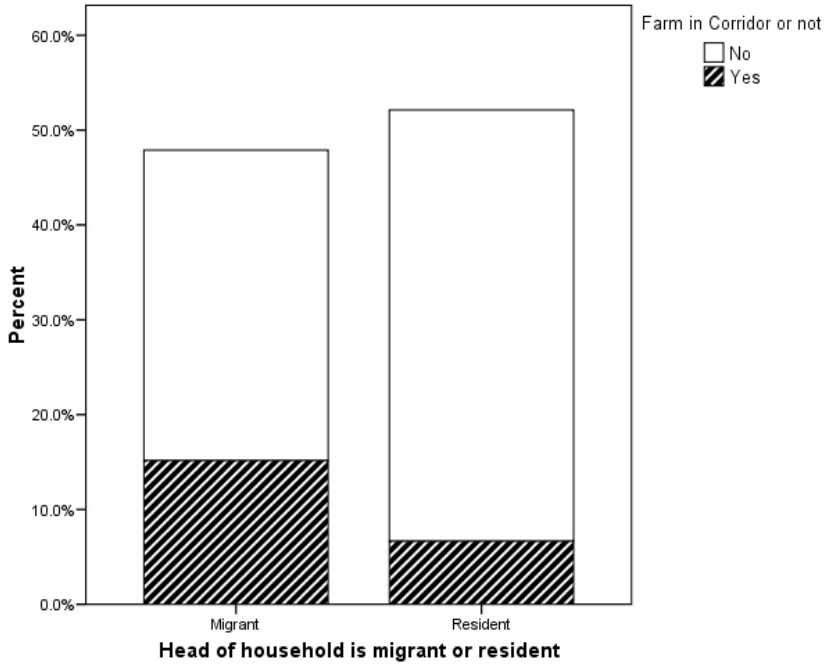


Figure 4. Human movement: residents and in-migrants outside & inside the corridor area (n = 165)

Disaggregating the data split by residence inside and outside the corridor area, the pattern of origin of migrants is the same as that of the sample as a whole. The main areas of origin of migrants are Iringa and Morogoro regions. However, the diversity of region of origin is far greater for households outside of the corridor area, with heads of households having migrated from ten regions compared to two (Figure 5).

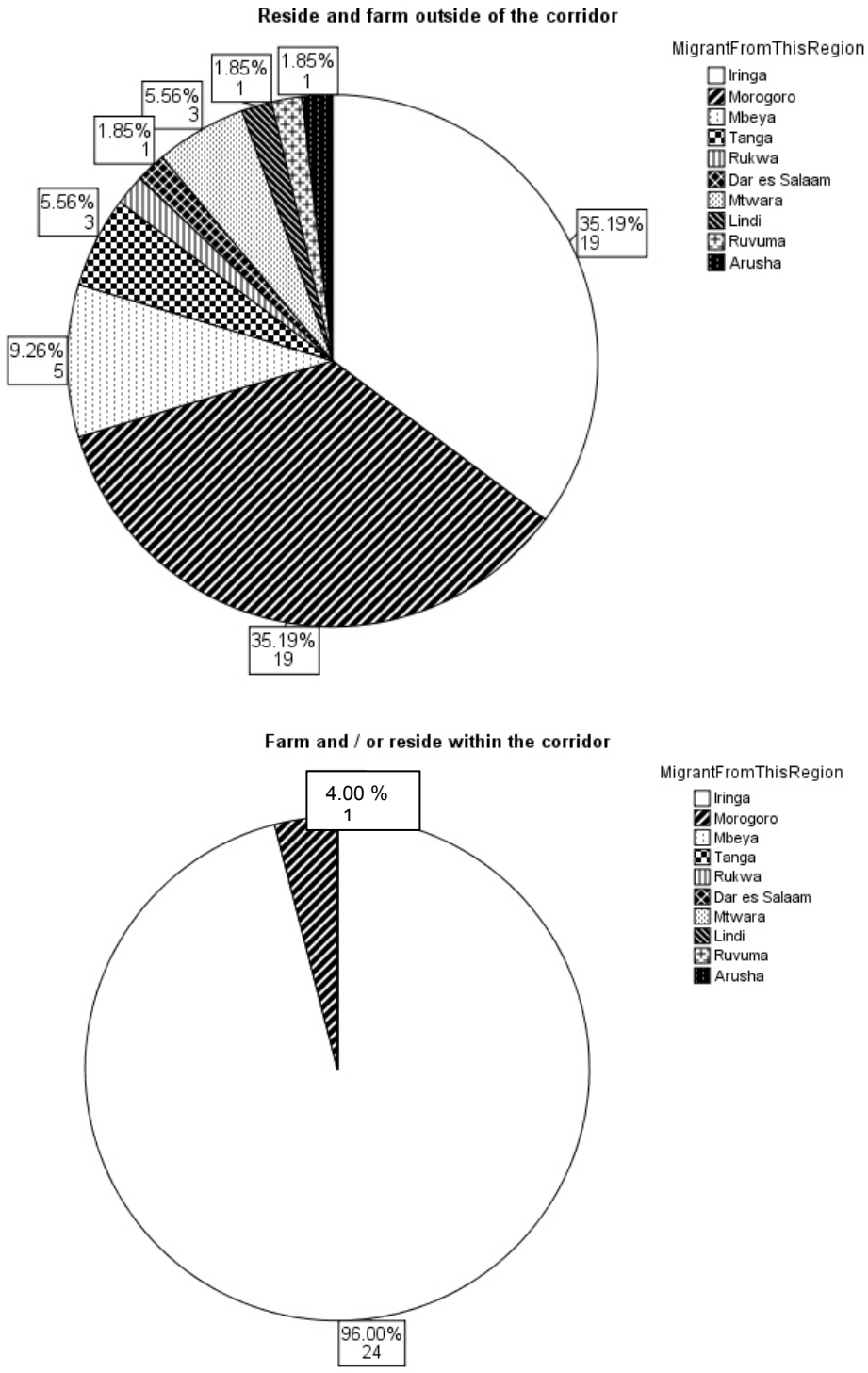


Figure 5. Origin of migrants outside (n = 54) and inside (n = 25) of the corridor area

Analysis of the proportion of residents versus migrants by settlement (sub village or hamlet) further highlights the higher proportion of in-migrants compared to residents within the corridor area compared to outside the corridor area (Figure 6).

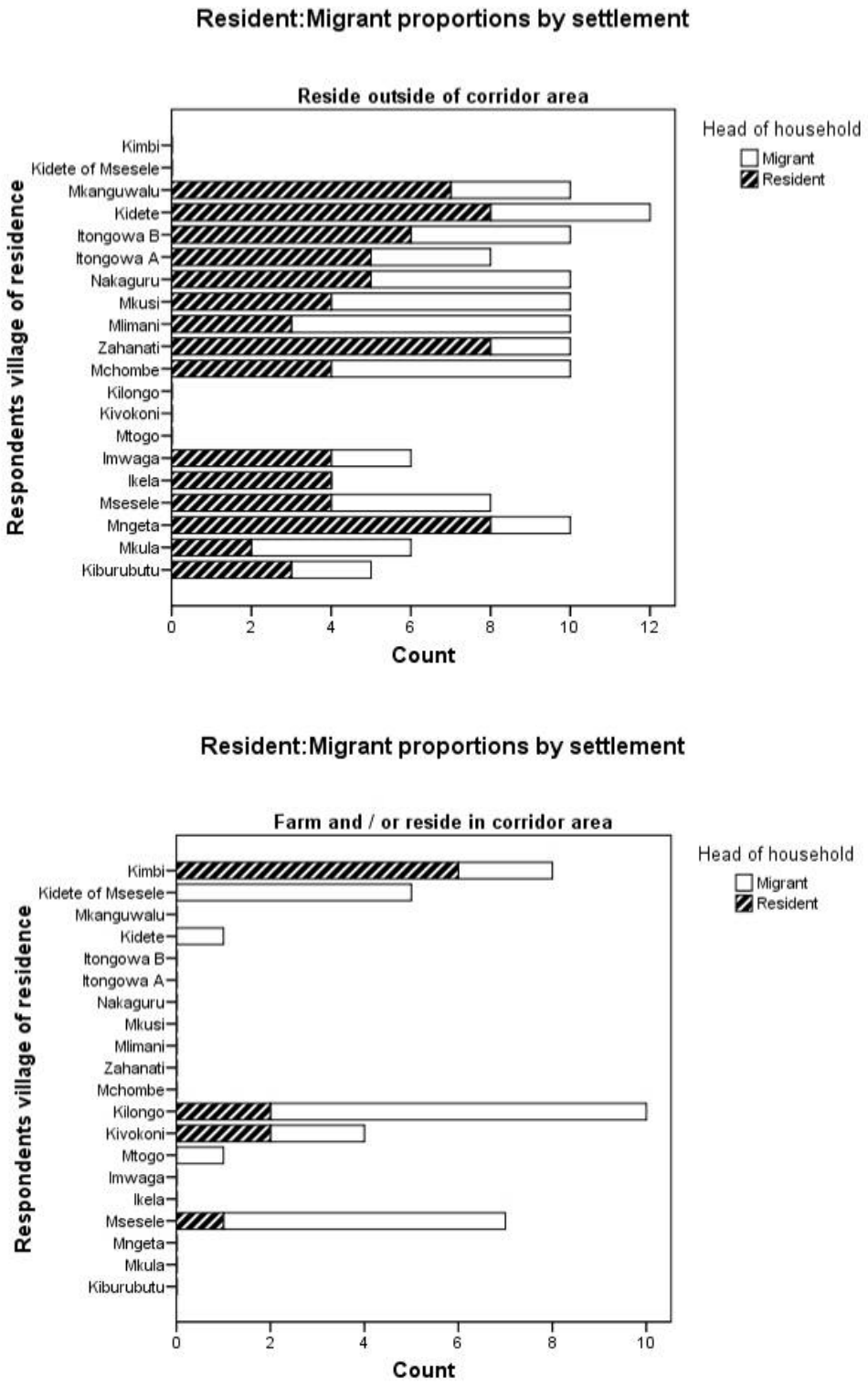


Figure 6. Resident : In-migrant proportions; outside (n = 129) and inside (n = 36) the corridor by settlement

Of the 79 migrant households consulted, the most frequently stated reason for migrating to the research area was better farming (64.6%, 51 respondents). Of the 25 migrants residing inside the corridor 88.0% (22 respondents) stated better farming as their reason for moving to the area (Figure 7).

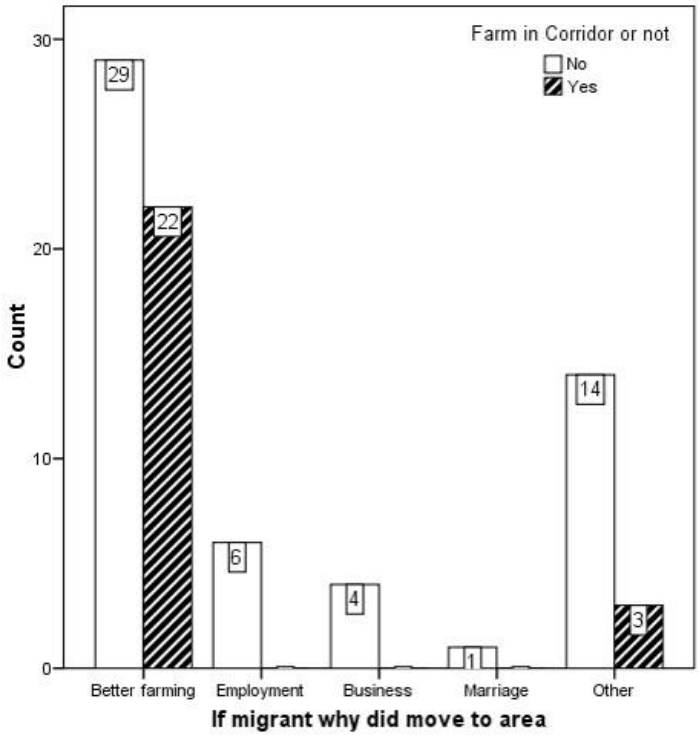


Figure 7. Reasons for migrating to the research area; outside and inside the corridor area (n = 79)

3.1.4 Socioeconomic characteristics

Data discussed in this section are summarised in Table 5. With respect to home ownership, most respondents (91.5%, 151 respondents) indicate owning their own house. All corridor residents owned their houses with no other type of tenureship being noted.

Table 5. Socioeconomic characteristics of the sample

	Overall frequency	Overall percentage	Percentage outside of corridor (n = 129)*	Percentage inside of corridor (n = 36)
HOUSE TENURE				
Own house	151	91.5	89.1	100.0
Relatives house	7	4.2	5.3	0
Rented house	7	4.3	5.4	0
Total	165	100.0	100.0	100.0
WALL TYPE				
Fired brick	108	65.5	82.2	5.6
Wood and soil	34	20.6	10.1	58.3
Soil only	12	7.3	6.2	11.1
Wood only	11	6.7	1.6	25.0
Total	165	100.0	100.0	100.0
ROOF TYPE				
Tin	83	50.3	63.6	2.8
Grass, banana leaf or palm	82	49.7	36.4	97.2
	165	100.0	100.0	100.0
LAND TENURE				
Own	117	71.3	67.2	86.1
Rent	36	22.0	25.0	11.1
Borrow	5	3.0	3.1	2.8
Combination of above	6	3.7	4.7	0
Total	164	100.0	100.0	100.0
SOURCE OF WATER				
River only	58	35.2	19.4	91.7
Community pump or tap	65	39.4	49.6	2.8
Personal well	22	13.3	15.5	5.6
River & community pump or tap	7	4.2	5.4	0
River & personal well	8	4.8	6.2	0
Comm. pump or tap & personal well	5	3.0	3.9	0
Total	165	100.0	100.0	100.0

* for land tenure n = 128

The majority of respondents living outside of the corridor area have houses with walls made of fired bricks (88.2%, 106 respondents); and a tin roof (63.6%, 82 respondents). In contrast to this, most respondents within the corridor area have houses with wood and soil walls (58.3%, 21 respondents) and grass roofs (97.2%, 35 respondents). There is a convention amongst rural and community development practitioners, to use house building materials as a proxy indicator of household wealth, where the richer households use more expensive and permanent materials such as fired

bricks and tin roofing (McKenzie, 2004). Therefore the survey data could easily be interpreted to mean that respondents living outside of the corridor area are wealthier than those living within the corridor. However, more realistically, this pattern reflects the distance of corridor residents from the source of modern building materials, and the lack of infrastructure; namely a road, permitting easy access to their homesteads.

