Land Use Changes, Optimization Strategies and the Role of Institutions for Sustainable Natural Resources Management in the Bale Eco-Region

SHARE Bale Eco-Region Research Report Series no. 4

ABOUT THE SHARE BALE ECO-REGION PROJECT

Conservation of Biodiversity and Ecosystems Functions and Improved Well-being of Highland and Lowland Communities within the Bale Eco-Region (BER) is one of the European Union (EU) funded projects that stands for Supporting Horn of Africa Resilience (SHARE). In Ethiopia, the project covers 16 districts (Districts) in West Arsi and Bale Zones of Oromia Regional State, around 22,000 km^2, with a population of about 3.3 million. The project life span is 42 months starting July 2014 and ending in November 2017. Five partners are implementing the project: Farm Africa, SOS Sahel, International Water Management Institute (IWMI), Frankfurt Zoological Society (FZS) and Population Health and Environment (PHE).

Location of the Bale Eco Region (BER) in Ethiopia

Acknowledgements

This report was prepared by Wondo Genet College of Forestry and Natural Resources, Hawassa University, in collaboration with the International Water Management Institute as part of the SHARE Bale Eco-Region

Contents

LIST OF FIGURES

List of Tables

Acronyms and abbreviations

B/C	Benefit-cost ratio
BER	Bale Eco-Region
BERSMP	Bale Eco-Region Sustainable Management Plan
BMNP	Bale Mountains National park
CBD	Convention on Biological Diversity
Koree	Village level state-community joint resource administration committee
CSE	Conservation strategy of Ethiopia
EPI	Environmental Performance Index
EPRDF	Ethiopian People Revolutionary Democratic Front
EWCO	Ethiopia Wildlife Conservation Organization
FAO	Food and Agricultural Organization of United Nations
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
FMA	Forest Management Agreement
GIS	Geographic Information system
Ha	Hectare
HHs	Households
ICRAF	International Center of Research in Agroforestry
IEM	Integrated environmental management
Kebele	The smallest administrative unit (ward) in Ethiopia
KII	Key Informant Interview
LMPs	Land Management Practices
LU/LC	Land Use/Land Cover
MC	Marginal Cost
MR	Marginal Revenue
NGOs	Nongovernmental organizations
NRM	Natural Resource Management

NRs	Natural Resources
NTFPs	Non-timber Forest Products
OFWE	Oromia Forest and Wildlife Enterprise
PFM	Participatory Forest Management
PNRM	Participatory Natural Resources Management
PPS	Probability Proportional to Size
PRM	Participatory Rangeland Management
REDD$^+$	Reduced Emission from Deforestation and Degradation
SHARE	European Union's Support for Horn of Africa Resilience
SLM	Sustainable land management
S P S S	Statistical Package for Social Studies
TLU	Tropical Livestock Unit
Woreda	An administrative structure in Ethiopia equivalent to District
WFP	World Food Program

1 Introduction

Bale Eco-Region (BER) is one of the most important eco-regions in Ethiopia and sub-Saharan Africa characterized by rich biodiversity and wide range of ecosystem services. It compromises 12 districts of Bale and 2 districts of West Arsi zones of the Oromia regional state of Ethiopia. The Bale Mountains National Park (BMNP) which hosts diverse fauna and flora, including a significant number of rare and endemic species is also found in the Eco-region. The ecosystem services from the eco-region support millions of people in the upstream (highland) and downstream (lowland) areas. The eco-region is also the source of two important trans-boundary rivers (Wabe-Shebele and Genale) that support the livelihood of large number of population in Northern Kenya and Somalia. Above and beyond the diverse ecosystem services, BER supports the livelihoods of many millions of human and livestock population nationally and regionally beyond Ethiopia.

However the globally important ecosystems and biodiversity resources of the BER are under increasing threat from wide range of stress factors. Addressing the multifaceted threats facing the eco-region's biodiversity and the institutional gaps and ineffectiveness of strategies put in place thus far essentially requires understanding and examining the trends of changes in land use and land cover, role and influence of the formal and informal institutions vis-a-vis land and natural resources management strategies on the natural resources and local livelihoods in BER.

This report provides findings of a multi-disciplinary research carried out (by a team of staff and MSc students from Wondo Genet College of Forestry and Natural Resources) for addressing temporal and spatial land use/land cover dynamics and its proximate and underlying drivers that are imminently leading to ecological damage that is currently affecting the whole system in the eco-region. It also highlights the institutional dynamics governing the interaction between community and the environment and links this to the land use dynamics in the eco-region over different government periods and among different institutional arrangements that are currently operating in the Eco-region. The reports also includes findings of the bio-economic optimality analysis and evaluation of the complementarities and trade-offs of different land management, land use and optimization strategies in improving the local livelihoods and environmental sustainability of land use in BER.

2 Summary of Research Methods and Tools

2.1 Location and description of the study area

This study was carried out in Bale Eco-Region (BER) located in the Bale administrative zone of the Oromia regional state of Ethiopia some 400km SE of the national capital Addis Ababa. The Eco-Region lies between 05˚22'-08˚08'N and 38˚41-40˚44'E (Charlene, 2013). The average annual temperature of the area is 17.5˚C ranging from 10˚C to 25˚C. The average annual rainfall of the area is 875mm with long rains experienced between June and October, and short rains between March and May (Yimer et al., 2006). The BER is rich in distinctive endemic flora and fauna as a result of its isolation from the bulk of the Ethiopian highlands and its topography and climatic history (Hillman, 1986, Yalden and Largen, 1992).

The afro-alpine plateau of the central area of the BER reaches more than 4000 meters above sea level (masl). Containing Erica, Giant lobelia (Lobelia rinchopatelum) and Helichrysum, this is the largest remaining area of Afro alpine habitat on the African continent (BMNP, 2007). South of the plateau the altitude falls rapidly with moist tropical forest between 2,600 masl and 1,500 masl. The moist forest is characterized by Hagenia abyssinica and wild coffee (Coffea arabica). North of the plateau habitats comprise of dry forest, woodlands, grasslands and wetlands, largely between 2,500 masl and 3,500 masl. The dry forests contain high-value commercial species such as Juniperus procera and Podocarpus falcatus as well as Prunus africanus, a threatened species. The lower altitude land of the south east of the BER, below 1,500 masl, is dominated by acacia woodland (UNIQUE, 2008; Teshome et al., 2011).

Demographically, the Eco-region falls within the Oromia regional state, the most populous province in Ethiopia with a population of 27,029,760 in 2007 (CSA, 2008) that is projected to reach 33,629,000 in 2015 (CSA, 2015). The dominant livelihood strategy in the BER, as in wider Ethiopia, is small-scale farming using traditional technologies of low input, low output and rain-fed mixed farming practices (World Bank, 2007, Rosell, 2011). Households (HHs) cultivate crops on distinct land plots. The most commonly cultivated food crops include: barley, wheat, horse bean, field peas, potatoes, flax, and Niger seed..

The highland is moderately productive; Wheat, barley and pulses are dominant crops grown in this area. Income is earned from sales of crops, livestock, fodder, and eucalyptus trees. Mid-altitude is moderately populated; Main crops grown in this agro-ecological zone are Maize, Sorghum, teff, pulses, wheat and oil seeds (Niger, sesame and flax). Lowland of BER is dominated by Agro-pastoralist livelihood strategies with main crops sorghum, teff and maize.

Livestock rearing for meat and milk products, manure making and tiling- power, local transport and skins has also been a long-standing livelihood strategy of the people in the Eco-region especially in the lowlands of the area. Livestock is mostly composed of cattle and goats. In addition, many households in the BER also gather a wide range of forest and biodiversity products from the natural forests and woodlands of the Eco-region. For poorer households in particular, income from daily labour and firewood sell are important economic activities to meet HH food requirements.

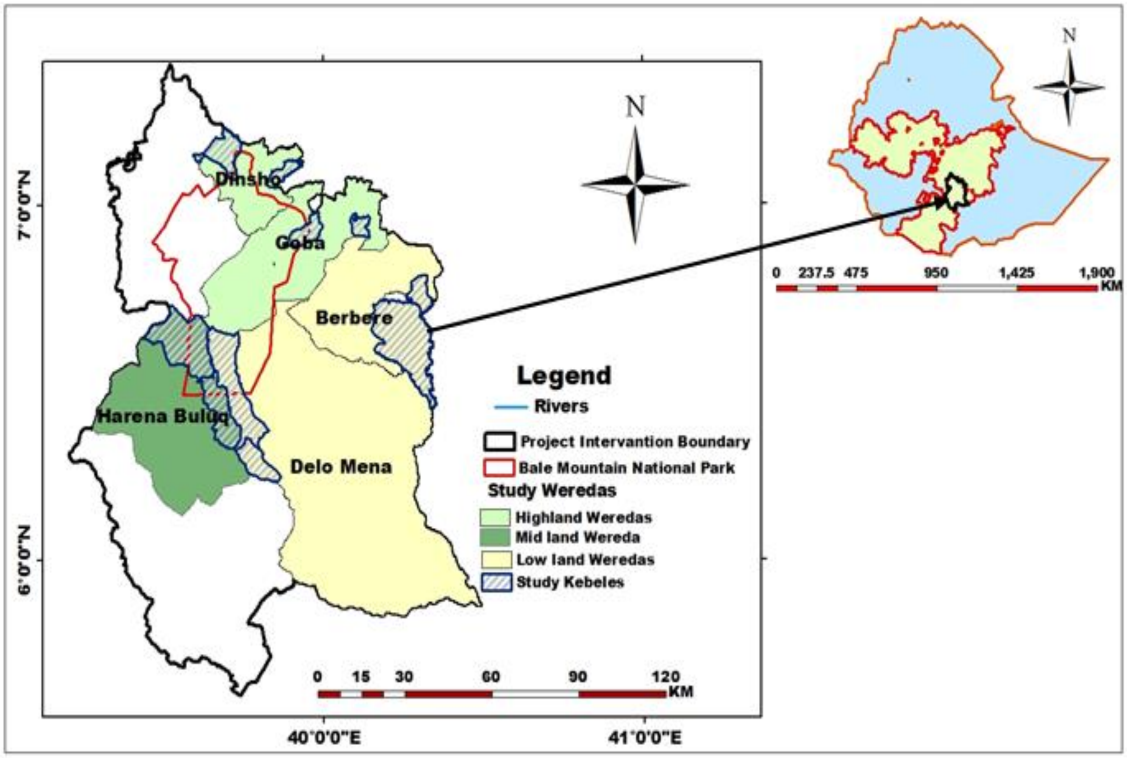

Figure 1. Map of the study area

2.2 Sampling strategy

In this study both purposive and multi-stage stratified random sampling approaches were used to identify study subjects and collect primary data. In the first stage, the fourteen (14) rural districts (Woredas) found in the ER were stratified into three groups (Highland, Midland and Lowland) based on agro-ecology. Then after, a total of five Districts (Dinsho and Goba from highland; Harena Buluk from midland and Delo-Mena and Berbare from lowland) were purposively selected for the study. The main criteria used to select the five Districts were representativeness of the Districts to major land use/land cover types, farming systems, land management practices, natural resources use interdependence and inter-links, existing land and natural resources management (NRM) systems and institutions such as participatory forest management (PFM) and participatory rangeland management (PRM) vis-a-vis trends in land use and land management interventions, environmental degradations and local livelihoods.

In the second stage, the sample size of the study in each agro-ecology (keeping the five Districts selected) was determined by adopting Green (1991) rule of thumb sampling approach as:

$$N \geq 50 + 8m$$

Where, N is the sample size of the study from each agro-ecology and `

m` is the number of key research variables of the study for the agro-ecology (Xi), m=1, 2…n.

For instance, the study sample size (farm HH units) from the highland agro-ecology where a total of 10 key variables were assessed for the four research topics covered was determined as:

$N \geq 50 + 8m$; $N \geq 50 + 8\ (10)$, $N = 130$ HHs

In the third stage, 2 representative Kebeles from each Woreda, accounting to a total of 10 Kebeles from the 5 Districts were purposively selected by adopting the criteria used to select the study Districts above. The aim was to distribute the sample size determined for each agro-ecology to the respective Districts selected in the agro-ecology and cascade the sample size determined to the 10 Kebeles selected. To that effect, the Probability Proportional to Size (PPS) sample size distribution technique was used to allocate the sample size determined for each agro-ecology to the respective Districts and Kebeles proportional to the total HHs size of each District and Kebele selected respectively (table 1).