Testing this assumption, another common proxy measure of wealth; household total landholdings (Cohen et al, 1985), was tested against house construction materials. A Mann Whitney U test showed there was no statistically significant difference ($p \geq 0.05$) between the size of the household land holding and house wall type ($U = 2941.000$, $p = 0.70$). The same test also showed that there was no statistically significant difference ($p \geq 0.05$) between the size of the household land holding and the type of roof on the house ($U = 3008.000$, $p = 0.23$).

Independent of land tenure type the average size of land holding was 3.7 acres per household ($n = 164$). Owning the land was the most common form of land tenure; this may not reflect that the household possesses a title deed for the land. Households outside of the corridor area reside upon village land as allocated by the Ministry of Lands and Settlements Development which has been responsible for spatial planning since 1965 when government funding for Rural Resettlement Programme of the Ministry of Agriculture was withdrawn (Lerise, 2000).

Water supplies in the area are basic, with the majority of respondents reporting their main water source being either the community well or tap (39.4%) or the river (35.2%). Of the 36 respondents living within the corridor area 91.7% fetch their water from the river this reflects the rural nature of these hamlets. Those respondents who indicate using two different water sources state seasonal variation of water supply as the reason.

The only form of transport owned by respondents is bicycles, with 50.3% of respondents owning between 1 and 5 bikes (mean = 1.37, S.D. = 0.6). The proportion of people owning a bike and living outside of the corridor area is significantly different ($p \leq 0.05$) to the proportion of people owning a bike and living inside the corridor area ($X^2 = 34.6$ $p = 0.000$, Yates' Correction for Continuity), with people inside of the corridor being less likely to own a bicycle. As with land holding, house wall and roof type, bike ownership does not necessarily reflect the wealth of a household. Within the corridor area it would be hard to move about on a bicycle as the path network is made up of very narrow foot paths.

3.1.5 Dependence on natural resources

When questioned about sources of cures and medicines for illnesses 100% of respondents stated that they depended upon the local dispensaries and chemists for medicines. No respondent mentioned using natural remedies extracted from their own land or the local forests. Only during the focus group discussion held in Mngeta did any person make a mention of natural remedies. The research area has three dispensaries and a number of chemists as such it is easy for households in the area to reach a dispensary and be treated for all but major ailments. Patient too sick to be treated at a local dispensary would have to travel to the hospital at Ifakara.

Table 6 below contains figures on fuel type dependency. Two types of fuel are used for cooking: wood and charcoal. A total of 92.1% (152) of all respondents have a high dependency on wood as a fuel source, reflecting a daily pattern of use for cooking and heating. Far fewer respondents (6.7%, 11 respondents) report a high dependence on charcoal as their main source of cooking fuel. Residents within the corridor have a higher dependency upon fuel wood (97.2% high dependency, 35 respondents) than do respondents living outside of the corridor (90.7% high dependency, 117 respondents).

Table 6. Fuel type dependency of residents within and outside the corridor

Fuel type degree of dependency	Overall frequency	Overall percentage	Percentage of out-corridor respondents (n = 129)	Percentage of in-corridor respondents (n = 36)
WOOD				
No dependency	4	2.4	2.3	2.8
Low	9	5.5	7.0	0
High	152	92.1	90.7	97.2
Total	165	100.0	100.0	100.0
CHARCOAL				
No dependency	119	72.1	66.7	91.7
Low	35	21.2	25.6	5.6
High	11	6.7	7.8	2.8
Total	165	100.0	100.0	100.0

Respondents identified five different forest locations as the main sources of fuel wood and three locations for charcoal. The level of dependency on these sources is illustrated in Table 7 below. The classification ‘High dependency’ reflects that household’s primary source of fuel.

Table 7. The dependency of residents within and outside the corridor on fuel wood from different source locations

Fuel source	Overall frequency	Overall percentage	Percentage of out-corridor respondents (n = 129)	Percentage of in-corridor respondents (n = 36)
WOOD: Public forest on hills				
High	69	41.8	32.6	75.0
Low	7	4.2	4.7	2.8
No dependency	89	53.9	62.8	22.2
Total	165	100.0	100.0	100.0
WOOD: Own trees				
High	53	32.1	34.9	22.2
Low	8	4.8	5.4	2.8
No dependency	104	63.0	59.7	75.0
Total	165	100.0	100.0	100.0
WOOD: Village, valley or floodplain				
High	53	32.1	13.2	0
Low	8	4.8	0.8	0
No dependency	104	63.0	86.8	100.0
Total	165	100.0	100.0	100.0
WOOD: Buy				
High	16	9.7	12.4	0
Low	1	0.6	0.8	0
No dependency	148	89.7	86.8	100.0
Total	165	100.0	100.0	100.0
WOOD: Company land				
High	5	3.0	3.9	0
Low	1	0.6	0.8	0
No dependency	159	96.4	95.3	100.0
Total	165	100.0	100.0	100.0
CHARCOAL: Buy				
High	43	26.1	31.0	8.3
Low	1	0.6	0.8	0.0
No dependency	121	73.3	68.2	91.7
Total	165	100.0	100.0	100.0
CHARCOAL: Other				
High	1	0.6	0.8	0
Low	1	0.6	0.8	0
No dependency	163	98.8	98.4	100.0
Total	165	100.0	100.0	100.0
CHARCOAL: Own trees				
High	1	0.6	0.8	0
Low	0	0	0	0
No dependency	164	99.4	99.2	100.0
Total	165	100.0	100.0	100.0

Fuel source dependency was further analysed by calculating a fuel source dependency score for both fuel wood and charcoal. To calculate this score high dependency received a score value of two. Low dependency received a score value of one. No dependency scored zero. Scores per fuel type were then totalled by source; the results are presented in Figure 8 below.

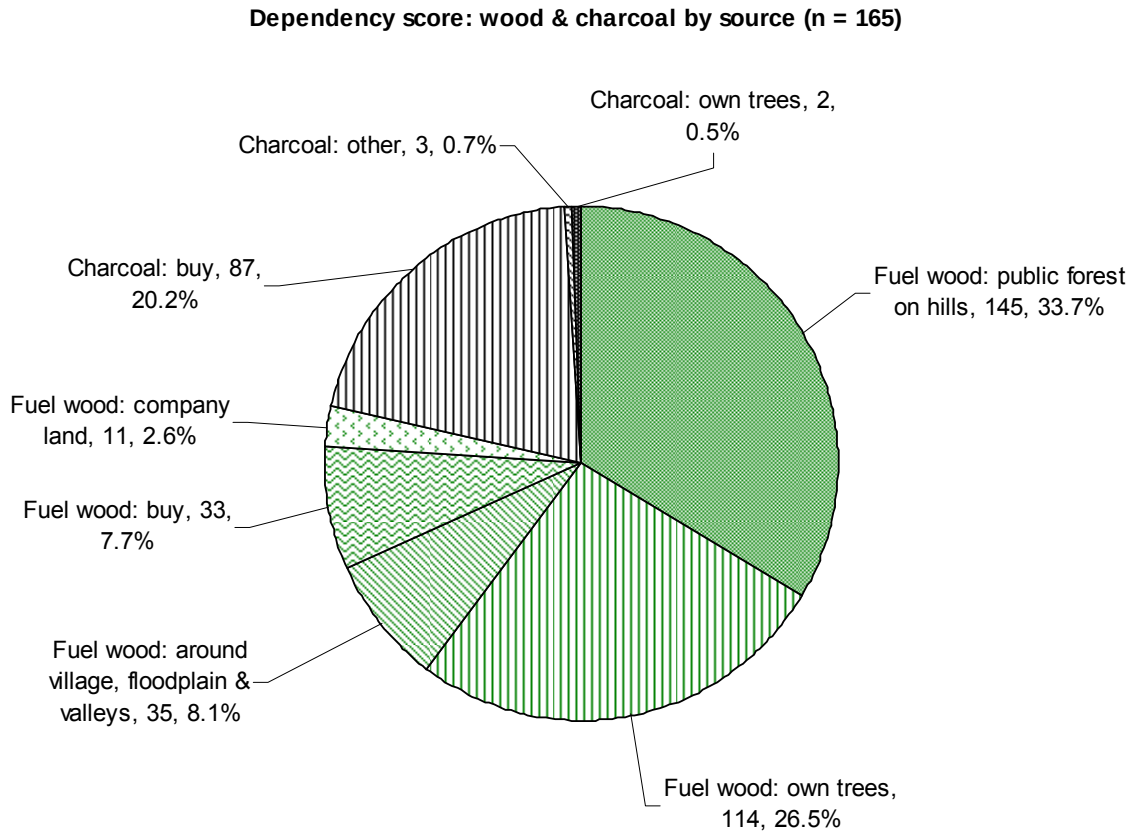


Figure 8. Dependency score: sources of fuel wood and charcoal

There are three significant trends summarised in Figure 8. Firstly, that the majority of respondents depend upon fuel wood from the public forests on the hills. Respondents perceive any un-gazetted area of trees to be 'public forest', or open access forest that they can use without hindrance. With the boundaries of protected forests in the area unclear and enforcement of laws regarding extraction of resources limited, this pattern of fuel wood collection

continues to have negative implications for the protected forest area. The second important trend is that, perhaps surprisingly, more than 26% of all reported fuel (i.e. 34% of all fuel wood) is being gathered from trees belonging to the household. There is a difference between those using own trees between inside and outside corridor area residents, with a greater proportion of those outside the corridor (35%) using this source compared to those within the corridor area (22%).

The third important point to draw from the summary is that more than 20% of all fuel wood use is as charcoal which is bought from local vendors. The category ‘buy charcoal’ does not indicate the exact source of the wood used for the charcoal, but data from Rovero (2007) indicates that charcoal production occurred within both Iyondo and Udzungwa Scarp Catchment Forest Reserves.

Disaggregating the data between respondents residing inside, and outside, of the corridor area shows differing dependence upon natural resource products; and on the source locations of those products, as illustrated in Figure 9.

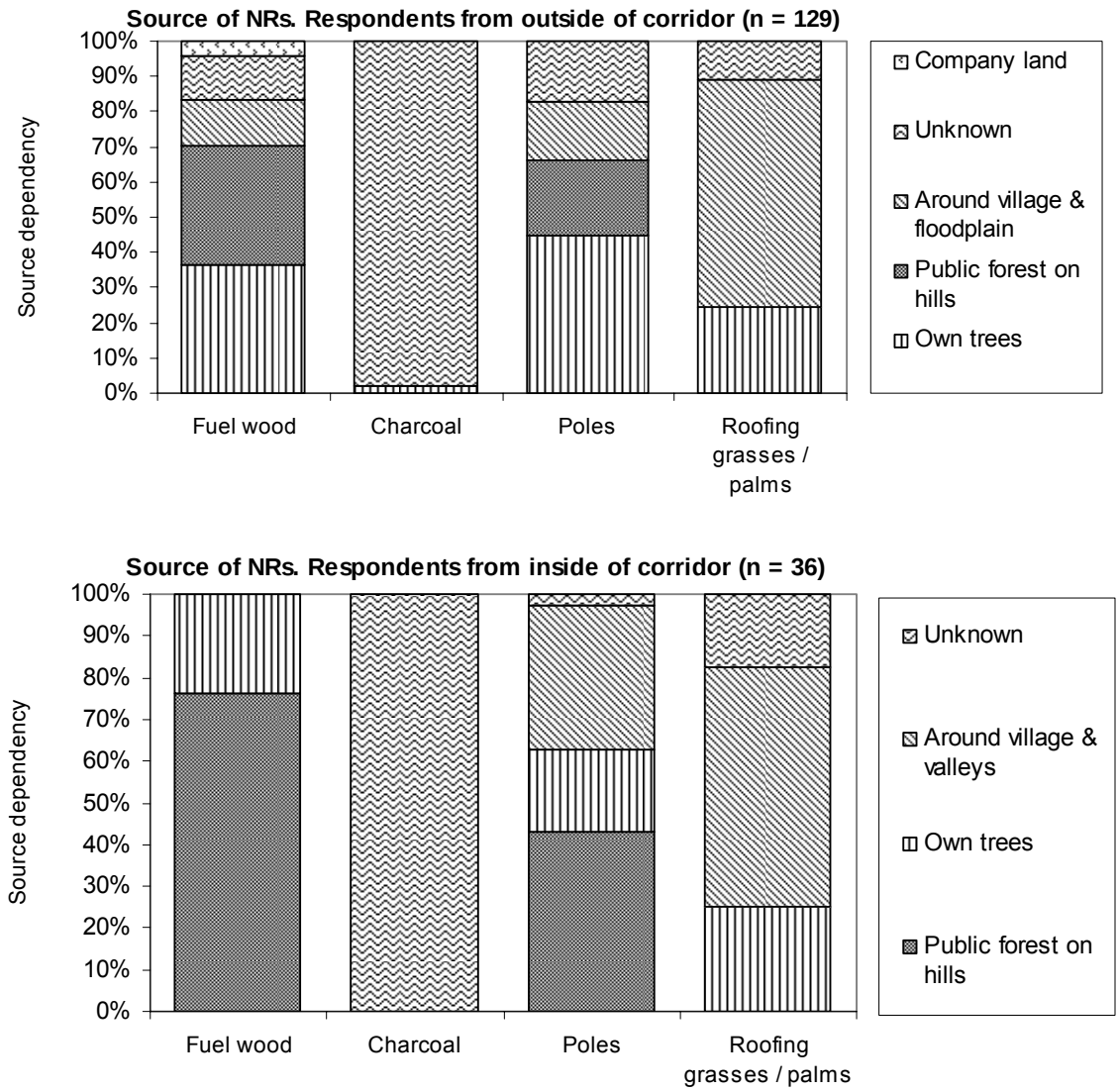


Figure 9. The dependency of residents within and outside the corridor on a range of natural resources from different source locations[4]

It is immediately evident from Figure 9 above that households within the corridor area depend more upon public forests for the collection of fuel wood and building poles than do households outside of the corridor area. Households outside of the corridor depend more upon their own trees as a

[4] Company land is located on the boarder between Mngeta and Mkangawalu villages.

source of fuel wood and building poles than they do on the public forests on the hills. Triangulating with qualitative data from mapping exercises during group meetings, shows that both the distance from the main villages outside of the corridor area to the public forests on the hills; as well as the availability of alternative sources mitigates against collection from public forests. Figure 10 below generated by a group of women in Mkangawalu, for example, shows that whilst household sources of wood are indicated, there is no reference to trees on the hills (i.e. the location of the public forest) drawn at the top of the picture, indicating that they assign little value to the public forest as a source of fuel wood.