In the fourth stage, stratified-random sampling technique was used to select sample HHs in each Kebele proportional to the sample size determined for each Kebele above. Accordingly, all rural HHs in each Kebele were identified and grouped into different categories (3 to 4) based on HHs' major livelihood strategies, gender, farming system, land management and use practices, land and NRM institutional arrangements, and engagement in green income generation activities. The grouping of the HHs in each Kebele into different respondent categories was carried out with the help of Kebele administrators and local experts. Consequently, the sample size determined for each Kebele was distributed to the different HH categories proportional to the total size of HHs in each category in the Kebele. The aim of stratifying HHs into the different respondent categories was to later compare and analyse study variables and findings with respect to the characteristics and practices of the different HH groups. Finally, random selection of sample HHs from each respondent category was carried out in each study Kebele through random lottery method and data collection and field assessment was carried out at HH-farm level through applying various data collection methods and tools.

Table 1. Summary of study Kebeles and sampled households by agro-ecology

No	Agro-ecology	Study Woreda	Sample Kebeles	No of sample households			Major farming systems/ land use	Major Land/NRM institutions
				Male	Female	Total		
1	Highland	Dinsho	Haro Soba	30	11	41	Cereal mono-cropping Crop-livestock mixed farming	Federal (Park) Regional gov PFM
			Mi'o	44	5	49		
		Goba	Fasil-angesso	14	3	17		
			Wajitu-shabe	14	7	21		
	Sub-total			102	26	128		
2	Midland	Harena-Bulluq	Bekaye	41	6	47	- Food cropping (Agroforestry) -Crop-livestock agro-pastoralism)	Federal (park) Regional gov PFM
			Shawe	82	8	90		
			Hawo	24	2	26		
	Sub-total			147	16	163		

3	Lowland	Delo-Mena	Chiri	55	3	58	Crop production	Regional gov
			Melka-amana	16	2	18	Crop-livestock mixed farming/ Agro/pastoralism	PRM
		Berbere	Sirima	48	4	52		
			Gora-iddo	52	8	60	Pastoralism	
	Sub-total			171	17	188		
	Total			420	59	479		

2.3 Data collection methods and tools

A combination of relevant quantitative and qualitative data collection methods and tools were used to collect reliable primary data and secondary information needed to make comprehensive assessment of key study variables. The methods included the following:

2.3.1 Household survey

Survey of a total of 479 farm and agro/pastoral HH units (out of the 486 sample HHs initially determined by the rule of thumb) was carried out to collect primary data in the 10 study Kebeles. To that effect, a semi-structured questionnaire was prepared for all the research topics separately (except for the Land use/land cover change study) and translated into Afan Oromo (local language). The questionnaire was first tested in five Kebeles during the reconnaissance survey, consequently amended and administered to the sample respondents in each Kebele via face-to-face interview conducted by trained enumerators and the researchers (see annex I-III for survey questionnaire templates for each research topic).

2.3.2 Participatory assessment and score ranking of environmental performances of different land use practices of farm/pastoral HHs in BER

In order to assess and determine the environmental qualities and performances of the different land use practices of smallholder farm/pastoral HH units, three important environmental quality indicators/parameters were assessed for most of the HHs surveyed. The environmental quality indicators assessed were:

a) Soil quality and productivity (including soil nutrient content/OM, texture, moisture, erosion, and yield/ha)

b) Tree/vegetation cover and biodiversity management (including number of tree species and populations/ha, percent tree/vegetation cover of the farm, abundance of wildlife and habitat conditions/corridors)

c) Land management and sustainable use (including forage quality and availability in range and grazing lands, condition of land, availability and management of water, signs of overgrazing and land degradation, fire).

The assessment and rating of the above indicators was carried out based on an Environmental Performance Index (EPI) classes established by the research team through adapting the matrix of

Moore et al. (1973). In view of that, 5 different EPI classes were developed; from very low (EPI =0-1) to very high (EPI = 4-5). The qualitative characteristics and quantitative score value ranges of the environmental quality indicators used were defined in detail for each class with respect to the three indicators established (See annex IX for sample EPI assessment indices). Accordingly, both quantitative and qualitative measures of the environmental quality indictor parameters were carried out for each farm/pastoral HH units surveyed by three different groups of evaluators but jointly working as a team.

The first groups of evaluators were the researchers themselves. These groups were responsible to quantitatively assess the environmental qualities of tree and biodiversity conservation on farm and rangeland. As such, the number of tree species (α- diversity), tree population and vegetation cover were assessed. Average crop yield in quintal/ha and annual livestock yield/[1]TLU were examined to relate soil and range quality to the different land use/farming practices. In addition, the researchers have also qualitatively assessed the other environmental quality indicators shown in the EPI matrix (annex IX) based on their knowledge and observation.

The second groups of evaluators were the surveyed HHs/land users themselves. To that end, survey HHs/land users were asked to rate the condition/status of each EPI quality indicator from 5 points (0 = lowest, 5 = highest) and trained data enumerators were responsible to quantitatively interpret the score ratings and judgments of the HHs/land users based on the score value ranges specified in the established EPI classes.

The third groups of evaluators were local development agents and experts in each study Kebele. These groups were asked for their opinions and knowledge on the environmental qualities and impacts of different land use/farming practices. The information obtained from these informants was later quantitatively interpreted based on the EPI matrix established.

2.3.3 Review of relevant policies, laws, development strategies and literatures

Throughout this study review and retrospective analysis of relevant government policies and laws, formal and informal institutions and development strategies was carried out with respect to: land and natural resources ownership and use right (property right) arrangements; governance and use systems, laws and regulations; informal and participatory NRM institutions as well as federal, regional and local development strategies and interventions. In addition, review of relevant scientific papers, SHARE project implementation reports, zonal and District government panel data and acquisition of satellite imageries of the BER over different periods and ancillary geographic information from Google earth on the Eco-region was made.

2.3.4 Key Informants Interview (KII)

In-depth interview with key informants from Bale zone and District agriculture/forestry offices, land administration and environment offices, local elders, focal persons of the SHARE project, Kebele

[1] TLU (Tropical Livestock Unit) stands for the number of livestock converted to a common unit. The conversion factors used for converting a livestock head to TLU were: for Camels = 1.6, Cattles = 0.7, Sheep = 0.1, Goats = 0.1, Donkeys= 0.4, Horse= 0.8, Mule=0.7, and Poultry = 0.01 (Pallas 1986)

administrators and experts was carried out to supplement and enrich the data collected from the HH survey and field assessment.

2.3.5 Focus Group Discussions (FGD)

In each study Woreda, 2 FGDs were conducted with selected participants from the community. As much as possible efforts were made to form homogenous groups for each FGD though mandatory presence of local administrators in the meetings was often a challenge for conducting more open discussions. Nevertheless, separate FGDs were made with groups formed from green income generating women only (forest coffee and female khat growers); green income generating men only (hone producer men); PRM user pastoral men only; Non-PFM user mixed farming men and women; PRM managing Koree/block committee men only.

2.4 Data analysis and interpretation

The primary data and secondary information collected from the various sources was sorted by key research themes (4 MSc research topics), feed into SPSS and accordingly analysed and interpreted by using the following methods and tools together with the four MSc students.

a) Spatial and temporal land use/ cover change analysis

Analysis of LU/LC changes for the entire BER from 1986 to 2016, as well as for selected Kebeles that are currently under different NRM institutional arrangements (Federal government /BMNP, Oromia regional government land administration, PFM and PRM) from 2006 to 2016 was carried out. The maps and satellite images of the Eco-region and the target Kebeles were obtained from Landsat TM of 1986 and 1996, Landsat ETM+ of 2006 and Landsat OLI/TIRS of 2016 respectively. Prior to the image classification, ground cruising and recording of GPS points was made to check the accuracy of the image classification with the ground cursing.

Image classification of the different LU/LC types identified in BER was carried out by using ERDAS IMAGINE 9.2 software and ancillary information from Google Earth.

Finally, total LU/LC in ha (1) and percent LU/LC change in ha (2) were calculated from the following two equations respectively:

$$\mathbf{Tota\ LULCC} = \mathbf{Area}_{\mathbf{final\ year}}\quad \mathbf{Area}_{\mathbf{initial\ year}} \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\mathbf{Percentage\ LULCC} = \left(\frac{\mathbf{Area}_{\mathbf{final\ year}} - \mathbf{Area}_{\mathbf{initial\ year}}}{\mathbf{Area}_{\mathbf{initial\ year}}}\right) \times \mathbf{100} \ldots\ldots\ldots(2)$$

Based on the findings from the LU/LC analysis and information collected from KIIs, FGDs, ground cruising and government panel data; qualitative analysis of the key drivers and agent of temporal and spatial LU/LC changes in BER was carried out.

b) Policy and institutional analysis and retrospective assessment of effects in BER

Analysis of changes in land and NRM policies and governance institutions over different periods and the resultant effects of the changes in the institutional arrangements on the property rights of rural HHs and NRs conditions in BER were carried out by using two analysis tools. The first involved review of policies and institutions (formal and informal) governing land NRM in BER by the last three governments of Ethiopia and by the two recent Participatory NRM systems: i.e. the Imperial period (1930-1974), Derg period (1974-1991) and the EPRDF period (1991- 2016); and PFM and PRM.

As such, relevant legal provisions and regulations enshrined for land/NRM by the three governments and the two PNRM institutions were reviewed and analysed in tabular analysis and qualitative narration (detailed of the analysis is presented in the MSc thesis).The second analysis, which is more elaborated in this report, involved retrospective examination of the effects of changes in the policy and institutional frameworks on the property rights, access and use of NRs by rural HHs in the BER. The later also involved assessment and comparative analysis of the effects and contributions of the different institutional arrangements for sustainable NRM and biodiversity conservation in the Eco-region.

To that effect, information on various issues related to land and NRs ownership, management and use under the different institutional arrangements and government periods was collected from review of pertinent policy documents, findings of the current survey and GIS analyses and key informant score rankings. Alike the EPI score rating, KIs and elders in the 10 Kebeles were asked to elucidate and rate the property rights, possessions and legal access of resource by rural HHs under the different institutions and governance systems from 5 points (0=lowest, 5= highest). The KI score rating also included evaluation of land and forest management activities, participation and benefit sharing of local communities from NRM, state of biodiversity conservation, productivity and income from local farming practices, deforestation and illegal use of NRs. The KI recalling method along with historical facts thrown by the researchers to evoke memory of the KIs were used to retrieve information from the KIs.

Accordingly, the information collected from the above sources were sorted and weighted average score values were computed for each policy and institutional issue assessed (see annex X for results of the score ratings). Based on these results, illustrative trend graphs were produced and contextual policy analyses were made as shown in section 3.2.

c) Empirical Analysis and bio-economic modelling

A number of quantitative and economic analysis methods and tools were used to empirically measure and comparatively analyse the contributions and effects of different land management strategies and land use practices to farm productivity and environmental sustainability in BER. To that end analysis of: adoption rates and economic contributions of different land management practices, correlation analysis between land management practices and economic performance of farming; marginal cost and revenue of crop farming/ha, marginal cost and revenue of livestock rearing/ TLU (total livestock unit), average crop yield/ha, average livestock income/TLU/Year, total farm income/HH/Year, benefit-cost ratio of land use. In addition, smallholder farm HH level bio-economic modelling (Groot et al., 2012) was used to measure and determine the level of interactions (synergies and trade-offs) between economic outputs and environmental effects (EPI values) of different farming/land use practices in BER. Subsequently, the regression coefficients and farm level production function curves drawn from the bio-economic modelling were used to analyse the economic and environmental optimality and sustainability of different farming and land use practices of smallholder HHs in each agro-ecology.

d) Descriptive statistics

Besides the above major analysis tools, descriptive statists such as average values, percentages and bar graphs were used to analyse some important explanatory variables of the study including demographic and socio-economic characteristics of studied HHs in different agro-ecologies.

3 Findings from the study

3.1 Land use and land cover changes in time and space in BER

3.1.1 Characterization of major land use and land cover types in BER

The major land cover types observed in the Eco-region are forest, woodland, bushland, grassland and agricultural/settlement (Table 2).

Table 2. description of major land use/land cover types in BER

LU/LC types	Brief description
Forest	Areas that are covered with dense growth of trees with closed canopies. It was made to include human made plantation forest, riverine forests, dry ever green forest and moist mountain forest. The grouping of this land covers was necessary because it was difficult to differentiate one from the other as they had the same tone on the satellite image.
Woodland	Land that is covered with scattered woods especially with acacia vegetation and scattered trees mixed with grass, bushes and with some open areas. It also includes the scattered rural settlements found within the Woodland (Molla, et.al. 2010).
Scrub/Bushland	Includes land covered by Asta scrubland, alpine vegetation especially with *Helichrysum citrispinum* and land covered by small trees.
Grass/Rangeland	Both communal and\or private grazing lands that are used for livestock grazing. The land is basically covered by small grasses and herbaceous species. It also includes land covered with grass like plants and shrubs and it is used for grazing.
Agricultural Land / Settlement	Areas allotted to rain fed cereal crops (e.g. Corn, Barley, Teff, and Wheat), cash crops (chat) and horticultural crops particularly vegetables (e.g. onion, potato and cabbage) crop cultivation both annuals and perennials, mostly in subsistence farming. The scattered rural settlements included within the cultivated fields (adopted from Shiferaw, 2011).It also includes land covered by urban towns, rural villages and clustered rural settlements.

3.1.2 Temporal trends of land use and land cover changes in BER from 1986 to 2016

The land use land cover of BER is dominated by woodland, forest and agriculture/settlement over the period of 1986 – 2016 (table 3). Woodland and forest covered the largest proportion of Southern part of the Eco-region (i.e. Harena Bulluk, Dello Mena and Medda-Wolabu). Water and scrubland/shrubland covered the smallest area of the BER over the last 30 years.

Table 3. Land use/land cover types in Bale Eco-region (1986 – 2016)

LU/LC category	1986		1996		2006		2016	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Water			2,455	0.2	2,401	0.2	1,121	0.1
Agriculture/settlement	270,976	17.2	341,976	21.7	375,476	23.8	444,345	28.2
Woodland	565,147	35.8	468,033	29.7	391,229	24.8	268,455	17.0
Forest	463,987	29.4	410,872	26.1	436,046	27.6	378,803	24.0
Scrubland/bushland	110,523	7.0	140,366	8.9	166,845	10.6	163,247	10.4
Grassland/rangeland	166,435	10.6	213,367	13.5	205,071	13.0	321,097	20.4

With regards to trends of land use land cover change (Fig 2), woodland showed the largest decline with a rate of decline of about 10,000 ha/year which is equivalent to about 2% of its area in 1986. This was followed by forest which was losing an estimated 2879 ha/year which is 0.6% of its area in 1986. Agriculture/settlement showed the highest increase inclining by an estimated 5779 ha/year in the period from 1986 to 2016 indicating an average increase by about 2% in relation to its area in 1986 every year.

The observed trends (see also Fig 2) in land use land cover change was not similar for forest in the different periods for the 30 years considered for this study and the explanation as understood from interviews and secondary sources also vary for the dynamics in each land use category. Forest area showed a slight decline from 1986 to 1996 and slight increase from 1996 to 2006. The increase in forest area in the later period is due to plantations established mainly in different parts of Goba, Dinsho and other highland Districts of the BER. Woodlands suffered a dramatic decline all over the 30 years period.

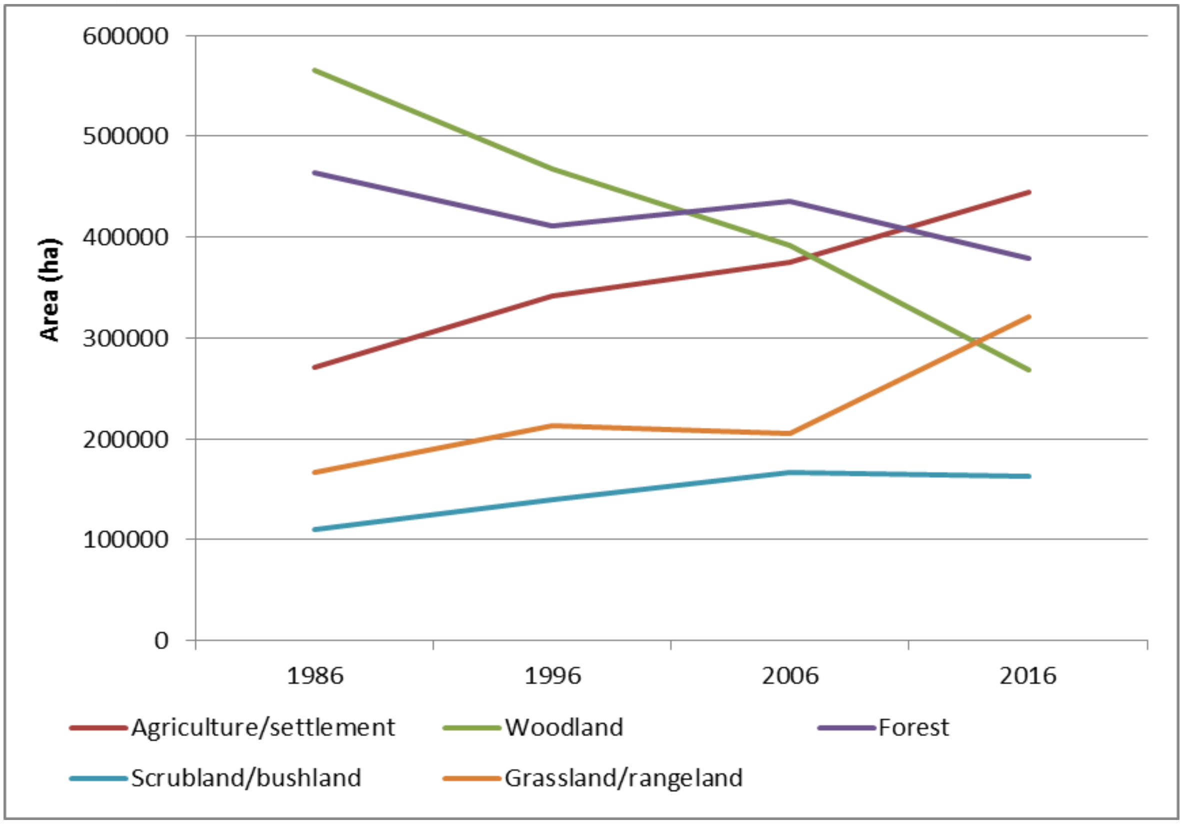

Figure 2. Trend of land use land cover change in Bale Eco-Region from 1986 to 2016.

It was understood that this was due to the influx of legal (government-initiated resettlement programs from Harrerge) and illegal migrants and settlers along the mid altitude (Harena-Buluk, and lower (Delo Mena) altitudes of the Eco-region. According to the data derived from Focus Group Discussion (FGD) and Key Informant Interview (KII), the immigration (legal and illegal) into the Eco-region coupled with the natural population increase (Figure 3) brought about an increase in agricultural land and at the expense of largely the woodland and also the forest of the area as also observed in the trend analysis. According to the informants on top of the legal settlement, high fertility rates due to traditional and religious practices of local communities such as early marriages and polygamy and legal and illegal migration from the neighbouring zone of Southern region (i.e. Sidama Zone) and from other zones of Oromia (North and West Shewa, East and West Haraghe and arid areas of Arsi) accounted for the population increase in the Eco-region.

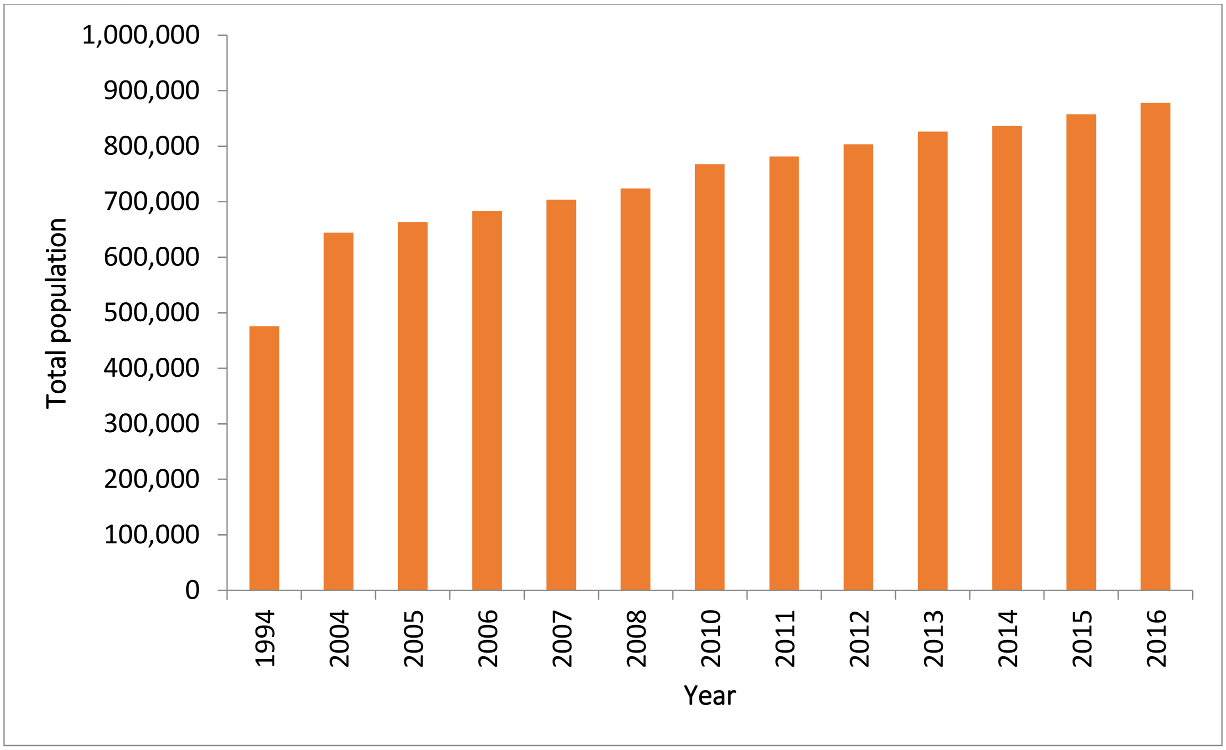

Figure 3. Trend of human population in seven Districts of the Eco-region (data from CSA, 2008).

Note: Due to the data gap from the central statistical agency (CSA) total population for the years between 1995-2003 and 2009 were not available for use.

The rate of increase in population varies between the areas found under the different altitudes in the Eco-region (Figure. 4). As can be witnessed from the following figure, there is higher rate of increase in population in Dello Mena and Harena Buluk Districts than Adaba District.

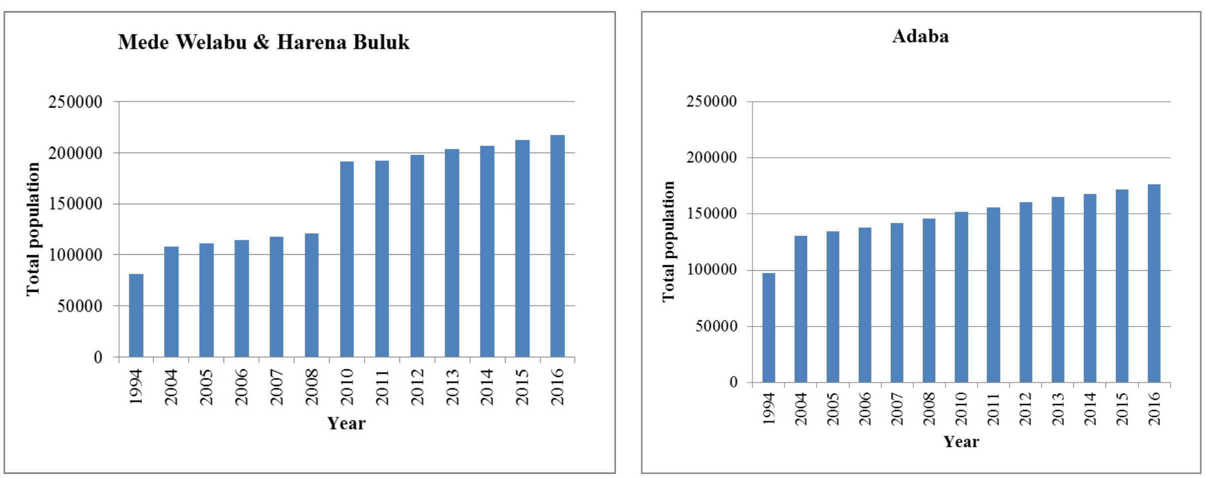

Figure 4. Differences in population increase in Districts within Bale Eco-region (data from CSA).

Note: There is a big jump between 2008 & 2010 in Delo Mena and Harena Buluk Districts. This might be due to the fact that prior to 2010 these two Districts were administered as one District and it was starting from 2010 these two Districts administered as a separate Districts.