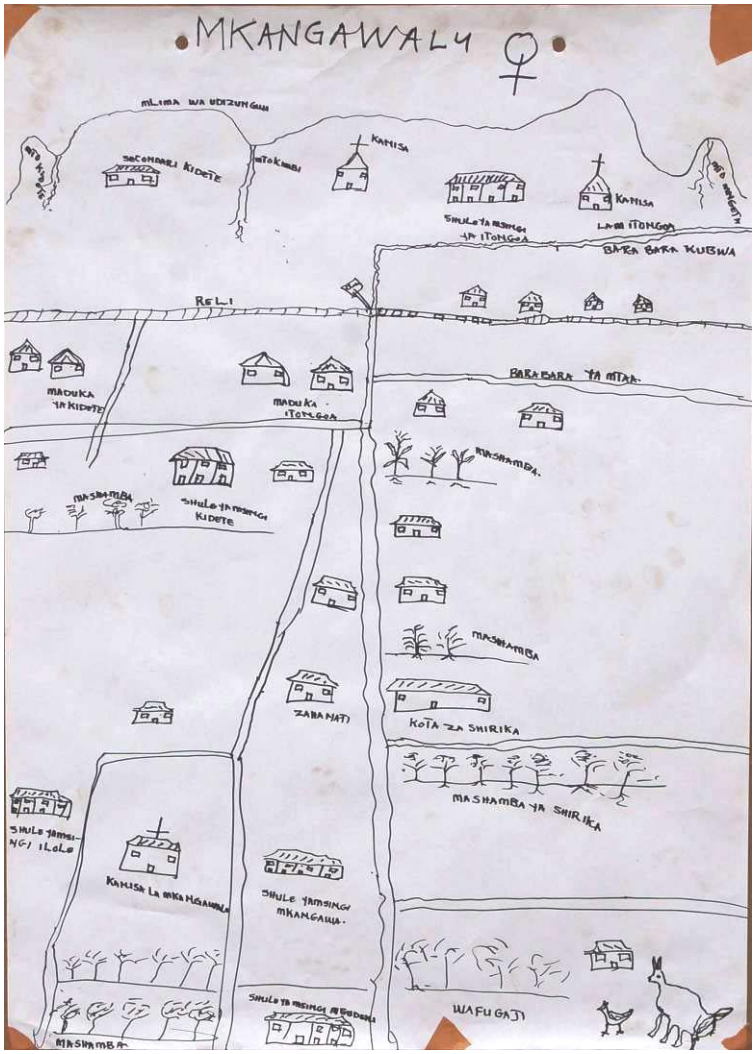


Figure 10. Mkangawalu Village map by women's group (n = 7)

3.1.6 Livelihood activities

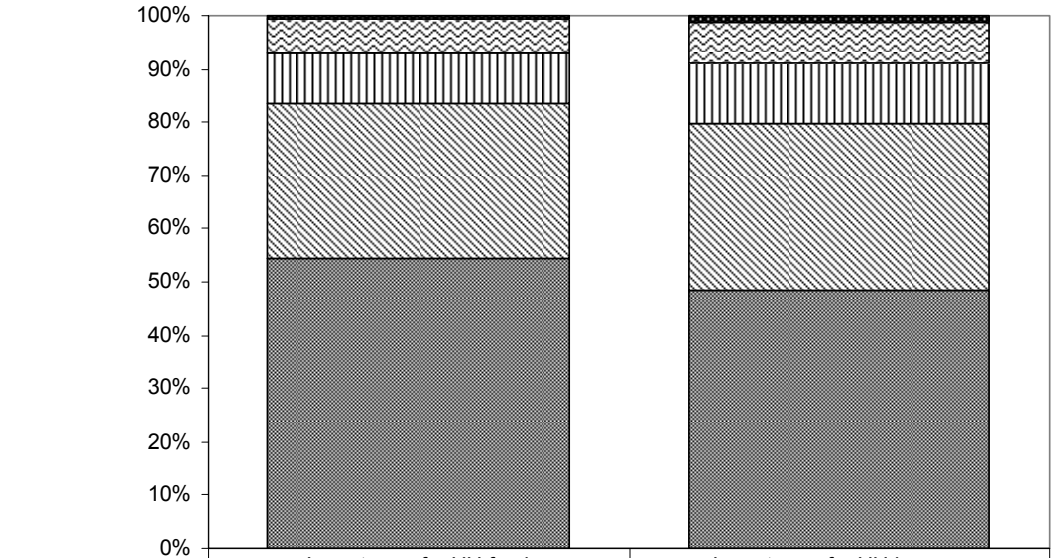
Eliciting information about the livelihood portfolios of the sampled households, a total of 23 different livelihood activities were identified. These are aggregated into five main categories as shown in Table 8 below. Overall households adopted an average of 2.3 livelihood activities (range 1 – 4, SD 0.73) with 99.4% of all households surveyed involved in agriculture.

Table 8. Livelihood activities by category

Category	Livelihood activity	Percentage of respondents undertaking activity
Agriculture	Agriculture	99.4
Livestock Keeping	Livestock keeping	82.4
	Butcher	0.6
Agriculture Based	Making & selling local brew	17.6
	Selling vegetables	3.6
	Selling processed rice	4.2
	Temporary labour - agriculture	1.8
	Processing & selling palm oil	0.6
Non-NR Based	Temporary labour - building	3.6
	Small market stall	3.0
	Clothes Tailor	3.6
	Shop owner	1.8
	Metal work	2.4
	Baking & selling buns	1.8
	Temporary labour – road & rail	1.2
	Walking shop	0.6
	Labour – watchman	0.6
	Teacher	1.2
NR Based	Carpenter	1.2
	Temporary labour - brick maker	0.6
	Fish monger / Fish farming	1.2
	Tree cutting	0.6
	Beekeeping	0.6

Respondents were asked to rank their livelihood activities with respect to importance for household food, and importance for household income. As respondents conducted between one and four livelihood activities, the most important activity received a score of 4, the second a score of 3 and so on. Looking at the results across the whole sample; agriculture followed by livestock keeping; and then agriculture-based activities, ranked 1st to 3rd

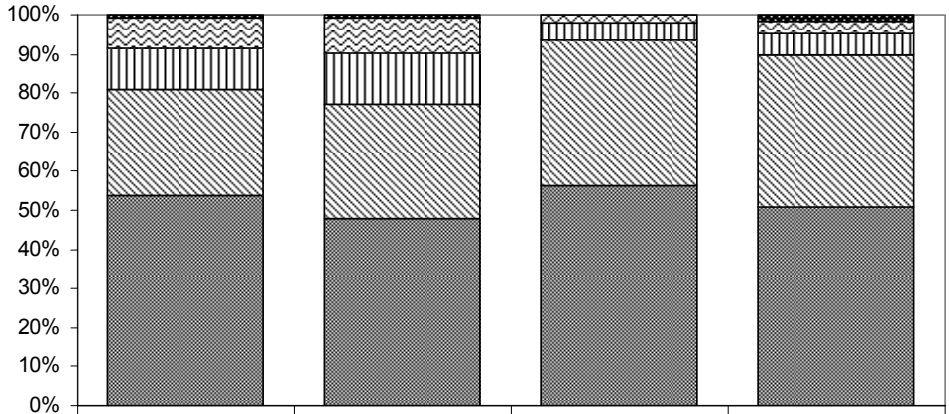
respectively. This was true with regards to perceived importance for both household food and household income (Figure 11). Of the agriculture-based livelihood activities, making and selling local brew was the most popular with 29 respondents (17.6%) involved with this activity.



	Importance for HH food	Importance for HH income
NR based	6	13
Non-NR based	77	88
Agriculture based	113	132
Livestock	347	359
Agriculture	650	558

Figure 11. Importance of livelihood activity categories for household food and income

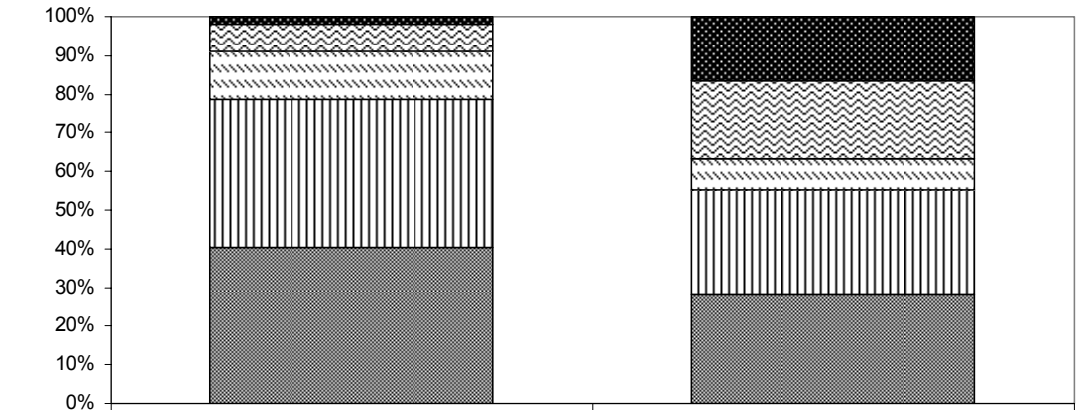
When the analysis is disaggregated between respondents residing outside and inside of the corridor area, there is no significant difference from the pattern for the sample as a whole, nor between the two groups (Figure 12).



	Outside corridor: Imp HH food	Outside corridor: Imp HH income	Inside corridor: Imp HH food	Inside corridor: Imp HH income
NR based	6	9	0	4
Non-NR based	72	80	5	8
Agriculture based	102	119	11	13
Livestock	251	263	96	96
Agriculture	506	432	144	126

Figure 12. Importance of livelihood activity categories for food and income for households outside and inside the corridor area

Looking at the data for agricultural activity for households working outside and inside of the corridor, five main crops dominate namely: rice, maize, cassava, banana and beans. Figure 13 shows that a greater proportion of respondents outside the corridor area grow rice and maize compared to residents inside the corridor area.



	Outside corridor (n = 128)	Inside corridor (n = 36)
Beans	6	19
Banana	20	23
Cassava	36	9
Maize	112	31
Rice	118	32

Figure 13. Main crop types grown outside and inside of corridor area

A chi-square test showed there was a significant difference ($p \leq 0.05$) between residing outside or inside of the corridor area and the growing of beans ($X^2 = 47.0$, $p = 0.000$, Yates' Correction for Continuity); with people living inside of the corridor more likely to grow beans than those living outside of the corridor area.

Seasonal calendars provide a picture of the annual rhythm of respondents' agricultural livelihoods. The data summarised in Figure 14 shows the aggregated seasonal calendar data from three groups of women (n = 18) and three groups of men (n = 26) from sub-village locations across the research site. From the separate female and male working groups, women and men reached general consensus over the timing of seasonal rains and periods of planting rice (wet season) and maize (dry season and again in the wet season). When data from the women's and men's groups are aggregated it can be clearly seen that most rice is sold during June and July; and maize in April and December (Figure 15). These periods of crop selling coincide with

harvest months and are inline with data presented in Figure 16 where respondents were asked when they sell their crop.

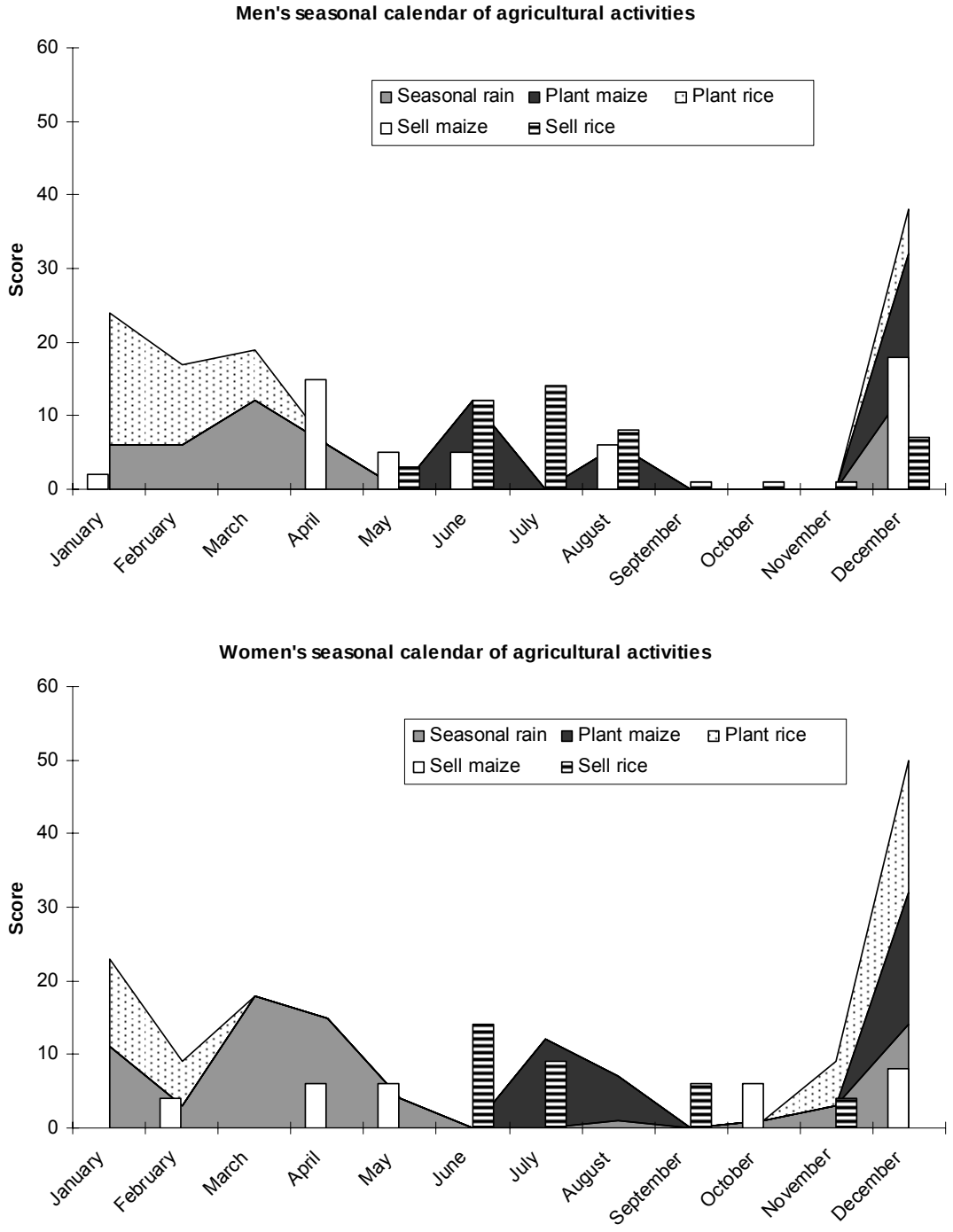


Figure 14. Seasonal calendars of important agricultural activity by male (n = 26) and female (n = 18) respondents

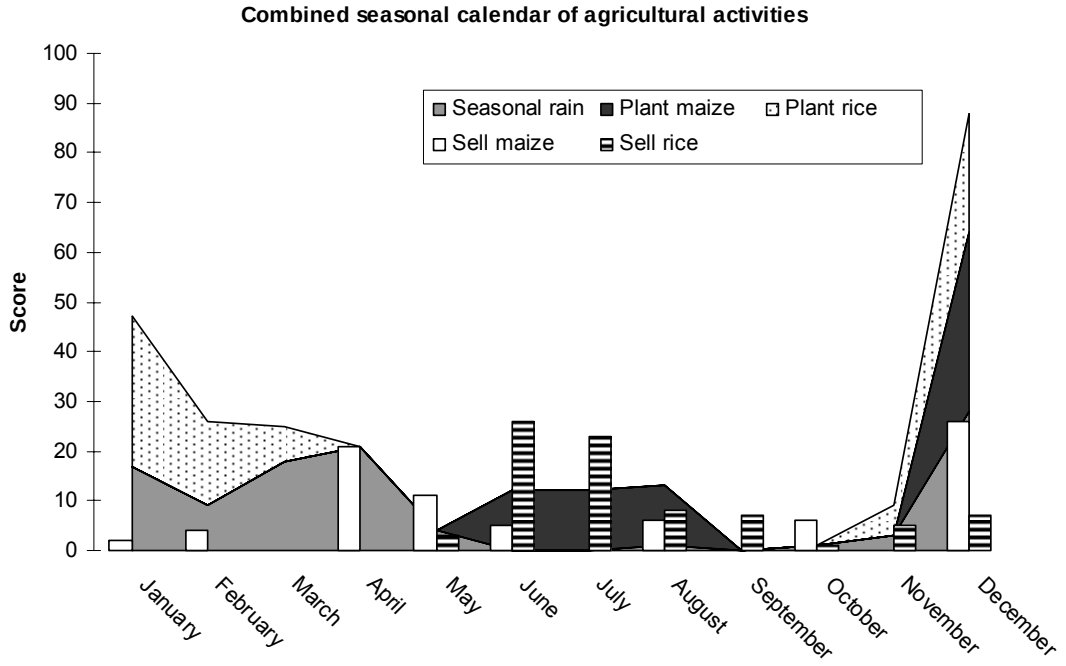


Figure 15. Combined seasonal calendar data (women's and men's groups) (n = 44)

For many households agricultural activity is mainly for household subsistence. From questionnaire data 50% of respondents stated that they only sell produce when they need money. Sickness in the family and the need to pay school fees were given as the most common reasons why money may be needed for the household. A further 24% of respondents do sell produce after harvest (Figure 16). The reasons why households sell their produce are important. Qualitative data collected whilst completing the seasonal calendars indicated that two of the most important production issues prompting the sale of crops were a general lack of post-harvest storage capacity; and the need to pay back loans taken out at the start of the farming season. The problem with these early 'forced' sales is the lower market price for agricultural goods a peak harvest season, the inability for households to realise a market premium later in the season, and the subsequent lower purchasing power the income from agricultural sales has when buying food for household

consumption later in the year. No one elicited comments about households compensating for this, for example, by switching crop type or opening up more land. Participants did however comment that this early 'forced' sale of agricultural goods did impact on the wellbeing of the household, specifically periods of hunger are experienced in the first months of the year.

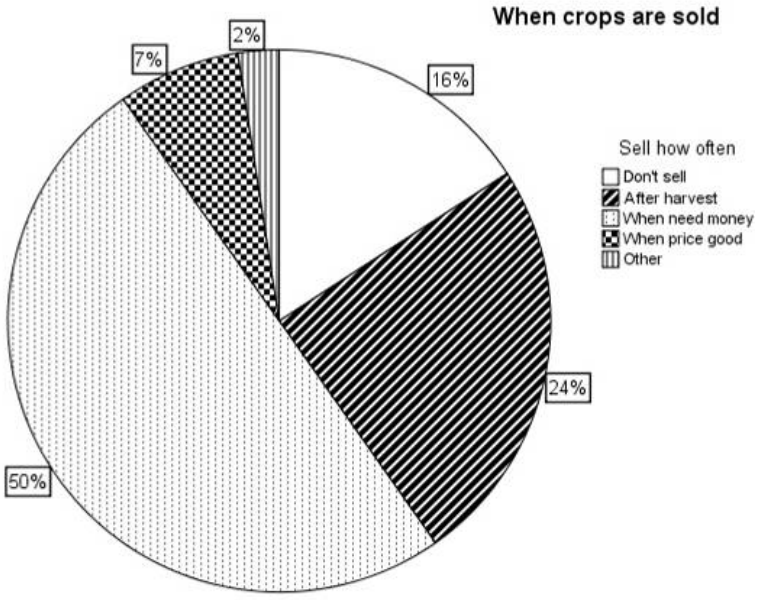


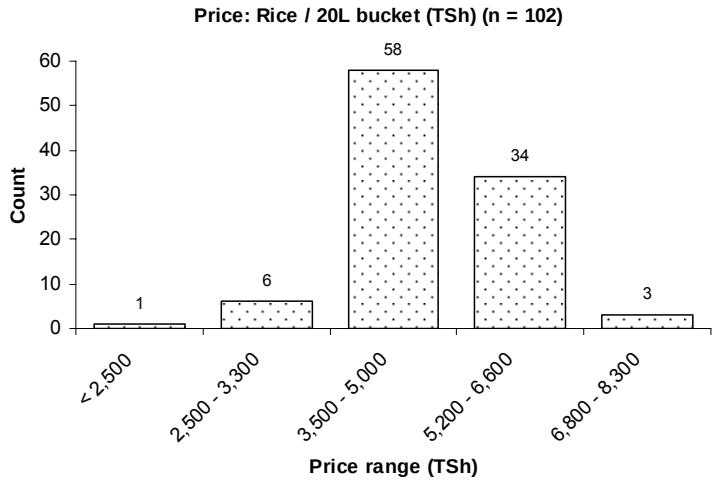
Figure 16. Times at which households sell crops (n = 164)

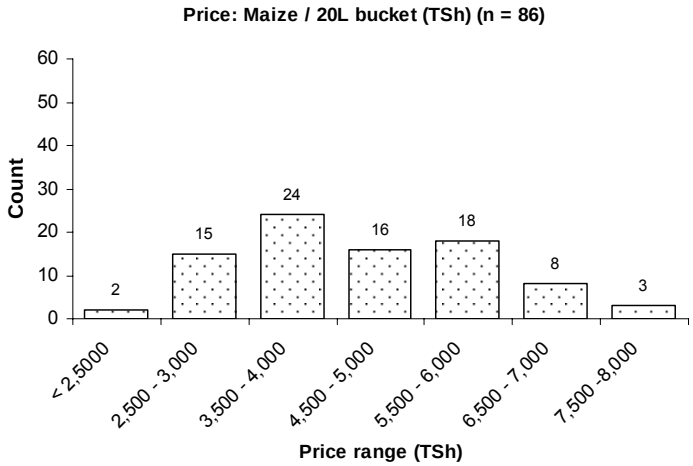
As already noted the selling price of produce varies throughout the year depending upon seasonal availability and other market influences. Figure 17 below shows the range of prices that people expected to get per unit of produce sold[5]. Produce is sold directly in local markets or to a middle man.

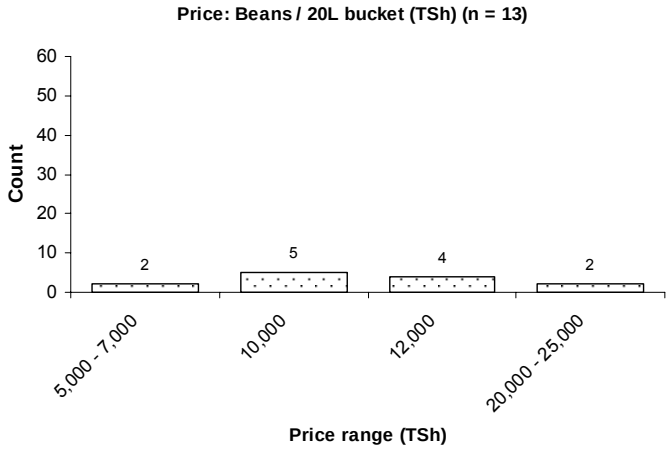
Per 20 litre buckets the price of rice is comparable to that of maize. Unsurprisingly, beans were demonstrated to be the more valuable cash crop. However, the market prices for these agricultural produce does not take into

[5] Exchange rate: US$1 = TSh 1,153

account the actual costs of production and economic investment that might have been made by the household in fertiliser, pesticides, seed, the labour costs of land preparation or other agricultural tasks. Due to the complexities of conducting a complete market survey that would take into account the seasonal variations in product availability and fluctuation in market price little more can be construed from this data than the quoted market prices per unit sold at the time of the study.







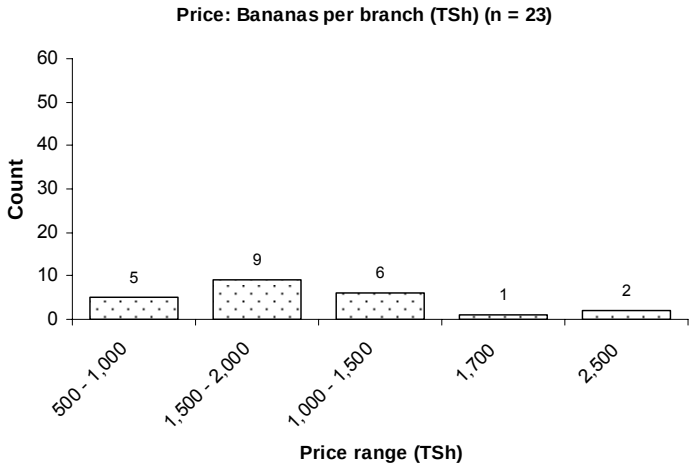


Figure 17. Price ranges of main agricultural crops

Seasonality of crop price comes through in the seasonal calendars of household indicators. Figure 18 below shows that household income is highest during harvest times (May to August) coinciding with households selling produce after harvest. Household food becomes more expensive the further one is from the main harvest season. Household expenses were concurrently exacerbated during this time of year by wet season illnesses, particularly malaria. Household expenses also showed a peak in July when school fees are due.