The land use land cover map of 1986 (Fig 5) showed that settlements and agricultural lands were found on the northern parts (higher altitude) of the Eco-region (Dinsho, Goba, and Adaba Woreda). However, as it is indicated on the subsequent maps of 1996, 2006 and 2016, these two land use /land cover types have greatly expanded to the Southern and South-Eastern part of the eco-region (i.e. Harena Buluk, Dello Mena, and Berbere Woreda). This is in line with the differential trend of population increase in the Eco-region (see Fig 3 above)

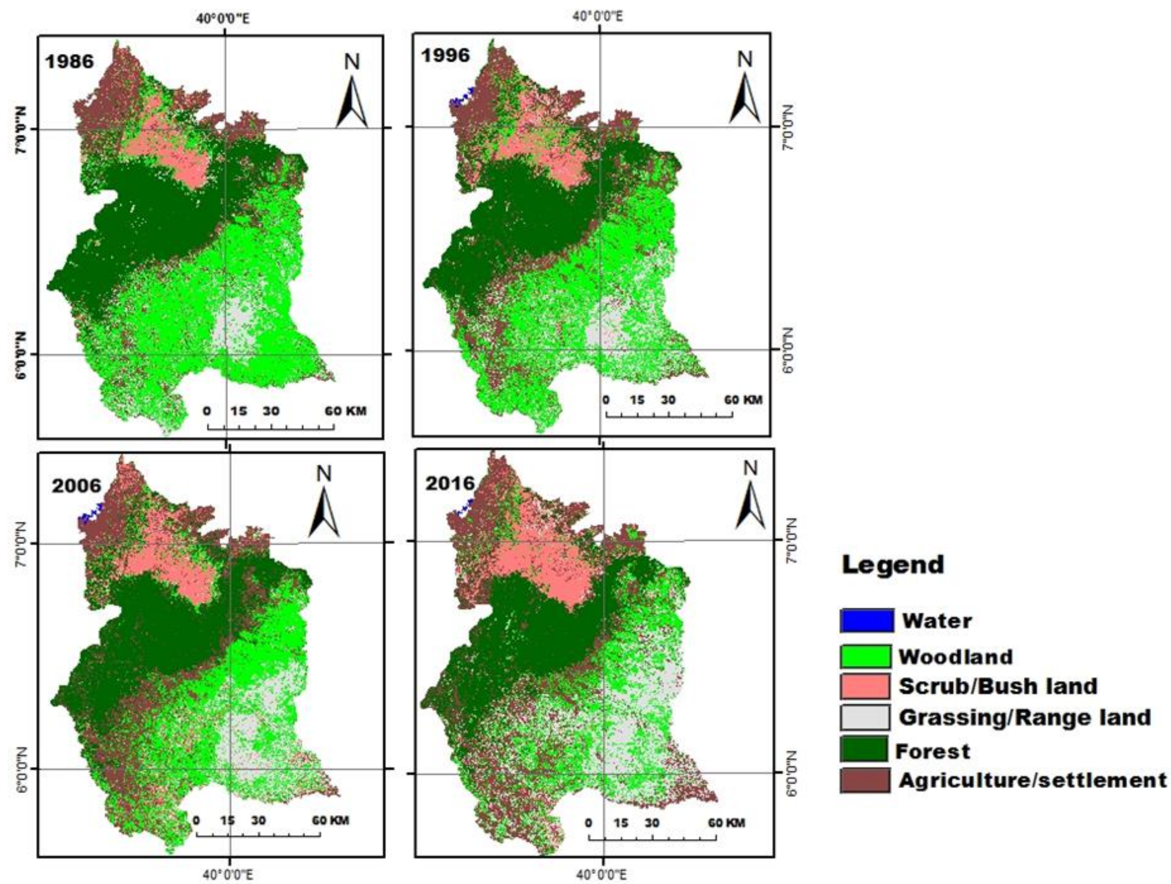

Figure 5. Major land use/land cover types in different periods at the Bale Eco-region

3.1.3 Land use land cover change under different institutional set up in Bale Eco-region.

The land use land cover change analysis under different institutional arrangement between 2006 and 2016 shows a similar trend of decline in forest/woodland cover and increasing agricultural land (Table 4) except under PFM and PRM where negligible change was observed. However, there is a variation in rate of change (ha/year). The woodland under the District administration in Berak Kebele showed the highest decline of 572 ha/year followed by a decline of 394 ha/year in Rira Kebele which is under the National park. The forests under PFM showed the lowest rate of decline as compared to the other institutional arrangements studied. Comparing Rira and Wajitu-Shabe Kebeles which are both in the same altitude but under National park and PFM respectively, the forest under the park is diminishing at a rate of about 28 times as compared to the forest in the Kebele under PFM. In contrast, grassland showed the highest decline under Wajitu-Shabe and Shawe Kebeles which are under PFM institutional arrangement.

Table 4. Land use land cover change under various institutional set up in Bale Eco-region.

Kebele Name	Agro Ecology	Instutitional type	LU/LC category	2006-2016		
				ha	%	ha/year
Tosha	Hightland	Wereda admin	Agriculture	272	28	27
			Forest	-375	-36	-38
			Grassland	103	38	10
WagituShabe	Hightland	PFM	Agriculture	559	86	56
			Forest	-139	-7	-14
			Grassland	-418	-54	-42
Rira	Hightland	National Park	Agriculture	2904	70	290
			Forest	-3945	-13	-394
			Scrub/bush land	1033	3	103
Hawo	Midland	National park, PFM & wereda admin	Agriculture	1642	30	164
			Forest	-1491	-6	-149
			Grassland	-163	-20	-16
Shawe	Midland	PFM	Agriculture	2453	39	245
			Forest	-217	-3	-22
			Grassland	-2231	-79	-223
Berak	Low land	Wereda admin	Agriculture	2759	7	276
			Woodland	-5722	-5	-572
			Rangeland	2987	6	299
Nani_Gadira	Low land	PRM	Agriculture	273	59	27
			Woodland	21	0	2
			Rangeland	-297	-5	-30

3.1.4 Drivers of deforestation and forest degradation in Bale Eco-region

The output of discussions and interviews as well as land use/ land cover analysis showed that various proximate and underlying causes are playing role as drivers of deforestation and forest degradation in Bale Eco-region.

Proximate/direct drivers

Agricultural expansion

Agricultural activities that induce land use change includes crop farming both small-scale cultivation and commercial farming. Cash crops like chat farming and coffee cultivation is also expanding in the Eco-region. Small scale farming is the dominant driver of change in Districts like Dinsho, Goba and Delo Mena. For instance in Dinsho District a number of hills which were previously covered by small grass, bush and forests have been converted to small scale crop farms. Chat and forest coffee farming are the major drivers of forest and grassing cover change in Harena Buluk District and in the highland Kebeles of Delo Mena District. Range lands in lowland Districts like Delo Mena are converted to commercial crop farm. For example according to the information obtained from participants of the FGD in Delo Mena Woreda, very vast areas of range lands were converted to commercial crop farming Berak and Ayoda Kebeles. Part of the huge decline in woodland of the Eco-region is also attributed the practice of shifting cultivation being exercised in different parts of the woodland. This has contributed to the transition of woodlands to rangelands creating huge openings in woodland after cultivation is abandoned.

Over grazing

There is a huge population of livestock both in the woodland and forested Districts of the Eco-region. Due to this, there is effect forest degradation mainly in the lowlands through browsing and trampling. In some areas, bush clearing is also practiced to reduce the completion of woody vegetation with grass and in this case some species are selectively cut causing degradation.

Illegal logging and fuel wood extraction in the form of *charcoal and fire wood* is also a major driver for the distraction of forest and wood lands spatially in Goba and Delo Mena Districts. Urban expansion and construction of infrastructures like schools and roads: Expansion of urban areas like Delo Mena, Angetu and Bidire Towns in the expanse of forest and woodlands.

Fire: occurrence of fire is one of the major proximate causes of LU/LCC next to agricultural expansion. Several fire incidents occurred in the BER causing destruction of forests and woodlands. In the national park alone about 142 fire incidents were occurred between1999-2008 (Abera & Kinahan, 2011). These fires caused loss of a total of 38, 15ha of woodland, mountain forest and Erica shrub. However the 1983/84, 2000 and 2008 fires were the worst fires in the BER. The fire occurred in 1983/84 destroyed about 195 km2 (Belayneh et.al. 2013) of vegetated lands in different parts of the Eco-Region, while the 2000 fire destroyed approximately 20,000 hectares (ha) of moist evergreen forest (Wakjira, 2013). On the other hand the 2008 fire destroyed 12, 825ha of vegetated land in the Eco-Region (Belayneh et al. 2013). Out of the 12, 825ha destroyed by 2008 fire, about 11,972 ha or 93.35% were destroyed within the intervention Districts. According to participants of FGD the ignition source of nearly all fire occurred in the eco-region were human via illegal hunting, honey harvesting (in which smoke is used to protect the beekeepers) and farm land clearing. It was also explained that afro-alpine scrub lands were being burnt over the years to get fresh grass for livestock.

Underlying causes

- Demographic factors: Population growth – Migration of peoples from various areas of the country (described above) and natural increase of population in the Eco-region are major underlying cause of the deforestation and forest degradation;
- Economic factors: poverty and food insecurity, unemployment, Change in rural economy and opportunity to drive high economic benefits from the sale of cash crops such as coffee and chat as well as from illegal extraction of natural resources;
- Technological factors: road networks, access to markets and the opening of forest areas through increased road construction and change in farming technologies (from hand tool (locally known as Haarkoo) to animal power and further to tractors);
- Policy & institutional factors: Villagization/expansion of settlements and agriculture; privatization of communal lands were carried out; Lack of proper land use plans and Policy; low investments in management and protection of natural resources such as forests,

woodlands and range lands as compared to other investments (e.g. investment on agriculture) and Change in land tenure system;

- Social and cultural factor: Resource use competition among non-migrant local communities and between migrant communities, and;
- Biophysical (natural) factors: climate variability and drought.

3.2 Institutional changes and natural resources management in BER

3.2.1 Institutional changes and property right arrangements over natural resources

Results of the retrospective analyses of land and NRs policy and institutions in BER showed that the property rights of rural HHs to access, own and use land and land resources has substantially changed over the last three government regimes of Ethiopia (Fig. 6). During the imperial period (1930-1974), land was a private property though much of the land in Ethiopia was owned by few landlords or associates of the feudal system in the form of 'gult', 'rist' whilst ordinary farmers had very small actual landholding sizes (elaborated in details in the MSc thesis). Despite the feudal ownership of large portions of land in the country during this period, ordinary rural HHs in BER had the full ownership and use right of significant size of land including the right to sell and transfer their landholdings. As a result many of the farmers in the present BER were owners of more than 1 ha of land as was confirmed by local elders and KIs interviewed.

However, the land ownership and use rights of rural HHs during the imperial period had also some limitations such as restrictions on expansion of private landholdings and tenure insecurity over the land owned to a lesser extent. In addition, HHs in BER were not allowed to use forests under the ownership and protection of the state as was the law in the country in general. As a result, these restrictions had at times led to infrequent conflicts between the state and community as shown in fig 8. Yet, the productivity and quality of land was very good during this period according to KIs and FGD participants. The reasons were the relative intactness of the land and smaller human population of the area back in the days. As a result, the *'real income'* (as opposed to nominal income) of rural HHs from crop and livestock production per unit of land was more than satisfactory to support their family according to the KIs and FGD participants.

When asked to elaborate what they meant by higher 'real income' in the imperial period, the KIs justified that 'during the Imperial period the land was productive and farm production costs were relatively very small. Indeed the income we get from selling a quintal of barley in those days was small in numeric value but that small money had very strong purchasing power. Hence the actual income (economic worth) of the HH from farming was more than adequate to support his family. In contrast today, the productivity of the land has declined and hence we incur a lot of costs for farm production inputs such as for inorganic fertilizer and pesticides. We are getting higher crop yield per ha today and the amount of money (nominal value) we earn from selling a quintal of barley is much higher when compared to the Imperial and Derg periods. However, much of this income we earn is spent back to cover production costs. Moreover, the purchasing power of the money we earn is low and hence our real income (economic worth) from farming may not even suffice to support our subsistence needs.'

The overthrow of the Feudal system by the military Derg regime in 1974 brought fundamental changes to the land ownership and use right arrangements of farmers in the BER and the country in general.

The most notable change was the 1975 land proclamation commonly known as the *'Land to the Tiller' decree* that unprecedentedly brought all lands and natural resources in the country under absolute state control. The new proclamation unequivocally vested the ownership of all lands and land resources in the country to the Ethiopian state/government while rural HHs were given the right to use the land they are tilling. The land proclamation was soon followed by a land redistribution proclamation to effect the land policy. According to the KIs and literatures reviewed, the new land policies and laws of the Derg brought two fundamental changes on the property rights of rural HHs to land and NRs in BER. On one hand the land decree significantly increased the landholding sizes of many rural HHs in BER. On the other hand, the proclamation effectively outlawed the private ownership right of land by rural HHs what so ever. Above and beyond, the absolute ownership of all lands by the state abolished the private and all other forms of land property right arrangements that existed during the imperial period.

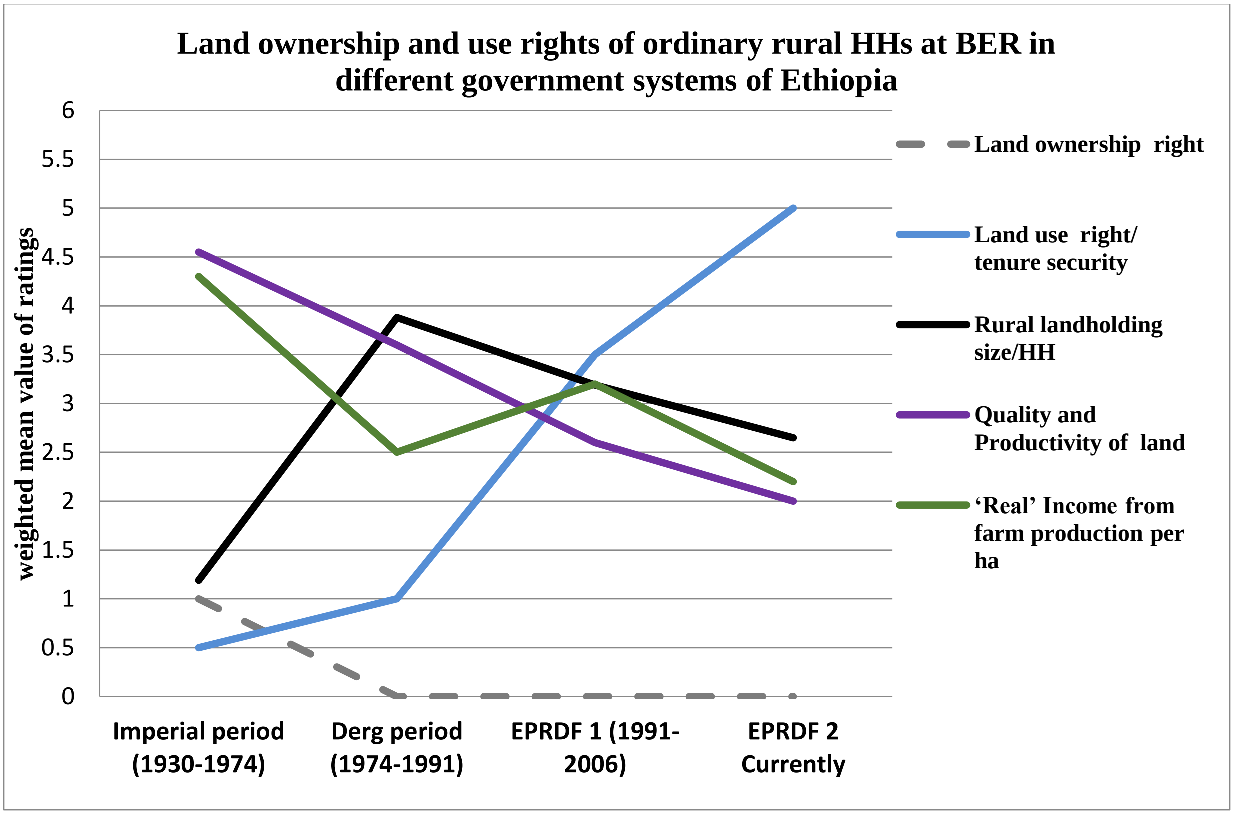

Figure 6. Land ownership and use rights of HHs at BER in different government regimes

The new land and NRs property right systems of the Derg had also led to changes in the state of forest and biodiversity management in BER. According to elders interviewed, the abolishment of the private land ownership institution and the redistribution of more land (including forest areas) to smallholder farmers by the Derg led to degradation of some valuable forest and biodiversity resources of the BER. The state control of all land and forests has also led to restricted private tree planting and use in the BER (fig 6,). Moreover, the new land property right arrangements of the Derg brought little improvement to the land tenure security of rural HHs in BER as one elderly KI in Goba District stated *"if the land is not ploughed in one month it will be taken away by the government (Derg) and given to other farmer who has oxen to plough it."*

However, the forest and biodiversity degradations observed in the early days of the Derg period were later backed by extensive state tree planting and afforestation programs in many parts of the country including some highland areas of the BER. The state afforestation programs were also accompanied by strict protections of forest and biodiversity resources in BER and the country through strong state law enforcement as shown in fig 7.

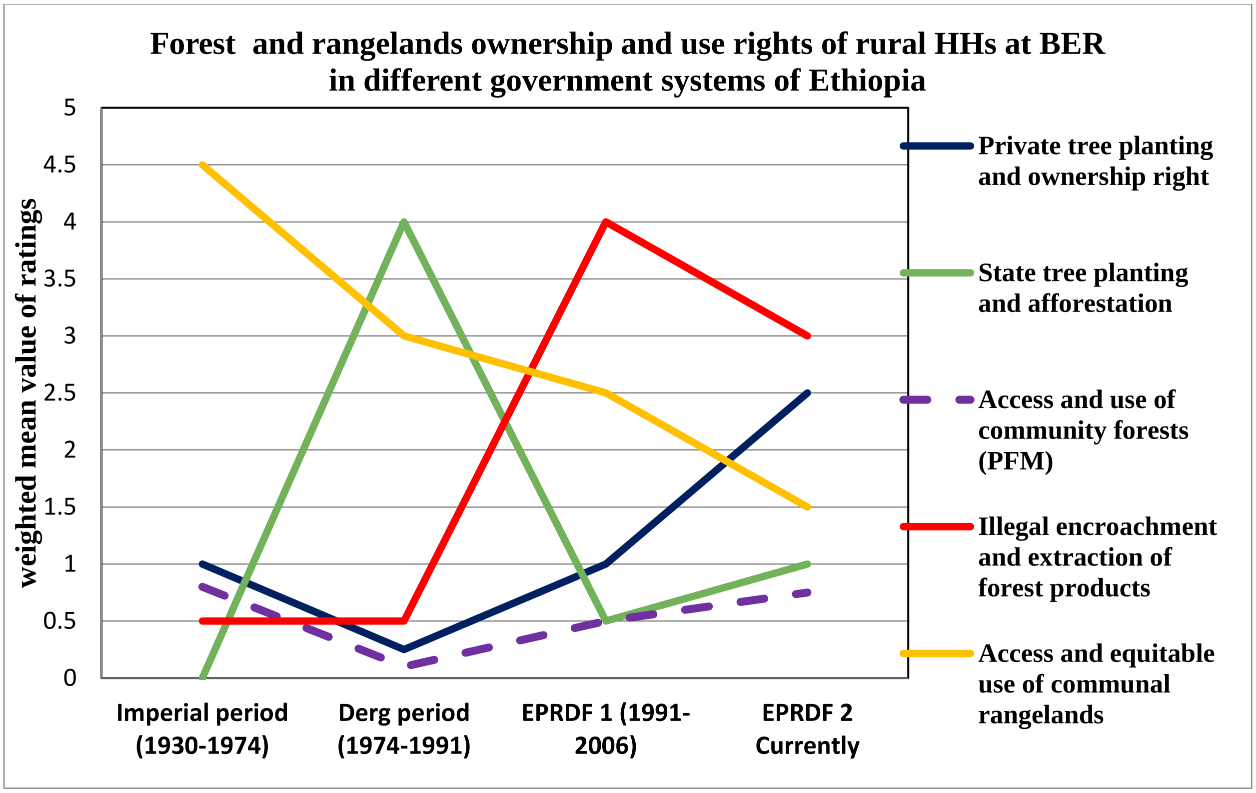

Figure 7. Forest/rangelands ownership and use rights of rural HHs in different government periods

The coming to power of the EPRDF government in 1991 was in most respects the continuation of the state ownership of land and forest resources in the Derg period although some notable changes were introduced. Article 40 of the 1995 constitution of the EPRDF government (which provides for property rights) declared that 'the right for ownership of rural and urban land as well as all natural resources is exclusively vested in the state and in the people of Ethiopia'. Pursuant to the 1995 constitution, "Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or other means of exchange." Hence, farmers have the right to use the land indefinitely, lease it out temporarily to other farmers and transfer it to their children but cannot sell it permanently or mortgage it.

The indefinite land use right given to rural landholders which was followed by the issuance of landholding certifications by the current EPRDF (reaffirmed by the 2005 land administration proclamation) sizably increased the land tenure security of rural HHs in BER (fig 6). However, the continued state control of land and land resources coupled with the weak law enforcement capacity of the state led to open access of forests and biodiversity resources in the BER during the early days of the EPRDF government. Aggravated by rapid population growth and demand for more agricultural land, forest and biodiversity resources of the BER were facing widespread illegal encroachment and extraction by smallholder farmers and agro-pastoralists for economic reasons particularly between 1991 and 2006. According to KIs the increased conflict over access to natural resources (which often have led to deforestation and degradation of biodiversity rich ecosystems in BER) during the EPRDF period was due to following underlying causes:

1) Rapid population growth and declining landholding sizes of HHs; illegal immigration and settlement in forest and communal woodlands leading to turf competition over NR's;
2) 'Unfair' state ownership and inequitable/restricted access to natural resources under state protection such as BMNP;
3) The devolution of the customary land and NRs administration institutions and systematic replacement of the same by formal state institutions;
4) Privatization of communal rangelands by the rich and elites along with expansion of large-scale investment in communal lands; and
5) Poor economic returns of forest and biodiversity conservation under state control intertwined with declining land productivity and limited livelihoods diversification.

In the mid-altitude and lowland areas of the BER in particular the increased scarcity of land and natural resources amid swelling human population has contributed to the sharp increase in inter community conflict over natural resources during the current EPRDF period (fig 8). In the same fashion, restrictions on access and use right of rural HHs over state lands and forests have led to increased state-community conflict during the same period (fig 8).

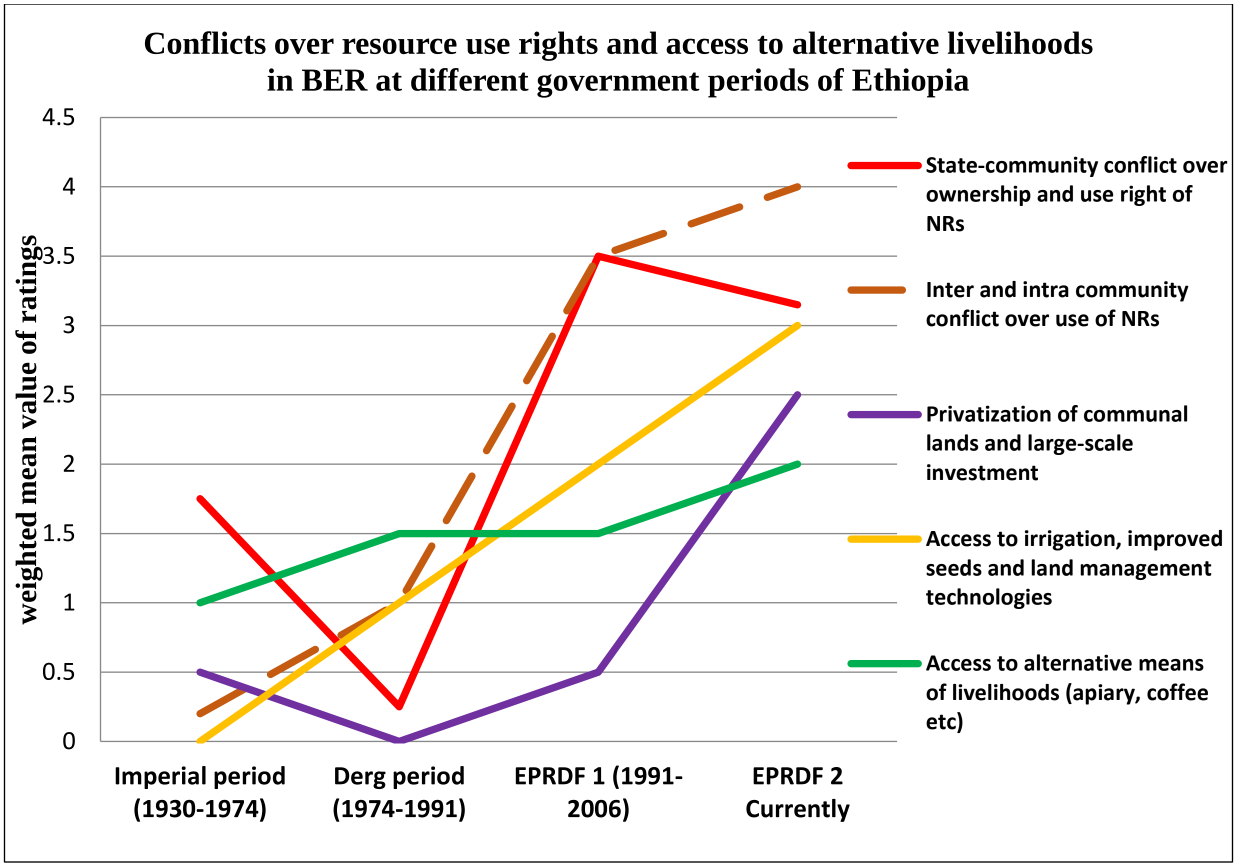

Figure 8. Conflicts over resources and access to alternative livelihoods indifferent governments

However, the EPRDF government is distinguished from its predecessors for implementing new institutional systems regarding the management of natural resources and participation of local community in NRM decision makings. As demonstrated by the results of the mean score values in figures 8 and 9, the EPRDF government was able to formulate new rural land policies and institutions that delegate power to regional governments for rural land administration (rural land administration proclamation No. 89/1997).