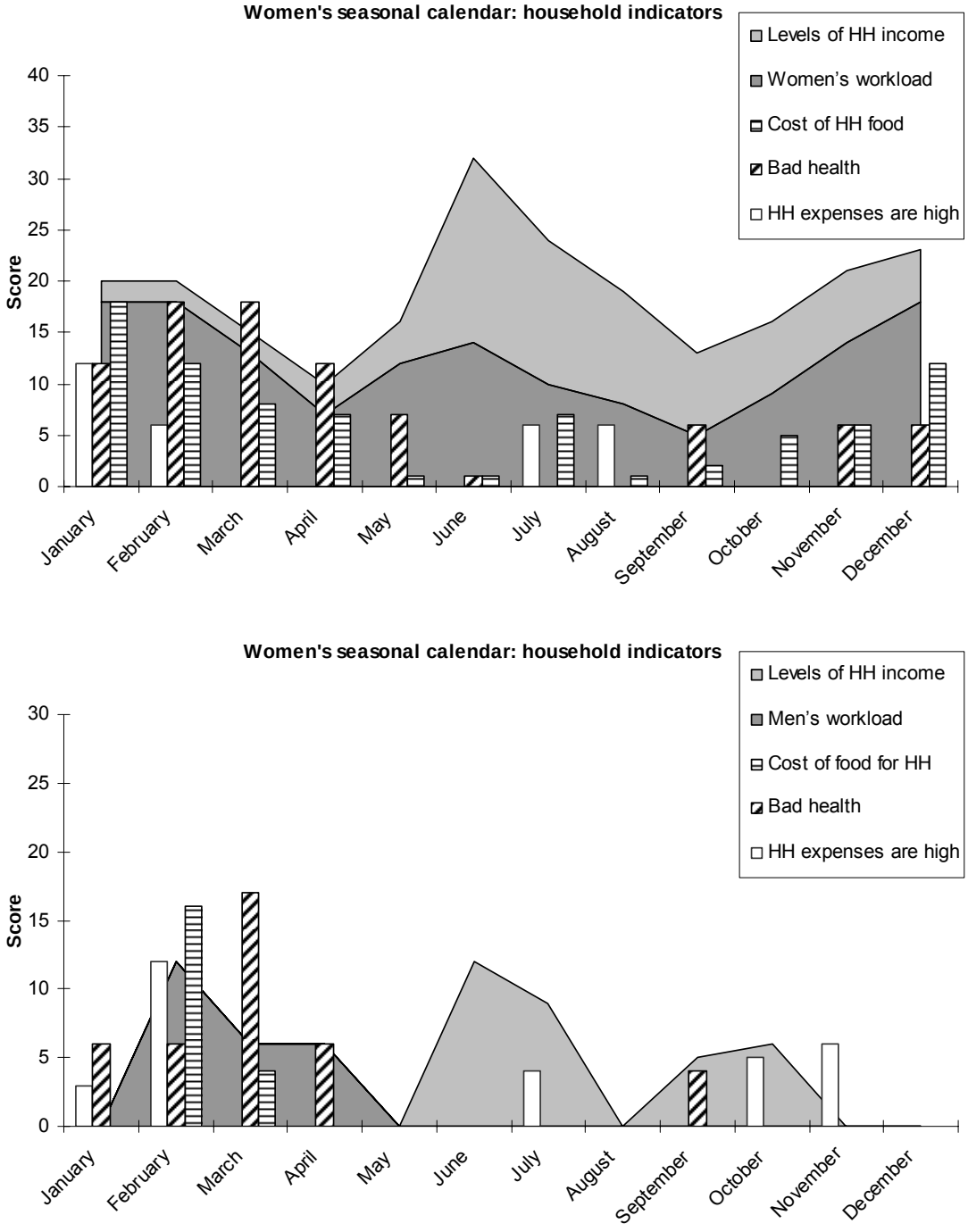


Figure 18. Seasonal calendars of household indicators

Livestock keeping is dominated by chickens with 95.6% of all respondents who keep livestock (n = 137) keeping them (Figure 19). The popularity of chicken keeping can be linked to the low level of investment required to initiate the activity. As with agricultural produce the main reason for selling livestock was the household needing money (48.5%) although 33.6% of respondents do not sell their livestock (Figure 20) with chickens commonly being consumed by the household. Both crops and animals were viewed as a bank account helping the household to survive at harder times of the year.

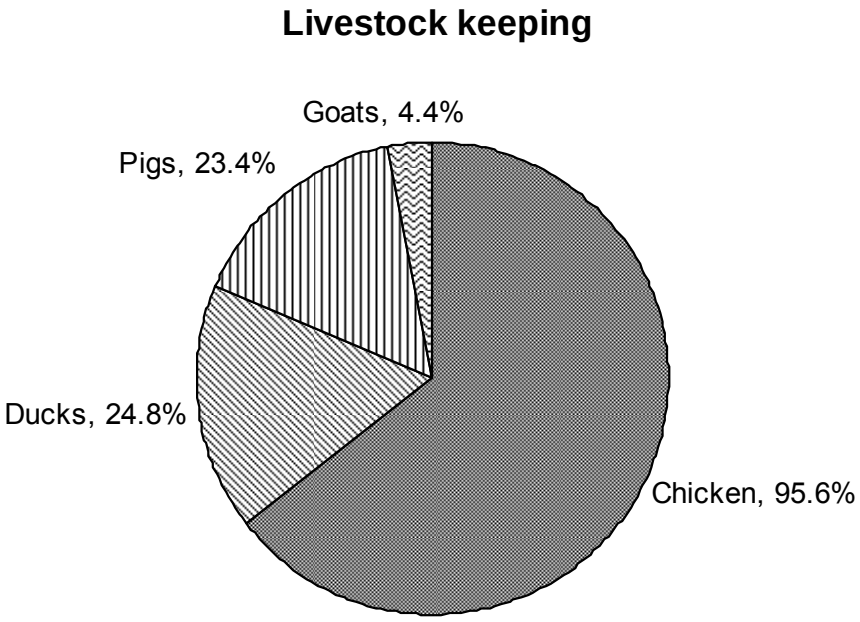


Figure 19. Percentage of respondents keeping different types of livestock (n = 137)

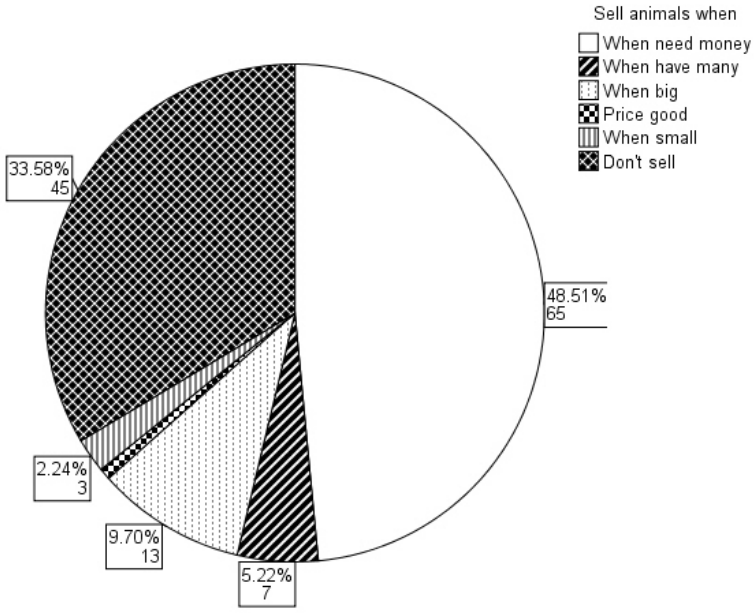


Figure 20. Times at which livestock are sold (n = 133)

Table 9 below shows that 88.3% of respondents who gave a price for chickens sell one bird for between 1,500 – 5,000 TSh the price range accounts for differences in the size of chickens. The large difference in the price ranges of pigs, as with chickens, indicates the difference in the size of the animal sold. When sold for slaughter as adults, most fetch prices in the range of 70,000 – 100,000 TSh.

Table 9. Financial value of chickens and pigs[6]

	Percent (n = 77)
Price: Chicken	
1,500 – 5,000 TSh	88.3
6,000 – 7,000 TSh	11.7
Price: Pig	
	Percent (n = 18)
20,000 - 30,000 TSh	27.8
50,000 - 60,000 TSh	22.2
70,000 - 100,000	44.4
150,000	5.6

[6]Exchange rate: US$1 = TSh 1,153

3.1.7 Perception of forests and the corridor area

Table 10 below shows the results of three focus groups discussions about local forests and the corridor area. The data show that participants from Mngeta and Mkangawalu villages are aware of the Village Land Forest Reserves in their villages. Mchombe village does not have any Village Land Forest Reserves although the village land boarders the Kilombero Nature Reserve (formerly Iyondo Catchment Forest Reserve). Participants of Mchombe village believe that all forests on the hills are managed by the Tanzania National Parks Authority (TANAPA). Whilst this is true for Udzungwa Mountains National Park, none of the protected forests in the locality of the research area are managed by TANAPA; they all fall under the jurisdiction of the Forest and Beekeeping Division; or in the case of Village Land Forest Reserve, the village government through Village Environmental Committees. Participants of Mchombe village also noted that boundaries of the forests are not clear or known by people outside of the village government. The lack of clarity over who manages forest reserve in the area may indicate a lack of presence of District Forestry personnel.

Participants from each of the three villages were able to discuss the corridor area, with participants from Mngeta and Mkangawalu villages being the most informative. Participants highlighted the presence of settlements reached by walking into the hills beside the Kimbi River. Residents of Msesele (sub village of Mngeta) noted the presence of settlements in hamlets associated with their sub village.

Table 10. Focus group discussion responses (n = 46)

Question	Response
Are there protected forests in the area? Name them.	Iwungi Village Land Forest Reserve
	Ipande forest (on floodplain) and Itongowa Kipuga (on hills behind village) both of which are Village Land Forest Reserves (i.e. under PFM). There is also Ngowu forest on the floodplain.
	TANAPA protect the whole of the Udzungwa Mountains all the way from Kilosa through Kilombero all the way to Chita. Most villagers are unsure where the forest boundaries are. Concerning forested land in general, not specifically forest reserves; only the village leaders know where the boundaries between village and government land are.
What are the benefits of the forest to the adjacent villages?	From the forest many things can be collected including: 1. fuel wood; 2. mushrooms 3. medicinal plants 4. building materials 5. charcoal Items 1 – 3 can be taken from the areas of trees around the village or from Iwungi VLFR. Items 4 and 5 can only be collected from Iwungi VLFR with permission and the correct permit.
	1. The forests are a source of rain; 2. source of building timbers; 3. source of fuel wood and charcoal (the latter requires a permit); 4. source of wood for making handles for tools; and 5. the forests are the source of the rivers.
	Concerning forested areas on the hills behind the village i.e. not protected forests the participants list the following benefits; 1. Provide fuel wood
Do you have responsibilities toward the forests?	People in the village should protect the forest areas from fire together with the Village Environmental Committee (VEC).

Question	Response
	From January to April trees are planted in Iwungi VLFR. People help to guard the forest from people cutting and removing trees from the forest. If offenders are found, they should be taken to the village office. When someone near the forest wants to clear their farmland using fire they must first report to the Village Environmental Committee. The VEC will send people with the farmer whilst he carries out the burning to ensure that the fire is controlled and does not spread into the forest. The following list of questions will be used to initiate group discussions about the proposed corridor area.
	Only the VEC has responsibilities towards the village forests. The VEC: 2. maintains the boundaries of the forests; 3. re-plants some trees; 4. has a tree nursery (sonobari, congo and milonge trees); 5. protects forest from fire; and 6. weeds the trees around the boundary.
	Again concerning forested areas on the hills behind the village i.e. not protected forests, the participants listed the following responsibilities the community has towards the forested area: 1. not to make fire; 2. not to cut trees; 3. not to make charcoal; and 4. if they notice a fire outbreak in the forested area they should report it to their village leaders.
Are you familiar with the corridor area?	Respondents confirmed that they know the area and described the valley where people live (the hamlets of Msesele sub village).
	If you climb the hill behind the village by Kimbi River you reach a valley which stretches until the Mngeta River.
	One participant knows that there is a valley beyond the hills backing on to the village. From this valley she describes how one can see the mountains of Iringa.

Question	Response
Do any of you farm in the area, or know of people who do? How many?	Only a few people should be allowed to live up in this area because if the environment is good up on the mountains the water supply to the floodplain is protected. Now many people from Iringa live in the area close to the boundary between Morogoro and Iringa Regions. Most of these people live on the Iringa side of the boundary with only about 20 houses on this Morogoro side of the boundary.
	People do farm in this area but only very old people. In 2006 the government told people to move from this area onto village land within the valley (i.e. near railway). The people living in the corridor area said that they would move if the government found them land where they could grow their crops. Until now the government has not done this. District officials told the village government of Mkangawalu to remove people living up in the hills and to place them on village land so that the area in the hills becomes a forest reserve[7]. The village government started to tell people in the hills to move into the village but the Ward leader told the village government to stop telling people to move because the village government had not made appropriate land allocation for the people coming from the hills within the village.
	None of the participants knew if people farm in this area as they have never been there.
Why do people choose to farm there?	People of Iringa choose to grow crops in the corridor area because the climate is favourable for their crops. The corridor area is more fertile.
	No response
	N / A. Respondents did not know that people farm there.
What do you / they farm in that area?	Beans, millet, banana and rice are grown. Cocoa should also grow well in the area.

[7] This statement may be in respect of a Vice Presidential declaration made after the 2006 elections whereby people were instructed to relocate off of mountain areas. Later this declaration was considered to have no legal standing.

Question	Response
	People in the corridor area grow coconut, bananas, beans, maize, sesame, mango, pineapple and rice.
	N / A
Do you use any natural products from this area?	There is red soil present which is used as a medicine.
	No response
	N / A
If unable to farm / get products from this area, what are the options?	If people are told to leave the corridor area they will move to areas on village land like Isago (sub village of Mngeta) because the climate is similar. There is TANAPA (Udzungwa Mountains National Park), the Forest and Beekeeping Division (Catchment Forest Reserves), the company (meaning Kilombero Plantations Ltd) and the pastoralists keeping cattle on the floodplain. Between these things the people of the area are being squeezed, how can everyone find space?
	There are few people living up in the hills (corridor area) and they could easily fit within idle land within the village boundary.
	N / A

KEY

Mngeta village	n = 21 (12 x men, 7 x women)
Mkangawalu village	n = 17 (10 x men, 7 x women)
Mchombe village	n = 8 (4 x men, 4 x women)

Worthy of note is a statement made by the participants from Mngeta village who comment on feeling squeezed between protected forests, Kilombero Plantations and the pastoralist community. Participants from Mkangawalu reflect the opposite opinion, noting that the few people who do live in the corridor area close to Kimbi River could easily be accommodated upon idle village land.