Following the 2005 delegation of power to the regional states by both federal government, the Oromia regional state issued the "Oromia Rural land Use and Administration Proclamation No. 56/2002" which was amended by proclamation No. 70/2003. The regional land proclamation states that 'the task of administering land will be carried out based on public participation'. The proclamations of both the federal government and the Oromia regional state have recognized community forests (under Kebele administration) and participatory management of forest and biodiversity resources..

Similarly, the Environmental Policy of Ethiopia issued in 1997 provides an adequate umbrella strategic framework, detailing principles, guidelines and strategies for the effective management of the environment. It also elaborates state of resource bases of the country, as well as the institutional arrangement and action plans for the realization of this strategy a policy document initiated in 1989 and approved in 1997. The Forest Development, Conservation and Utilization Proclamation No 542/2007 of the federal government in particular underpins that the sustainable utilization of the country's forest resources is possible through ensuring the participation and benefit sharing of local communities. Article 9(3) of the same Proclamation stipulates that forest development; conservation and utilization plans shall be formulated to allow the participation of local communities in the development and conservation and also in the sharing of benefits from the development of state forest.

In addition to formulating the above policies and legal frameworks, the EPRDF government of Ethiopia and the Oromia regional state have prepared and implemented a number of agricultural and rural development strategies and NRM approaches. The goals are to improve the livelihoods of rural HHs and productivity of land while maintaining the continued provision of ecosystem services from forest and biodiversity resources. Some of these development activities included: integrated watershed management, improved land management practices, farm production technologies and inputs, small-scale irrigation, improved access to market, credit and extension services along with diversification rural livelihoods especially after 2006.

After 2006 in particular, the government of Ethiopia and Oromia region have made considerable effort to create enabling policy and institutional frameworks for embracing and implementing sustainable and participatory natural resources management (PNRM) schemes in collaboration with national and international NRM organizations. This has contributed to the implementation of new and joint forest management initiatives for sustainable biodiversity management in BER over the last few years. Some of the PNRM initiatives in BER included: PFM/PRM projects of SHARE, REDD+ (Reduced Emissions from Deforestation and Degradation) of OFWE (Oromia Forest and Wildlife Enterprise). As a result access and benefit-sharing of local communities from PNRM schemes as PFM and PRM has shown positive progresses after 2006 (fig 6). Similarly, private tree planting by rural HHs has increased after 2006 while illegal encroachment and deforestation of state and community forests has declined over the same period compared to the pre-2006 EPRDF period. Albeit the recent encouraging trends highlighted above, the sustainable management and use of natural resources in the BER is still faced with some severe challenges. In particular, impacts of population pressure and rising inter and intra-community conflicts over access to the already shrunk land and land resources as shown in fig 8.

Examining the overall trends of forest and biodiversity conservation and use in the BER over the last three governments of Ethiopia (in light of the respective policies, strategies and institutional arrangements) has revealed the trends shown in figure 9. According to the results, the different land and NRs governance, administration and use policies and property right institutions of the three government regimes have rendered varying positive and negative influences on sustainable management and use of the biodiversity resources of the Eco-region.

For the most part, many of the influences of the changes made to the land and NRM policies and governance institutions by the different governments of Ethiopia were typically countrywide. However, some influences of the institutional changes were different and peculiar to the BER in many ways. One important reason was that, land resources in much of the Bale state (particularly in the pastoral lowlands) were historically governed by customary Gadaa system. Though the Gadaa system might had its own limitations (as some argue), it had well-built NRs governance and administration institutions that were effectively implemented through socially-entrenched power and responsibility sharing structures. As a result, management and use of land resources in (lowlands) BER was more sustainable and equitable under the customary system. The systemic devolution and replacement of the Gadaa institutions by ‘imposed’ state institutions from the successive government regimes of Ethiopia has thus led to the total loss of some critical roles of the customary institutions for sustainable NRM in BER.

Another reason was that, rural communities in Bale state had two long-established means of livelihoods: crop farming in the highlands and pastoralism in the lowlands. The natural resources use interaction and interdependence between the two communities (highland and lowland) was traditionally guided by the principles of mutual benefiting and cooperation. As such, protection of forests and biodiversity resources of the Eco-region was not the interest of one segment of the society only. The state-initiated human settlement, and illegal immigration and settlement of people from other areas with new livelihood strategies into the BER (during the EPRDF periods) led to the disruption of the traditionally shared NRM responsibilities of the local communities. As a result, land resources become scarcer and conflicts over access and use of NRs sharply rose following the settlements and illegal immigration.

Another important reason could be linked to the natural resources endowment of Bale, and the apparent failure of the different government institutions to recognize the unique biodiversity of the area and strike balance between local economic needs and sustainable NRM. Local farmers, in the historically breadbasket region of Bale, are now challenged by swelling human population, land degradation and declining land holding size and farm productivity. At the same time, Bale is home to valuable natural ecosystems with immense global and national significance; hence its sustainable management is indispensable amid rising climate change impacts.

However, findings of this study showed that most of the policies and institutional arrangements of the federal and Oromia regional government do not have separate and customized strategies to deal with the unique situation of the BER. Except the few recent initiatives, much of the land and NRs governance in the BER is pursued by the same institutions designed for administering lands in the country at large. This lack of locally customized NRM and use institutions recognizant of the distinct problems facing the BER has contributed to the differing outcomes of state policies and institutions from successive governments in the BER compared to other areas.

In light of the above reasoning for the differing influences of land and NRs governance policies and institutions in the BER compared to other areas in Ethiopia, the overall trends of effects of changes in land/NRs policies by successive governments to the BER is summarized hereunder. During the imperial period, biodiversity conservation was relatively good for all rural lands and forests had clearly defined owners (state, private, communal, etc.). Non-owners were unable to access forests without the permission of its owner thus effectively criminalizing and banning illegal encroachment and tree cutting. During the same period the expansive woodlands used as communal rangelands were administered by the customary Gadaa institutions.

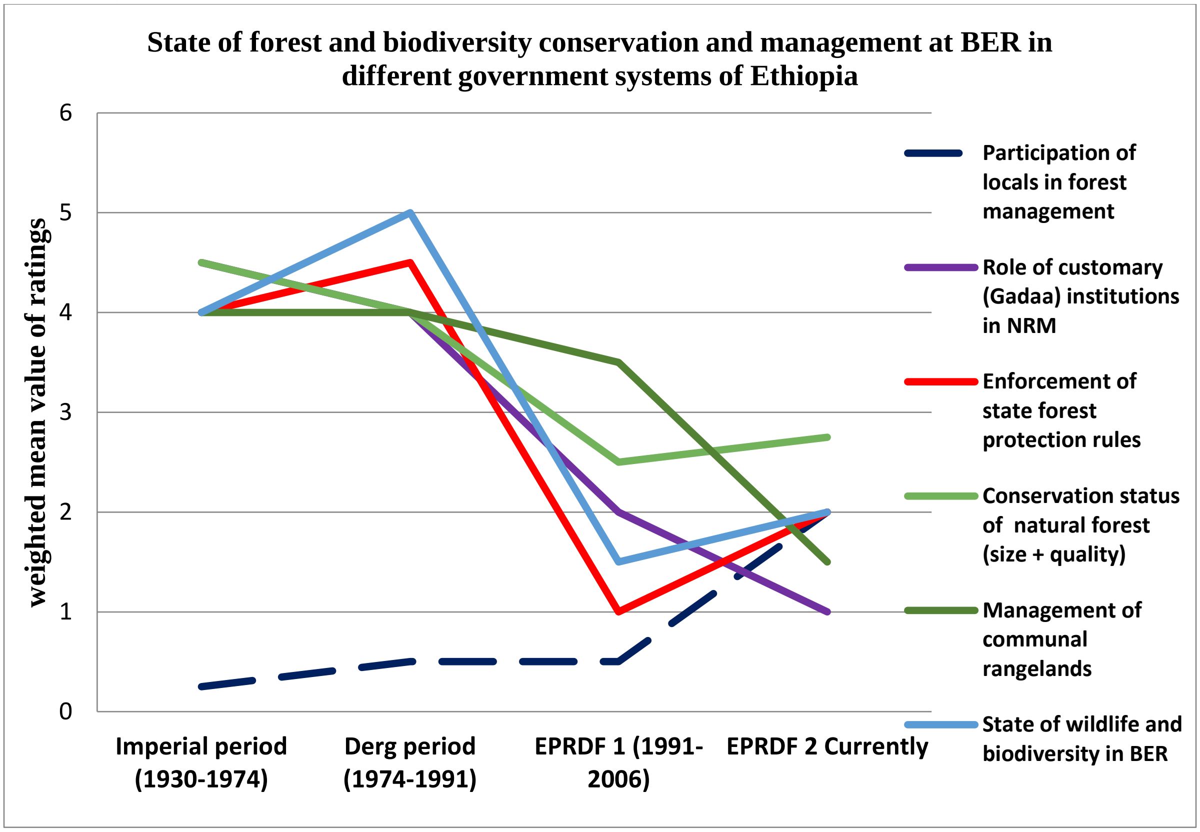

Figure 9. Trends of forest and biodiversity conservation at BER in different government periods

In contrast, Derg assumed all ownership of land resources and redistributed land to HHs in effect expanding smallholder agriculture and landholding sizes per HH. Enforcement of state forest protection rules was the highest while the customary institutions were fading. Asa result, the conservation of forest and biodiversity resources in most parts of the BER particularly in the highlands and midlands was the highest during the Derg period. In contrast, the first 10-15 years of EPRDF were periods of de facto ‘open access’ of forest resources and the capacity of the state to enforce forest and wildlife protection laws was very limited. During the same period the role of the customary Gadaa institutions was increasingly weakened or deliberately bypassed by the state and regional government.

The result was sharp decline in the area cover and conservation of forest and biodiversity rich ecosystems in the highlands vis-à-vis privatization and conversion of vast communal rangelands and woodlands in the mid and lowlands of the BER. After the introduction of participatory land administration and NRM initiatives by the regional governments and establishment of PFM and similar schemes some improvements are observed in the state of forests and biodiversity management in the eco-region. Yet, the new participatory NRM institutions appear to face new challenges from the economic trade-offs for ordinary rural HHs in the BER.

3.2.2 Comparative analysis of NRM and use in different institutions at present in BER

Within the umbrella of the 1995 constitution of the FDRE (which vested the right to ownership of all lands and natural resources exclusively in the state and in the people of Ethiopia) and the amended

'Rural land Use and Administration Proclamation No. 70/2003"of the Oromia regional state which underscores the principle of administering rural land and natural resources based on public participation; current administration of land and natural resources in BER falls under four different institutional arrangements i.e.:

1. Federal/Ethiopian Wildlife Conservation Agency (Bale Mountains National Park);
2. Oromia regional state government (Zone and District administrations),
3. Participatory Forest Management (PFM) implemented by SHARE, OFWE, REDD+;
4. Participatory Rangeland Management (PRM) implemented by regional gov+ customary leaders joint committee or 'Koree' under the facilitation of SHARE and other initiatives.

In light of the four institutional arrangements, participatory assessment and comparative analysis of the provisions and effects of each institutional arrangement on the property and use right and benefit sharing of rural HHs from the NRs was carried out as presented in table 5. Consequently, the resultant influences of the institutional arrangements on NRM and biodiversity conservation in BER was analysed (see table 4 for sample Kebeles from each institutional arrangement).