3.1.8 Presence of wildlife on farming land and in Village Land Forest Reserves

A greater proportion of respondents residing outside of the corridor area report the presence of wildlife upon their farm land compared to those respondents residing inside the corridor area (54.7% (70) compared to 44.4% (16)). Respondents outside of the corridor area also indicated seeing a greater diversity of animals upon their farm land. Species noted from outside of the corridor area but not inside the corridor area include: puku *(Kobus vardoni)*, hippo (*Hippopotamus amphibius*), buffalo *(Ayncerus caffer)* and elephant *(Loxodonta africana)*. Farmland outside of the corridor area is largely situated upon a seasonal floodplain dominated by elephant grass *(Pennisetum purpureum)*. This is in contrast to the deciduous woodland and grassy valley of the corridor area. The differences in habitat type between outside and inside the corridor area likely accounts for the presence of different species. Species present upon farm land outside and inside of the corridor area are shown in Figure 21 below. (These data in no way constitute a full species list of the area).

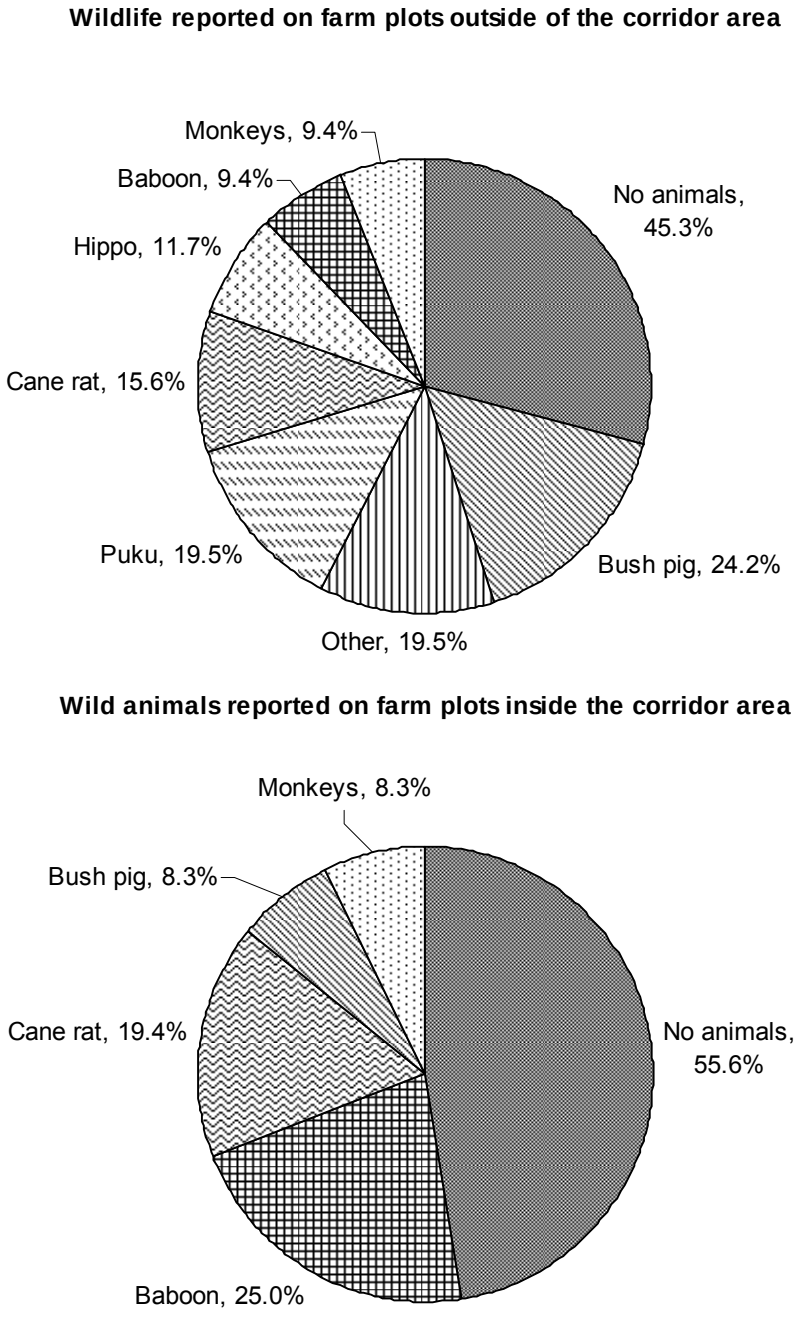


Figure 21. Reported presence of wildlife species on farm land outside of (n = 128) and inside (n = 36) the corridor area

94.3% (83) of respondents who reported the presence of wild animals on their farm land say that the animals cause damage and / or eat crops.

Members of Village Environmental Committees of Mngeta and Mkangawalu villages noted the presence of the species shown in Table 11 within Iwungi and Itongowa Kipuga Village Land Forest Reserves which neighbour the corridor area.

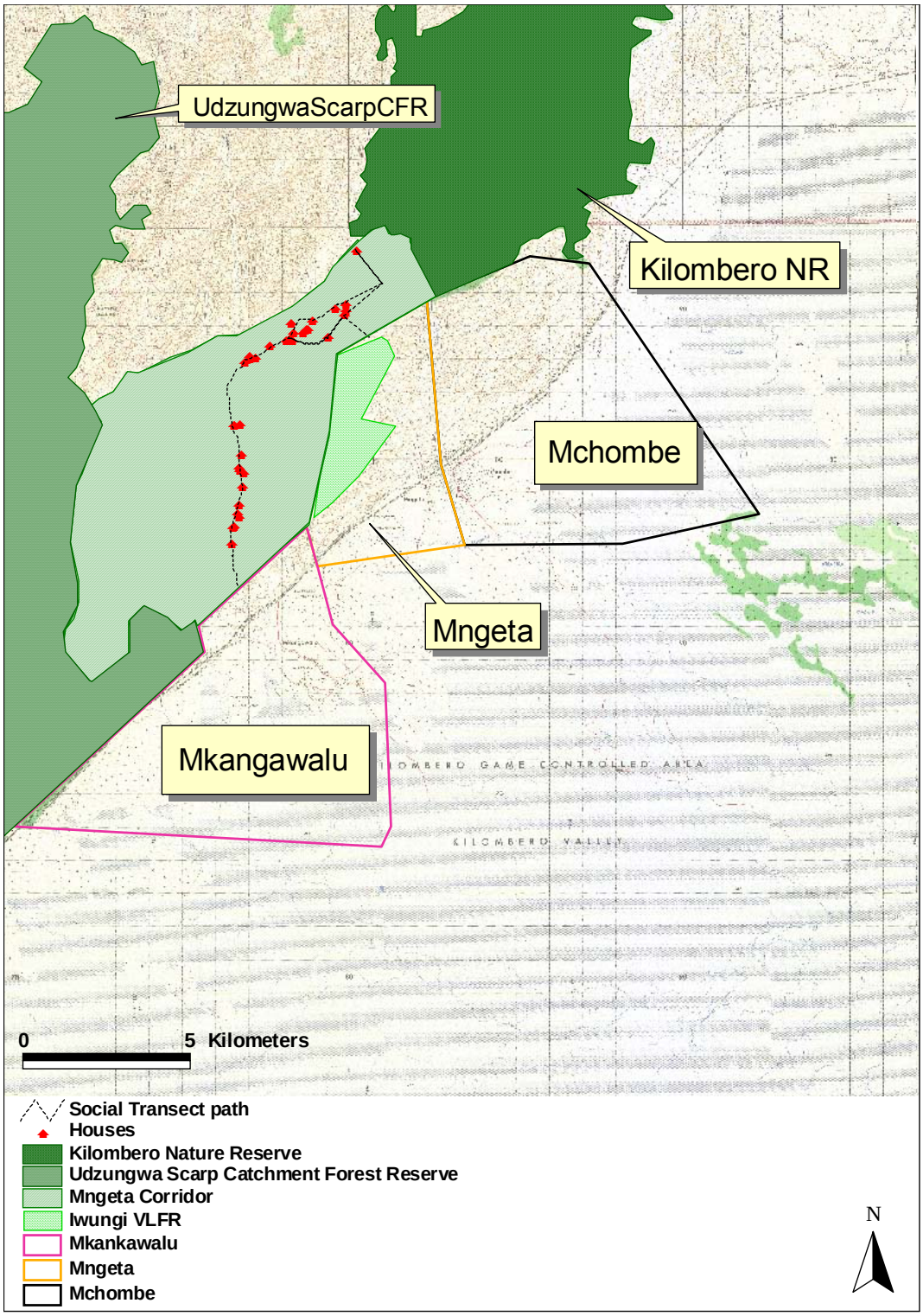
Table 11. Animal species reported as present in Village Land Forest Reserves

Species	Iwungi VLFR	Itongowa Kipuga VLFR
Black & white colobus *(Colobus angolensis)*	X	X
Red colobus *(Piliocolobus gordonorum)*	X	X
Baboon *(Papio cynocephalus)*	X	X
Klipspringer *(Oreotragus sp.)*	X	
Leopard *(Panthera pardus)*	X	
Cane rat *(Thryonomys sp.)*	X	
Bush pig *(Potamochoerus larvatus)*		X
Hyrax *(*genera *Hydracoid)*		X

3.1.9 Social transect

GPS coordinates of settlements collected whilst conducting the social transect confirmed that there are permanent households within the corridor area. Settlements are present within the fertile valleys that provide favourable farming land whilst also being close to either a river or stream. GPS coordinates of settlements collected during this study have been plotted against a background of the 1:50,000 topographical map (URT, 1983) of the area using ArcView GIS 3.3. Also depicted on the map are: the village boundaries; and the boundary of Iwungi Village Land Forest Reserve;

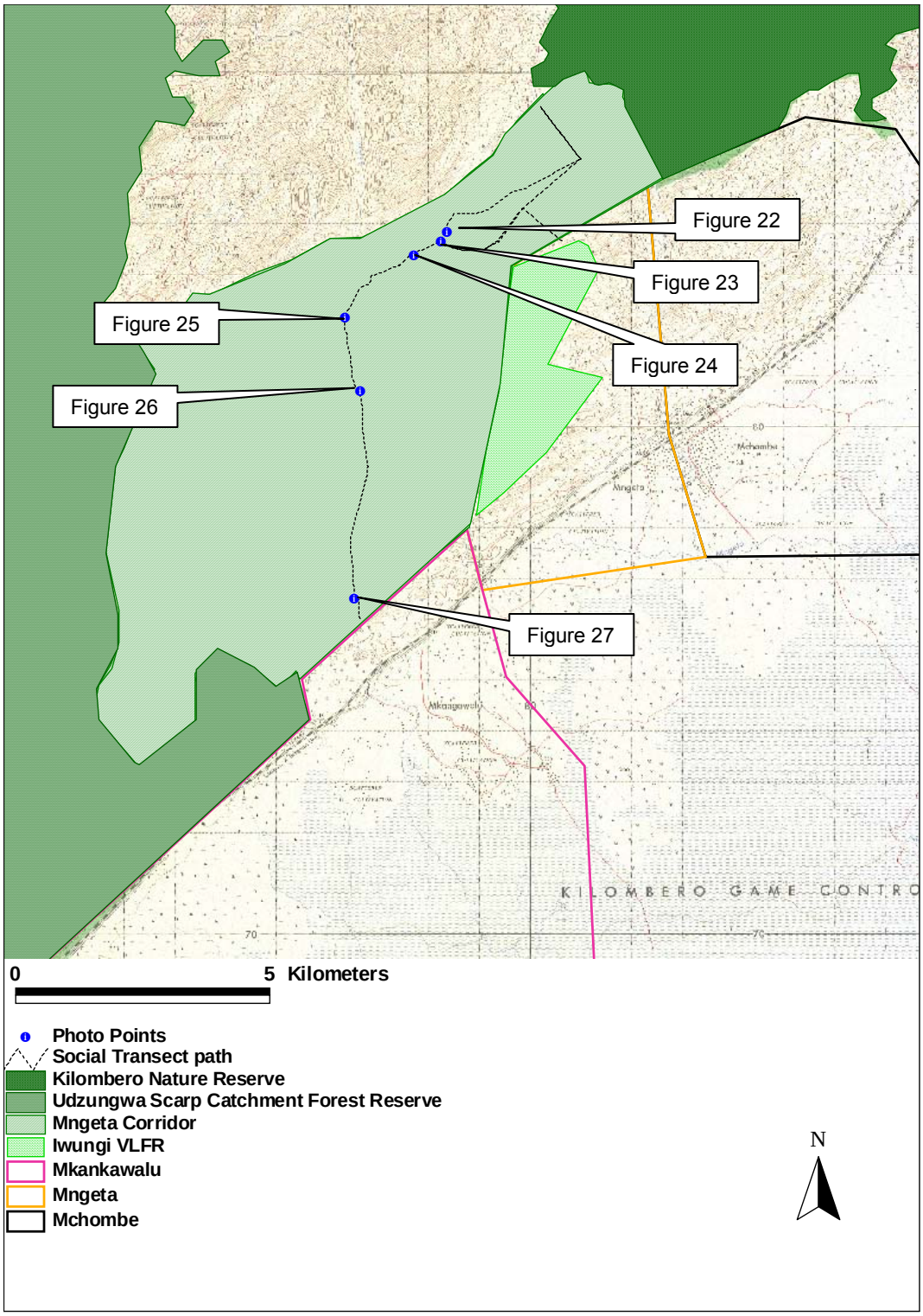
(Projection of these data were done by converting the beacon GPS coordinate data supplied by the Land Office, Kilombero District Authority, and the Kilombero District Forest Office respectively, into polygons in ArcView GIS 3.3) the Kilombero Nature Reserve; Udzungwa Scarp Catchment Forest Reserve; and the proposed Mngeta corridor (Map 6).