From the participatory assessments and ratings; local HHs right to access and use land and NRs, income from crop and livestock production, participation and benefit sharing from biodiversity conservation as well as state of land and NRM have all shown substantial variations among the four institutional arrangements. Keeping aside the likely influence of factors external to the institutional arrangements, the results in table 5 show that average landholding size/HH, crop yield/ha, livestock holding/HH and HH net income from farm production are all significantly higher for HHs under regional and federal land administration. In contrast HHs under PFM and PRM own lesser land and livestock holding, and made significantly lower net income from crop and livestock production per year.

The relatively higher crop yield/ha, livestock holding/HH and total farm income/HH for HHs under regional and federal government institutions compared to those under PFM could suggest that agricultural practices and land uses that better conserve biodiversity have presumably compromised the natural capital holdings and associated economic gains of the latter HHs. The interpretation of these results however should also be recognizant of the potential influence of factors related to local agro-climatic conditions and farming practices besides the institutions.

In contrast, the higher crop yield/ha, livestock holding/HH and the associated higher total farm income/HH/Year for HHs under the regional administration (in the highlands in particular) could be related to the higher landholding sizes and environmentally costly mono-cropping activities of these HHs. Besides the mono-cropping, the less restricted access of natural resources and grazing lands from state and community forests by these HHs is contributing to unsustainable use of land and biodiversity resources in the Eco-region.

On the other hand, analysis of diversification of local livelihoods among rural HHs in the four institutional structures has shown differing results. Farmers and agro/pastoralists in Kebeles under PFM and PRM are engaged in more diverse and environmentally friendly (biodiversity-smart) income generation activities and NTFPs utilizations. The most important green income sources identified were: forest-coffee production, fruit and cash-crop production, apiary, forage development, cut and carry of grass, income from seasonal rent of grazing parcel (range) for livestock herders from adjacent

Districts and petty trade. These alternative income sources were additional livelihood strategies to the common crop-production, livestock production, and crop-livestock mixed farming practices of rural HHs in the areas.

In contrast, HHs in Kebeles under the federal and regional government institutions are engaged in less diverse livelihood strategies of mainly crop production and livestock production or crop-livestock mixed farming (fig. 10). As a result, the total income of HHs from alternative green income generation activities was highest in PFM and PRM with an average income of 1,287 Birr/HH/Year and 669 Birr/HH/Year respectively. Expectedly, the average total income of HHs in federal and regional institutional arrangements from green income sources and NTFPs were smaller with average income of 385 Birr/HH/Year and 312 Birr/HH/Year respectively.

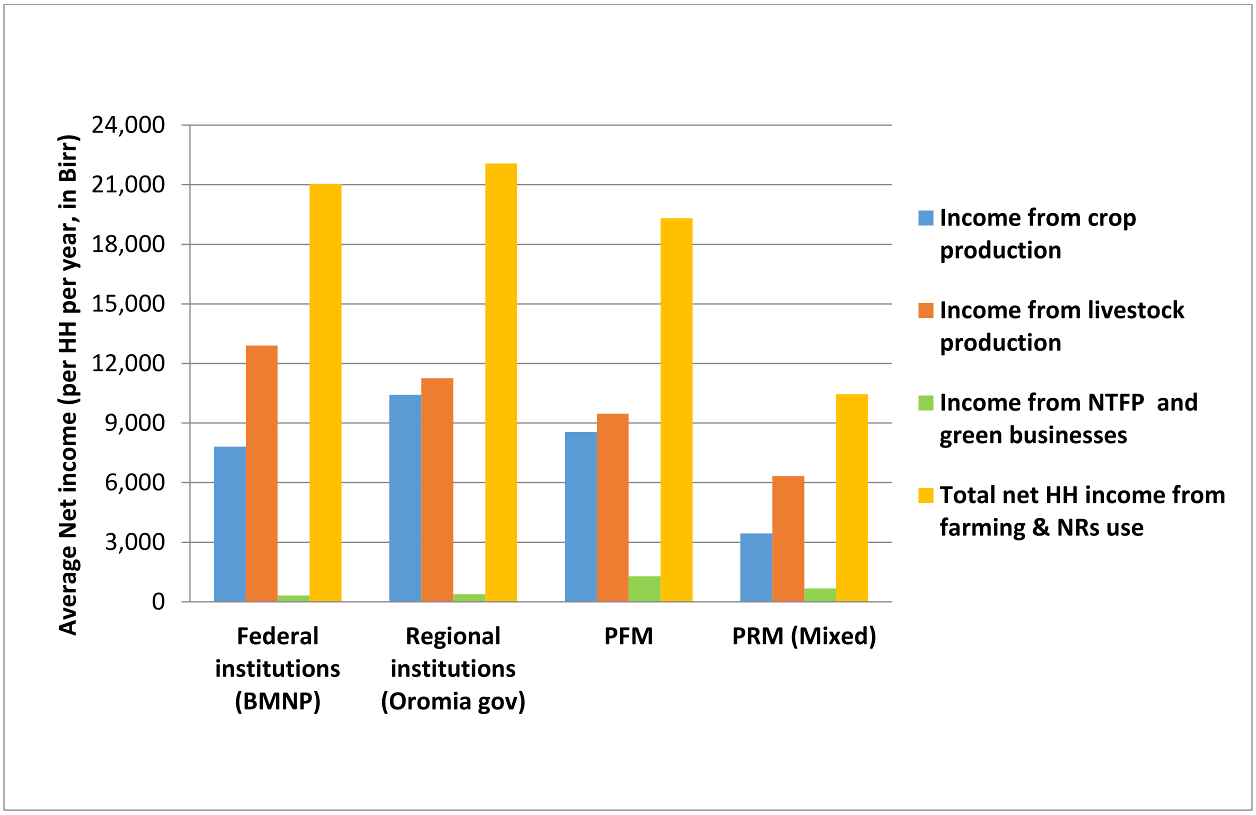

Figure 10. Average income of HHs under different institutions in BER today in Birr/HH/Year

Table 5. Average assessment values and participatory ratings of land and NRM and use conditions by local HHs under different institutional arrangements that currently exist in BER

No	Land and NRs management and local use	State (BMNP)	Regional Government (Oromia)	PFM/ REDD+	PRM (Koree)
1	Av. total landholding size in ha/HH	2.01	2.56	2.15	1.74
2	Av. Livestock holding size in TLU/HH	3.07	10.97	5.22	8.51
3	Av. Food crop yield in quintal/ha	17.83	26.63	15.90	8.25
4	Av. Total income from cropping in Birr/HH	7,814	10,425	8,558	3,445
5	Av. Total income from livestock in Birr/HH/Year	12,910	11,255	9,466	6,333
6	Av. Total income from alternative green income sources and NTFP businesses in Birr/HH/Year	312.5	385	1,287.5	669.5

7	Total net income from land & NRs use in Birr/HH/Year	21,036	22,066	19,312	10,448
8	Access and use right on forest/rangelands	0.75	1.53	2.82	2.99
9	Range quality and forage availability	1.22	1.72	2.30	3.51
10	Access to market and credit services	2.22	3.27	2.88	2.51
11	Livelihood diversification -income source	2.0	2.5	7.0	4.0
12	Overall direct economic benefits of land and NRs use under the current institution	2.65	3.02	2.01	1.45
13	Awareness on land and forest degradation, sustainable NRM	83.3%	80.1%	85.7%	77.2%
14	Awareness on family planning, and green income generation	1.67	1.91	2.88	2.63
15	Participation and decision making in joint forest management activities	63.9%	43.5%	78.1%	80.0%
16	Equitability of access and benefit sharing from forest and NRM and use	1.02	1.83	2.818	2.64
17	Rate of forest and woodland cover change (last ten yrs) in ha per year	-394	-305	-18	2
18	Rate of agricultural expansion (last ten yrs) in ha per year	290	152	151	27
19	Rate of grazing / rangeland cover change (last ten yrs) in ha per year	103	154	-132	-30
20	Rate of soil erosion and land degradation	1.50	2.97	1.31	2.14
21	Role of customary institutions and leaders in NRM & conflict management	0.50	1.15	1.35	2.30
22	Conflict over access and use of NRs	1.71	2.77	1.20	2.33
23	Confidence on current land use right and tenure security	2.31	4.00	2.15	3.67
24	Level of enforcements of government land use and NRM laws and local bylaws	1.55	1.01	3.52	2.73
25	Condition of forest, rangeland and biodiversity in the areas	1.80	0.83	3.53	2.70
26	Overall ecological sustainability of NRM & use under the current institution	1.85	1.12	3.01	2.15

Estimating the total net annual income of HHs by institutional arrangement (by combining the net incomes from crop and livestock production with additional incomes from NTFPs and green income generation activities) however showed that HHs under the regional government land and NRs use systems make an average net income of 22,066 Birr/HH/Year followed by those under the jurisdiction of the BMNP with an average total net income of 21,036 Birr/HH/Year. In contrast, the total net incomes of HHs under the PFM and PRM were 19,312 Birr/HH/Year and 10,448 Birr/HH/Year respectively.

The results of the comparative economic analysis showed that, regardless of other influencing factors, the direct economic benefits of natural resources use under the PFM and PRM arrangements are less rewarding for HHs under the systems compared to the relatively bigger direct economic benefits of HHs under the federal and regional government systems. This suggest that despite the diversity of income sources and better legal access and use right to NRs by HHs in PFM and PRM; the income and benefit gained by these HHs from farming and alternative green businesses was not able to offset the sizable forgone benefits and opportunity costs incurred by the HHs for the conservation of forest and biodiversity. The poorer economic performance of NRs use under PFM and PRM was also reflected by the complaints of some KIs and FGD participants in Shawe Kebele who stated that *'there is no doubt* *that we need the sustainable management of our forests but we also need to get more access and better economic benefits from the conservation to support our lives as farmers in the regional administration are benefiting from their agriculture and livestock production'*.

According to local SHARE staff and HHs engaged in green business activities, part of the poor economic performance of income generation under PFM and PRM is the lack of market outlets, transportation and market networking to sell products such as coffee and honey at better prices in bigger markets. According to KIs, another economic challenge of PFM and PRM for HHs are the small landholding sizes, restrictions on access and use of resources and ecological stress factors as insufficient and erratic rainfall. The later in particular are hampering the full-size practicing of conventional cropping and livestock production systems by these HHs. As a result, tendencies and acts of sporadic illegal agricultural expansion and settlement as well as illegal wood harvesting in PFM and PRM frontiers especially by poorer HHs and jobless and/or land less youth are not uncommon in Kebeles under PFM and PRM.

Despite the economic trade-offs, natural resources management and use under PFM and PRM institutional arrangements has shown remarkably higher environmental sustainability as fig 11 and subsequent discussions indicate.

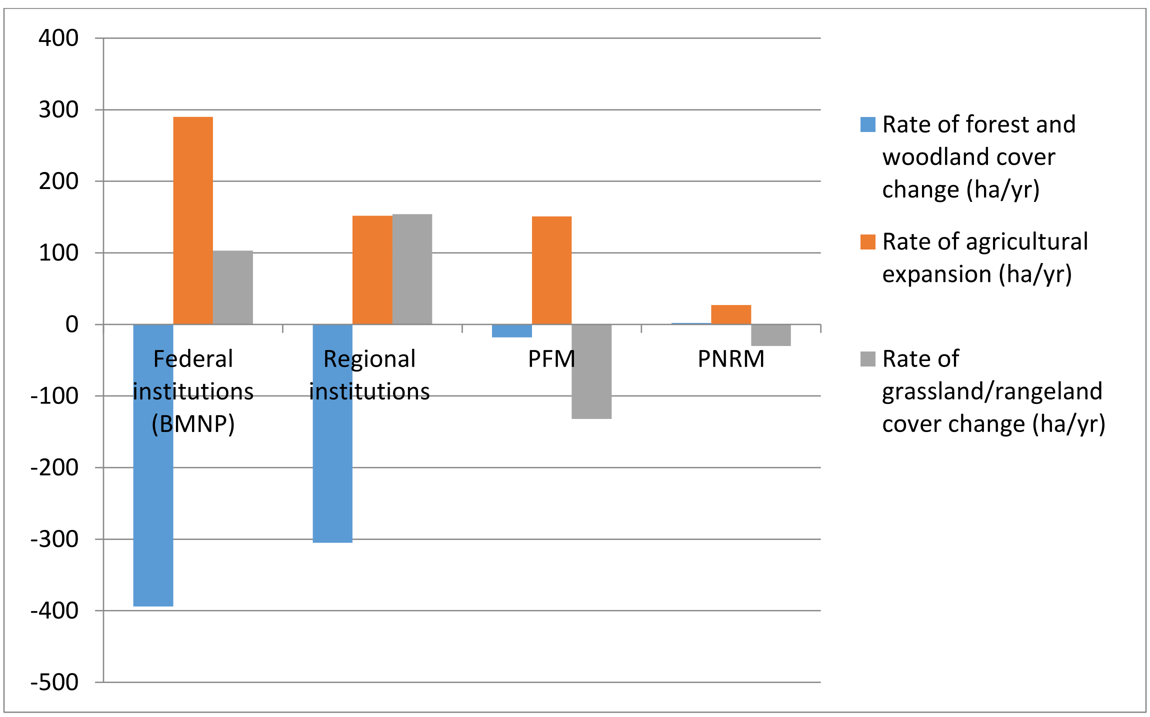

Figure 11. Rate of LU/LC changes in ha per year for selected Kebeles of BER by institutional arrangements from 2006-2016

As can be seen from fig 11, natural resources management and use through PFM and PRM has significantly reduced the rate of deforestation and land degradation with promising potential for enhancing the sustainable management of biodiversity of the Eco-region based on consent and participation of local community in the joint NRM. Observably, PNRM through PFM and PRM has improved the quality and ecological stability of farm and rangelands that could enhance the long-term productivity and yield of crop and livestock production in these areas amid growing threats of climate change and land degradation.