Map 6. Mngeta corridor settlements

Households within the corridor use the network of narrow footpaths to move about the area on foot. They travel to the main villages of Mchombe, Mngeta and Mkangawalu to sell their produce; visit the medical dispensaries; and to buy supplies such as kerosene used for lighting the house after dark.

Map 7 below shows a limited selection of geo-referenced photo points, the photos for which are presented in Figure 22 to Figure 27. The corridor area is dominated by gentle rolling slopes and riverine valleys. Scattered patches of deciduous woodland were present, interspersed with patches of farm land in use, new farmland being cleared and areas of fallow farmland.



Map 7. Mngeta corridor photo points

Figure 22. Maize and scattered trees on gentle slopes

Figure 23. Valley in corridor area, grasses and scattered tree cover

Figure 24. Valley in corridor area; crops, grasses, bracken and scattered trees

Figure 25. Thick bracken and grasses, scattered tree cover on slopes

Figure 26. Bean fields

Figure 27. Maize crop, denudes slopes, some scattered tree cover

4.0 Discussion

4.1 Anthropogenic activities in the research area

Evidence suggests that the corridor area supports approximately 90 households, this is in keeping with the estimate of Rovero (2007), who suggested that less than 100 households exist in the corridor area. This study has confirmed the existence of 74 houses within the corridor with sub-village leaders and local informants. In addition to these houses, the data indicates that other households who reside outside of the corridor, do farm within the corridor (22% of the sample farming in the corridor). The main driver causing people to reside or utilise land within the corridor area are the conditions favourable to agriculture, particularly the cultivation of rice, maize and beans. Whilst rice and maize are grown by most farming respondents (91.5% outside the corridor and 87.2% inside the corridor), the environment inside of the corridor is also suited to growing beans. Beans are an important cash crop that 52.8% of respondents inside of the corridor; compared to just 4.6% of respondents outside of the corridor grow. These crops also form the mainstay of the local diet.

The data indicates that proxy indicators of household wealth, such as house construction materials and the size of the household land holding should be used with caution. For this research site such indicators are not a reliable way of identifying the poorer members of the community – a target requested by some donors and development agencies. The social data resultant of this study should not be construed to indicate that people residing within the corridor are poorer than those living upon village land. The data does however reflect the distance of corridor residents from the markets and the limited access (no road) to reach the corridor area.

Data collected by this study do not support the statement made by Rovero (2007) that most farmers within the corridor area are seasonal farmers. Only 16.7% (n = 36) of the households sampled within the corridor area were

seasonal farmers with 83.3% residing permanently within the corridor area. Nor do the data support the statement by Rovero (2007) that residents from Mngeta village residing in the corridor area have been told to move back inside village land to allow for the establishment of a Participatory Forest Management scheme. The Participatory Forest Management scheme of Mngeta village – Iwungi Village Land Forest Reserve – exists entirely within Mngeta village land and as such people residing within the corridor area behind Mngeta village are not affected be the demarcation of Iwungi Village Land Forest Reserve. In addition village government representatives did not indicate that any households were being asked to relocate as a result of the establishment of Iwungi Village Land Forest Reserve.

With respect to livelihood strategies, households outside and inside of the corridor area both depend most upon agriculture to provide both food and money for the household. Livestock keeping also makes an important contribution. Households adopt on average just 2.3 livelihood strategies with households most frequently being involved in agriculture and livestock keeping. Due to the dependency of these most commonly chosen livelihoods upon environmental conditions, the future security of these livelihood activities are inherently linked to provisioning, regulating and supporting ecosystem services, which in turn influence overall human well-being (MA, 2005).

Households outside and inside of the corridor area have complete dependency upon wood, in the forms of fuel wood and charcoal, as their source of energy for cooking. Close to 35% of households sampled from outside of the corridor area source fuel wood from their own trees. However, few households residing within the corridor area echo this pattern of resource use, with the majority of households (75.0%) sourcing fuel wood from public, open access forests that surround houses and farm land inside the corridor area. If resettlement of corridor residents to village land is to be considered sources of fuel wood that can support the households being added to the host

villages should be established in order that pressure on natural resources is not simply being moved from one place to another without considering sustainability.

Over time expansion of agricultural lands has been the single most significant driver of forest loss within the Eastern Arc Mountains with forest loss between the 1970's and 2000s estimated at 12% (Mbilinyi & Kashaigili, 2005). Whilst rates of forest loss have declined in recent years, this is largely associated with the overall decrease in forests outside of reserves; with most forest reserves having farm land right up to the boundaries (Mbilinyi & Kashaigili, 2005). Compared to other areas within the Eastern Arc Mountains, to date it would appear that the Mngeta corridor area has faired better than other areas outside of forest reserves in maintaining a modicum of forest cover. Figure 28 below shows the typical scenario of forest clearance up to the boundary of a forest reserve in Tanzania – note the denuded slopes. Figure 29 shows an aerial shot of the Mngeta corridor, from this image it can be seen that at the time of the photo (March 2006) land utilisation was largely confined to the valley on either side of the river, rather than on the slopes; a utilisation pattern observed during the social transect conducted as part of this study; although some cultivation was observed upon slopes within the corridor area.

Figure 28. Boundary of Nguru South Catchment Forest Reserve, Morogoro District, Tanzania (by M. Menegon)

Figure 29. Aerial photo of the Mngeta corridor. Source: WCS Conservation Flight Program March 2006.

The population within the research area has a high dependency upon agricultural land and access to wood as the main source of fuel. Given the lack of easily available alternative sources of fuel wood, or indeed an alternative fuel, the pattern of wood utilisation from public forests for fuel, either directly as wood, or as charcoal, is set to continue. The high dependency that people within the research area have upon agriculture as their main livelihood suggests that agricultural land will continue to expand as the local population increases (1988 – 2002 intercensal growth rate for Morogoro Region was 2.6% (URT, 2002)). These compounding factors could soon lead to denuded slopes within the research site, particularly within the corridor area where dependency upon fuel wood from public forests is greater and livelihood strategies are less diverse.

4.2 Corridor habitat and function

Rovero (2007) noted that 80% of the Mngeta corridor appeared covered by natural vegetation in the form of shrubs, woodlands or forest; the latter of which was estimated to account for 25% of the natural vegetation cover. By the estimate of Rovero (2007) this meant 20% of the corridor's 63 kilometre square area was covered by farm land. Data collected during this study shows that farmers within the corridor have an average land holding of 0.017km^2 (S.E. 0.003, Min. 0.004, Max. 0.081). Based on 90 households farming an average of 0.017 km^2, data from this study estimate that just 1.53km^2 of the corridor area are covered in farm land. This estimate is considerably lower than that of Rovero (2007), who estimated 12.6km^2 to be covered in farm land. As this study was not able to afford time to measuring the size of respondents farms the size of land holdings reported have not been subject to ground truthing. As such, the considerably lower estimate may be a result of inaccuracy of respondents in knowing the size of their land holding; or an error of the digital photo analysis conducted by Rovero (2007).

The lower estimate (established by this study) of farm land inside the corridor area is positive in respect of establishing the corridor. Maintaining existing linkages where they already exist is significantly easier than retro-fitting a conservation corridor (Hobbs, 1992). As such Hobbs (1992) argued that maintenance of existing linkages should be an important component of any conservation plan. Therefore securing the Mngeta corridor now will increase the probability of forest dependent fauna moving between the Udzungwa Scarp Catchment Forest Reserve and the Kilombero Nature Reserve. Establishing the corridor increases the probability of species survival by minimising the impacts of inbreeding depression and demographic stochastic (Hobbs, 1992). The corridor would also protect the water catchment for the area, thus complimenting the existing ecosystem services provided by Udzungwa Scarp Catchment Forest Reserve and the Kilombero Nature Reserve. The significant coverage of natural habitat within the corridor area

should mean that if farming were prohibited within the corridor, and residents re-settled to village land, given time for natural habitat regeneration the Mngeta corridor could fulfil the functions of a habitat corridor based on definitions of Hess & Fischer, (2001); whereby organism can survive and reproduce within the corridor area.

Data from Eastern Arc Mountain Catchment Forest Reserves within the same District reported that human disturbance, quantified by the level of timber and pole extraction, is higher at the edge of reserves (transects starting at the edge and entering 900m deep into the reserve) than at the interior (Bracebridge, 2005a; Bracebridge, 2005b). This pattern of human disturbance may have negative implications for the Mngeta corridor which has widths ranging from 2.1 to 6.8 km. The narrow portion of the corridor may be subject to levels of human disturbance great enough to prevent the reestablishment of forest-interior habitat that is not dominated by edge effects in their many and complex guises (Laurance et al, 2002; Hobbs, 1992).

Data collected during this study indicate that boundaries of forests are unclear and that people who reside in the area are unsure about who has jurisdiction over the forests. Establishment of the Mngeta corridor and the inclusion of it, together with the Udzungwa Scarp Forest Reserve to the Kilombero Nature Reserve would not only provide habitat linkage but also increase the status and resources available for effective management of the area as one contiguous forest block.

5.0 Conclusions and Recommendations

5.1 The global situation

When running six scenarios of global policy intervention upon biodiversity the Secretariat of the Convention on Biological Diversity (2006) concluded that national and *locally tailored* solutions for reducing biodiversity loss were required. The statement highlights that it is of paramount importance to:

- minimise the rate of land conversion;
- enhance agricultural productivity in order to reduce the need for land;
- provide payment for environmental services: compensating for the opportunity cost of non-conversion;
- establish a comprehensive and effectively managed network of protected areas; and
- ensure trade liberalisation combined with policy interventions that avoid unnecessary loss of biodiversity through land conversion (Secretariat of the Convention on Biological Diversity, 2006).

Based upon the above recommendations and the findings of this study it seems appropriate to recommend that any further conversion of land within the corridor area be prevented because of: the current low density of human settlements; the continued existence of remnants of deciduous woodlands within the corridor area; and the biological importance of Udzungwa Scarp Catchment Forest Reserve as a unique centre of endemism.

5.2 The local situation

Due to the location of settlements running through the centre of the corridor area, reshaping of the corridor in order to avoid settlements is not viable. As such, the establishment of the Mngeta corridor depends upon the resettlement and fair compensation of some 90 households. The majority of

these households reside and farm within the corridor. Others reside outside of the corridor but utilise land within the corridor for agricultural purposes.

The establishment of the Derema corridor in the East Usambara Mountains of northern Tanzania provides a useful case study of compensation payments to farming households within a biodiversity hotspot. Lessons learned during the payment for compensation of the Derema corridor highlight that:

- compensation is costly and requires solid financial commitment;
- clear lines of communication between the facilitators of the compensation scheme and the communities affected are vital;
- a good compensation has the potential to improve peoples lives and improve conservation; and
- compensation payments must be made correctly and on time (Doggart & St. John, 2006).

In addition Dr. Jambiya (pers comms) of WWF in Tanzania, who headed the Derema corridor compensation project; noted that the resources required to efficiently carry out crop surveys in order that compensation payments can be calculated must not be underestimated. He also noted that surveys, once initiated, should be carried out promptly across the full extent of the target area, to avoid a sudden increase in the number of farmers settled within the corridor area; a negative consequence of people hearing that compensation is being paid for land holding within a designated area. Procedures for the compensation of land or property in Tanzania are guided by a number of Government Acts including: The Land Act No.4; and the Village Land Act No.5 of 1999 (URT, 2003b).

The resettlement of people from the corridor area alone will not address the driving forces of natural resource use. Of greatest significance is access to a source of fuel wood. People throughout the research area will for the

foreseeable future require a source of fuel wood, or a suitable alternative. If pressure upon open access forests is to be reduced, and illegal extraction from protected forests eliminated; or at the very least reduced to a level that may still permit the protected area to achieve its conservation objectives; alternative sources need to be identified. Establishing multiple sources of fuel wood for community use seems appropriate. Sources could include village wood plots and trees planted upon private land holdings. The latter may be readily taken up by the target communities as households outside of the corridor area already exhibit the behaviour of using their own trees as the main source of fuel wood. Participatory Forest Management through the establishment of Village Land Forest Reserves is already established in two of the three research villages, these offer a source of fuel wood to people in the villages of Mngeta and Mkangawalu but Mchombe has no such land allocation. If the situation in Mchombe village does not change, it is highly likely that residents will continue to illegally extract resources from the Kilombero Nature Reserve (Rovero, 2007) in an attempt to meet local demands.

Respondents consulted during this study noted that demarcation of Catchment Forest Reserves in the research area is poor. This is a situation that should be resolved as it may contribute to better protection of these reserves, however, limited resources available to the Forest and Beekeeping Division (Burgess & Kilahama, 2005) may be a limiting factor. Iwungi and Itongowa Kipuga Village Land Forest Reserves have been demarcated with a teak boundary.

96% of migrants that have settled within the corridor area indicated that they are from Iringa. The village of Iluti was mentioned by the seasonal farmers using land within the corridor at the top end of the Kimbi River. As such any discussions around land use within the area must include representative from villages upon the Iringa side of the Mngeta corridor.

Agricultural experts also have a part to play within the research area. Given appropriate advice from agricultural experts it may be possible for farmers in the area to increase yields and improve storage of crops after harvest. This would improve household security, reducing vulnerability to shocks. If people can support their households on the land that they already have it will reduce pressure upon areas that conservationist wish to protect. This study calls for conservationists to work together with agriculturalists to ensure the security and sustainability of the agricultural livelihoods so heavily depended upon in the research area.

This study recommends that the Mngeta corridor be established between Udzungwa Scarp Catchment Forest Reserve and the Kilombero Nature Reserve as per the design proposed by Rovero (2007). To increase resources available for management of Udzungwa Scarp Catchment Forest Reserve, it is recommended that Udzungwa Scarp Catchment Forest Reserve and the Mngeta corridor be annexed to the Kilombero Nature Reserve. This option means that the Forest and Beekeeping Division of the Ministry of Natural Resources and Tourism maintains ownership of Udzungwa Scarp Catchment Forest Reserve. This option is likely to be preferred by the Tanzanian Government over awarding Udzungwa Scarp Catchment Forest Reserve National Park Status. This alternative option proposed in Rovero (2007) would see the ownership of Udzungwa Scarp Catchment Forest Reserve given to the Tanzania National Parks Authority (TANAPA). This may be a politically unpopular move due to the implications associated with central government revenue losses and TANAPA revenue gains. As noted by Rovero (2007) it remains the decision of the Government to decide what designation is bestowed upon the Udzungwa Scarp Catchment Forest Reserve.

Those households that would have to re-settle as a consequence of establishing the Mngeta corridor will by law require fair compensation for

property, land and crops. It is critical that lessons learned during the establishment of the Derema corridor in the East Usambara Mountains be thoroughly studied prior to the initiation of consultations with the communities to be affected by the Mngeta corridor in order that the process happens as smoothly as possible for all involved.

Cernea and Schmidt-Soltau (2003) note the importance of achieving double sustainability when establishing protected areas; with socially responsible conservation policies and interventions resultant from both social and biological research; being implemented for the sustainability of both people's livelihoods and biodiversity. Applying the Impoverishment Risks and Reconstruction Model to case studies within the Congo-basin of central Africa Cernea and Schmidt-Soltau (2003) reported that forced displacement of residents in order to establish national parks in the heart of the rainforest had negative implications to the lives of thousands of residents evicted and upon thousands of people within host communities. Forms of impoverishment included landlessness, homelessness and marginalisation. Resettlement may also have negative impacts upon the ecology of the host area, for example through the extraction of forest resources by a now larger population.

Cernea and Schmidt-Soltau (2003) advocate that if people must be resettled the process must be conducted according to international standards set down by institutions such as the World Bank or OECD. It is critical that the livelihoods of affected households be protected and preferably improved but certainly not diminished. Only if these criteria can be guaranteed, should the case for resettlement be considered acceptable for the attainment of conservation goals.

This study has presented evidence advocating for the protection of the earth's ecosystem services, including biodiversity, in order to safeguard human well-being. Rovero (2007) indicated the urgent need to ensure the continued

existence of the unique forest ecosystem that is the Udzungwa Scarp Catchment Forest Reserve specifically through establishing connectivity of forest patches within the Udzungwa landscape; proposing the Mngeta corridor; and improving the management of the protected forests. This study has provided quantitative data of livelihood strategies and the dependency that households in the area have upon natural resources, both within and outside of the Mngeta corridor. The data indicate that: relatively few households would be affected (resettled) as a consequence of establishing the Mngeta corridor; local villages have adequate land resources to accommodate the affected households; and that social exclusion of the resettled households is unlikely given the residents / migrant mix already present in the villages.

A double sustainability approach as defined by Cernea and Schmidt-Soltau (2003) is critical to ensuring that the conservation goal of the Mngeta corridor becoming an established habitat for forest dependent species is to be achieved.

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Appendix 1: Household survey

TEREHE / Date: **……** JINA LA MSAILI / Interviewer: **……**

KIJIJI / Village**: ……**

Identified as farming within the corridor YES / NO

MAELEZO KWA JUMLA / HOUSEHOLD & INTERVIEWEE PROFILE

1a	**JINA LA MTAHINIWA /** Name of interviewee:
1b	**JINSIA LA MTAHINIWA /** Gender:
1c	**MTAHINIWA ANA UMRI GANI /** Age of respondent:
2a	**JINA LA MKUU WA KAYA /** Name of head of household:
2b	**JINSIA YA MKUU WA KAYA?** Gender:
2c	**KAMA MKUU WA KAYA NI MWANAMKE** If female: Single / Married / Divorced / Widow **(A) HAJAOLEWA N / H** **(B) AMEOLEWA N / H** **(C) NI MTALAKA N / H** **(D) NI MJANE N / H**
2d	**MKUU WA KAYA ANA UMRI GANI?** Age of head of household:
3a	**WATU WANGAPI WANAISHI KWENYE KAYA YENU?** How many people live in the house?
3b	**WATU WAZIMA?** How many in total?
3c	**WATOTO?** How many children?

RESIDENT OR MIGRANT

4a	**ANAPOTOKEA MKUU WA KAYA - NI MZALIWA WA HAPA?** Is the head of the HH from this village? **NDIYO / HAPANA**
4b	**KAMA HAPANA, AMETOKEA WAPI?** If NO, where are you from?
4c	**ALIKUJA MWAKA GANI?** What year did they move here?
4d	**KIPI KILIMVUTIA KUJA HAPA? (zungushia jibu yenye ukweli zaidi)** Why did you move here? *Kilimo Bora Uvuvi Ufugaji Bora Ajira Biashara Kuoa/Kuolewa Ujamaa* Better farming / Fishing / Better livestock keeping / Employment / Business / To marry / Villageisation
4e	**MKUU WA KAYA NI KABILA GANI?** Head of HH is from which Tribe?

KUTA ZA NYUMBA / THE MAIN HOUSE

	UKUTA / household buildings	**WEKA ALAMA**	**IDADI YA NYUMBA**
5a	**NYUMBA YA MITI** / Wood only		
5b	**UDONGO** / soil only		
5c	**MITI NA UDONGO** / Wood & soil		
5d	**MATOFALI YA KUCHOMA** / Block		

	PAA / roof	**WEKA ALAMA**	**IDADI YA NYUMBA**
6a	**HAKUNA PAA** / no roof		
6b	**NYASI** / grass		
6c	**MAKUTI** / palm		
6d	**MABATI** / tin		
6e	**VIGAE** / tiles		

MNAPATA WAPI MAJI / WATER SUPPLY (**Rank** in order of importance: 0 – 4. 4 being ALWAYS, 0 NEVER).

7	**TUNAPATA KUTOKA BOMBA LA UMMA / KIJIJI** Community pump or tap	**TUNACHOTA MTONI** River	**TUNA KISIMA BINAFSI** Personal well	**VINGINE?** Other - Specify

HOUSEHOLD FUEL TYPE (**Rank** in order of importance: 0 – 5. 5 being ALWAYS. 0 NEVER).

8a	**JE, KUPIKA UNATUMIA NINI?** What fuel(s) do you use for cooking?				
	KUNI / Wood	**MKAA** / Charcoal	**KEROSINI** / Kerosene	**LPG**	**NINGINE?** Other - Specify
8b	**MNAPATA WAPI KUNI?** Where do you get fuel wood from?				
	SHAMBANI / MSITU BINAFSI / Own trees	**MSITU WA KIJIJI** / Community forest	**MSITU WA HIFADHI** / Forest Reserve	**KUNUNUA** / Buy	**NINGINE?** Other - Specify
8c	**MNAPATA WAPI MKAA?** Where do you get charcoal from?				
	SHAMBANI / MSITU BINAFSI / Own trees	**MSITU WA KIJIJI** / Community forest	**MSITU WA HIFADHI** / Forest Reserve	**KUNUNUA** / Buy	**NINGINE?** Other - Specify
8d	**HUWA UNAWASHA KITU KUKIWA GIZA?** Do you light the house after dark? Yes / No **NDIYO / HAPANA**				
8e	**KAMA NDIYO, UNATUMIA NINI?** If yes, what do you use?				
	KEROSINI / Kerosene	**MSHUMAA** / Candles	**TANESCO** / electricity	**BATTERI** / Battery	**NINGINE?** Other - Specify

KUJENGA / BUILDING MATERIALS (**Rank** in order of importance: 0 – 5. 5 being ALWAYS. 0 NEVER).

9a	**WANAPATA WAPI NGUZO?** Where do you get building poles from?				
	SHAMBANI / MSITU BINAFSI Own trees	**MSITU WA KIJIJI** Community forest	**MSITU WA HIFADHI** Forest Reserve	**KUNUNUA** / Buy	**NINGINE?** Other - Specify
9b	**Where do you get roofing grasses / palm from?**				
	SHAMBANI / Own farm	**ENEO WA KIJIJI** / Community land	**MSITU WA HIFADHI** Forest Reserve	**KUNUNUA** / Buy	**NINGINE?** Other - Specify

DAWA / MEDICINES (**Rank** in order of importance: 0 – 5. 5 being ALWAYS. 0 NEVER).

10	**WANAPATA WAPI DAWA?** Where do you get medicines from?				
	MSITU BINAFSI Own trees	**MSITU WA KIJIJI** Community forest	**MSITU WA HIFADHI** Forest Reserve	**DUKA LA DAWA** / chemist	**NINGINE?** Other - Specify

11. BEI GANI KUNUNUA? (TSh) / PRICE (TSh)

KUNI Fuel wood / bundle	**MKAA** Charcoal / sack	**NGUZO** Building pole x 1	**DAWA** Medicine / dose

USAFIRI / Transport

12a	**WANA USAFIRI BINAFSI?**			
	HAKUNA Nothing	**BAISKELI** Bicycle	**PIKI PIKI** Motorbike	**GARI** Car

WANAMILIKI SHAMBA? / LAND TENURE STATUS **WANAMILIKI NYUMBA** / HOUSE TENURE STATUS

13	**SHAMBA**	**TICK**	**EKA** Acres	14	**NYUMBA** House	**TICK**	**IDADI** / Qty
	HAWANASHAMBA / HAWALIMI	No farm			**WANAKAA NYUMBA YA NDUGU**	Relatives	
	WANAAZIMA SHAMBA	Borrow			**WANAKODI NYUMBA**	Rent	
	WANAKODI SHAMBA	Rent			**WANAMILIKI NYUMBA**	Own	
	WANAMILIKI SHAMBA	Own					

FARMING

15a	**JE, UNALIMA MAZAO?** Do you grow crops? **NDIYO / HAPANA**
15b	**KAMA, NDIYO, UNALIMA MAZAO GAIN NA KIPINDI GANI?** If YES, what crops do you grow and when?
15c	**JE, UNAVUNA KIASI GANI YA KILA MAZAO NA LINI?** How much of each crop do you harvest and when?
15d	**JE, UNAUZA KIASI YA MAZAO?** Is any crop sold? **NDIYO / HAPANA**
15e	**KAMA NDIYO, UNAUZA MAZAO YAPI, LINI NA MARA NGAPI?** If yes, what is sold and when and how often?
15f	**JE, UNAUZA MAZAO KWA SHILLINGI NGAPI?** Prices per unit of sold product?

WANA **MIFUGO?**
LIVESTOCK

16	**WANYAMA** / Animals	**IDADI** / Quantity
	HAKUNA / None	
	KUKU / BATA Chickens / ducks	
	MBUZI / Goats	
	KONDOO / Sheep	
	NGOMBE / Cows	
	NGURUWE / Pigs	
17a	**JE, UNAUZA MAZIWA / NYAMA / NGOZI** Do you sell milk / meat / skin? **NDIYO / HAPANA**	
17b	**KAMA NDIYO, UNAUZA YAPI, LINI NA MARA NGAPI?** If yes, what is sold, when and how often?	
17c	**JE, UNAUZA KWA SHILLINGI NGAPI?** Prices per unit of sold product?	

SHUGHULI KWA MAHITAJI YA KAYA / WORK DONE FOR HOUSEHOLD NEEDS (scoring exercise, highest no. is most important)

18. What activities are members of your household engaged in?

SHUGHULI / Work	**NDIYO / HAPANA** Yes / No	**FAIDA NI CHAKULA** Importance for HH food	**FAIDA NI PESA** Importance for HH income	**WATU YA KAYA WANGAPI?** How many HH members?
WAKULIMA / Agriculture				
WAFUGAJI / Livestock				
Small business				
Artisanal work				
WAVUA / Fishing				
Labour – specify				
Logging				
Other - specify				

WANYAMA PORI / Wildlife

19a	**JE, UNANE WANYAMA PORI SHAMBANI LAKO?** Do you see wild animals on your farm? **NDIYO / HAPANA**
19b	**KAMA NDIYO, UNAONA WANYAMA GANI?** If Yes, what wild animals do you see on your farm?
19c	**WANAYAMA PORI WANAFANYAJE SHAMBANI LAKO?** What do the animals do on your farm? (just pass through / cause damage?)

Appendix 2: Seasonal calendar

Working in groups draw seasonal calendars. Locally available equipment can be used e.g. stones to depict answers.

1. Groups define when the year starts and define it in terms of months or seasons.
2. Groups develop a diagram answering questions asked (see left hand column) by indicating their response in the form of a score (Minimum score = zero, indicated by a blank cell. Maximum score = 6).

Village: …… Number of participant in group: ……

	1	2	3	4	5	6	7	8	9	10	11	12
Rainy season	∘ ∘ ∘ ∘ ∘ ∘		∘ ∘ ∘ ∘ ∘ ∘	∘ ∘ ∘ ∘	∘ ∘			∘			∘	∘ ∘ ∘ ∘ ∘ ∘
Women's / men's workload												
Plant maize												
Plant rice												
Sell maize												
Sell rice												
Price of rice is high												
Levels of HH income												
HH food is expensive												
HH expenses are high												
Bad health												

Appendix 3: Question for focus group discussion

The following list of questions was used to initiate the focus group discussion:

1. Are there protected forests in the area? Name them.
2. What are the benefits of the forest to the adjacent villages?
3. Do you have responsibilities toward the forests?
4. Are you familiar with the corridor area?
5. Do any of you farm in the area, or know of people who do? How many?
6. Why do people choose to farm there?
7. What do you / they farm in that area?
8. Do you use any natural products from this area?
9. If unable to farm / get products from this area, what are the options?