On the other hand, both the findings of the LU/LC change analyses made from 2006 to 2016 (fig 11) and the participatory on-farm environmental quality ratings (table 5) revealed that the rate of deforestation was significantly higher in Kebeles under the federal (BMNP) and regional institutions with estimated loss of as high as 400 ha of forest per year in Rira Kebele located inside the BMNP. However, the rate of agricultural expansion in the last ten years was generally high in the three institutions (Federal, regional and PFM) the highest in Rira Kebele under the BMNP as high as 290 ha increase per annum followed by Kebeles under PFM in highland and mid lands with 1,501 ha increase and Kebeles under District institutions with 150 ha increase per annum. The two most important reasons for the highest rate of agricultural expansion in Rira Kebele (inside BMNP) were food cropping and coffee production by the rural HHs. In particular, barley is the dominant crop grown by most of the HHs followed by coffee farms. A related factor to the highest agricultural expansion in Rira Kebele was the rapid increase of settlements as was also confirmed by the GIS analysis, KIIs and field observation of the researchers. In contrast, the rate of agricultural expansion was much smaller in PRM (lowlands) with an increase of 27 ha per annum.

The above results indicate that, land use conversion from forest and woodlands to agricultural crop farms remains to be a critical challenge for sustainable natural resources management in the highlands and midlands of the BER.

Unlike the agriculture, results of analysis of the rate of change of grazing land (grasslands) in the highlands and mid-lands, and rangelands in the lower altitudes of the BER has shown remarkable differences among the four NRs governance institutions. Apparently, in Kebeles located in the BMNP, grassland cover has increased by over 103 ha per annum while the rate was much higher in Kebeles under the regional institutions. Evidently, close to 300 ha of forest and woodlands are annually converted to other land uses in Kebeles under the regional administration (mostly in mid and low altitudes). In contrast, Kebeles under PFM and PRM have shown dramatic decline in grazing and rangeland covers over the last ten years the highest decline being observed in PFM Kebeles with -132 ha change per year and in PRM with -30 ha change per year.

The main reason for the increasing rate of grassland cover under the federal (BMNP) and District(regional) administrations especially in the highland and mid-lands of the BER is the need for more grazing area for the increasing number of HHs living in the area. However, it should also be noted that fallowing is one of the major land management practices of rural HHs in the Eco-region and fallow lands may appear as grass/rangelands on satellite imagery during the fallow year thus contributing to the increased grassland/range cover especially in the lowland Districts under regional administrations.

The possible explanation for the significant decline of grassland/rangeland cover under PFM and PRM especially under PFM could be due to the expansion of agriculture through converting the also grasslands along with the decline in livestock holding/HH in these Kebeles partly as a result of livelihood diversification and/or positive influences from pressures (restriction to advance into forest/woodland areas) of the PFM and PRM institutions or a combination of these factors.

At household level, awareness on short-term and long-term impacts and costs of land and forest degradation, benefits of sustainable management of NRs, role of community participation and collaboration with PFM/PRM implementing task-forces and Koree (Joint committee), the role of income generation from biodiversity-smart green businesses and access and benefit sharing from forest and NRM use to support HH economic demands have all shown better ratings in Kebeles under PFM and PRM in most respects. Moreover, awareness of HHs on family planning and its contribution for improving the health of women and reducing the vulnerability of the family to poverty and food insecurity has shown higher ratings by HHs under PFM and PRM.

In this line attempts were made by the research team to verify if the higher awareness ratings on the role of family planning by HHs in PFM/PRM Kebeles was related to the current SHARE intervention. According to survey HHs in the PFM/PRM Kebeles, the reason for their increased awareness on family planning was due to the information disseminated and awareness created by the Kebele health extension agents (government). However, key informants and FGD participants in the same Kebeles later clarified that some of the health extension agents (indicated by survey HHs) were part of the Village Health Committee (VHC) that was created by SHARE. According to these KIs, the VHC is a village level family planning education platform established from multiple local stakeholders including Kebele administration, women and religious leaders. The VHC disseminates information on family planning and women health through meetings, village level discussions, religious leaders and government health extension workers to the community.

The same KIs and FGD participants have also stated that some awareness creation activities on family planning have been there before the VHC by the SHARE mainly through the District and Kebele health extension services. But its impact was limited. The current intervention by SHARE brought relatively better awareness to the community perhaps because it uses an all-inclusive task-force (VHC) and participated men, women and religious leaders among others. As a result, SHARE and the government have been able to moderately influence the understanding of the HHs on family planning and health positively. Nevertheless, the family planning interventions by SHARE and the government hitherto still need to walk long distances to actually influence the large family, polygamist and many-children traditions of local HHs, according to the KIIs.

In this regard, the current very large family sizes of HHs in the BER that were obtained from the survey data (with average 8-10 individuals/HH and as high as 20 people per HH particularly in the highlands) compared to the national average of 4.9 people/HH in rural Ethiopia (CSA, 2008) signifies the existent challenge of population pressure on the sustainable management of land and natural resources in the eco-region.

With respect to farm and rangeland-level environmental sustainability, the assessment ratings of tree abundance &diversity, grass &vegetation cover of farm, grazing//rangeland quality and forage availability, and soil fertility have all shown better ratings in Kebeles under PFM and PRM compared to Kebeles under Federal and regional institutions. However soil erosion and land degradation still remains equally challenging for HHs in all institutions especially in mid and lower altitudes. More interesting was the lower rating value of confidence of HHs on current land use right and tenure security in Kebeles under PFM even lower than those HHs under the federal BMNP while the highest tenure security was shown by HHs in the regional government institutions. When asked to justify the source of the tenure insecurity despite the better rights to use NTFPs in PFM; FGD participants overall stated that their current landholdings and use rights could be compromised or lost if the PFM or federal government resettles them outside of the forest area.

Overall comparative analysis of the four NRs governance institutions in the BER has shown that NRM and use through PFM & PRM schemes has brought remarkable improvements to the environmental sustainability and perpetuity of the valuable ecological services of the eco-region. Nonetheless, achievements made in improving the environmental sustainability and ecological integrity of the Eco-region under PFM/PRM need to be squarely backed by innovative and productive alternative income sources to HHs in these arrangements. Realizing sound income generation and benefit sharing from PNRM could certainly create a better win-win scenario to sustainable management of the BER and improvement of local livelihoods. Most importantly ensuring meaningful benefits could off-set the huge costs incurred by local communities from the restrictions on agricultural expansion, free grazing and wood harvesting under PFM and PRM.

3.3 Land Management and land use optimization strategies in BER

3.3.1 Type and adoption of land management and optimization strategies in BER

Over the last two decades a number of improved Land Management Practices (LMPs), production technologies and rural development strategies have been introduced and/or reinforced in many parts of rural Ethiopia and BER alike by the Federal Ministry of Agriculture and regional agencies. The goal is to tackle land degradation and promote sustainable land use to increase the productivity and optimal use of land for improved rural livelihoods. During the same period and earlier farmers and agro/pastoralists in BER have also been practicing a number of indigenous and locally-adopted land use/rangeland management practices aimed at improving soil fertility, livestock feed availability, and to cope with impacts of climate variability. In line with the efforts of the federal and regional governments, NGOs and development partners of Ethiopia have also been supporting farmers and agro/pastoralists to sustainably manage land and NRs and improve their livelihoods from improved production technologies.

Despite accounts of increased crop yield and ecological stability mainly by federal and regional government media, these official reports lack comprehensive assessments and evidence based analyses regarding the tangible economic and environmental changes brought by the different LMPs, the socio-cultural compatibility and cost-effectiveness of the various LMPs being promoted vis-à-vis prioritization of most optimal LMPs for wider scaling up. In view of this, farm and HH level identification of major LMPs and technologies and comparative analysis of farm income and environmental quality was carried out for adopters and non-adopters in all the three agro-ecologies as shown summarized table 6.

As shown in table 6 below, a minimum of 18 different LMPs and farm productivity improvement methods/ inputs are currently being used by farmers and agro/pastoralists of BER classified into soil fertility improvement, agronomic, physical, biological and grazing/rangeland management practices.

Table 6. Type and adoption of major land management practices in BER by agro-ecology

No	Type of land management practice/tech	Application of the tech/practice	Highland Dinsho N=46		Midland Harena Buluk N=67		Lowland Berbere N= 52	
			% adopters	% non-adopters	% adopters	% non-adopters	% adopters	% non-adopters
1	Soil fertility improvement	Inorg. fertilizer	63	37	48	52	46	54
		*Manure	85	15	58	42	66	34
		*Compost	50	50	41	59	29	71
		Mulching	69	31	85	15	77	23
2	Agronomic practices	Improved seed varieties	57	43	52	48	54	46
		*Fallowing	41	59	6	94	2	98
		*Crop rotation	40	60	42	58	28	72
		Row seeding	57	44	57	43	44.2	56
		*Inter-cropping	37	63	73	27	52	48
3	Physical structures	*Traditional terracing	43	57	63	37	69	31
		*Modern terracing	40	60	30	70	23	77
		Soil bund	38	62	40	60	42	58
		Counter plough	72	28	82	18	84	16
4	Biological practices	*Agro-forestry	26	74	52	48	42	58
		Grass strip	47	53	32	68	23	77
5	Range and grazing management	*Traditional rotational grazing	55	45	31	69	60	40
		*Hay making	53	47	21	79	33	67
		*Cut and carry system	39	61	45	56	64	37

*significantly different across the three agro-ecologies at α = 0.05 (i.e. 95% CI)

Closer examination of the results in table 6 shows that the adoption rate of more than half of the LMPs is generally low (<50%) and varies both by type of LMP (soil, physical etc.) and by agro-ecology (farming system). Evidently, LMPs that have shown significant relation to the highland agro-ecology were manure, modern terracing, crop rotation, fallowing and hay making. Other well adopted LMPs in the highland though not exclusively related to the highland included inorganic fertilize, mulching, improved seed varieties, row seeding/planting, counter ploughing and traditional rotational grazing.

Except for hay making and traditional rotational grazing, the majority of the LMPs in the highlands are related to improving soil fertility and crop productivity in an area where the livestock holding per HH is considerably higher than in the mid- and lowland areas. According to the respondents of the HH surveys in the highlands part of the reason for high number of soil fertility related LMPs in the highlands is due to the over exploitation of soil for cereal mono-cropping and mixed crop farming. However, many respondents have also stated that they are adopting practices such as soil bunds and terraces merely because of pressure from District agriculture offices while the soil in the highlands is much thicker and less prone to erosion compared to the mid and lowlands. .

In contrast, LMPs that are significantly related to the mid and low altitude agro-ecologies were inter-cropping, traditional terracing, agro-forestry, traditional rotational grazing and cut and carry of grass. Other LMPs adopted (though not significantly related to the mid and low altitude agro-ecologies) were mulching, inorganic fertilizer, counter ploughing, and use of improved seeds. The results indicate that unlike in the highlands the land management objectives targeted in the mid and low altitudes are multiple and diverse notably soil erosion, soil moisture stress and scarcity of livestock feed and forage among others.

In this regard, many of the FGD participants and KIs in the mid and low altitude areas noted that the fertility of soil in these areas (mid-altitude and lowland) is good but the soil is light and highly vulnerable to erosion. ; In addition they have serious problem of shortage of water, rainfall and forage for their livestock. However, there were some differences between the perceptions of men and women participants on the above-stated problems though equal representation of both groups was not made during the FGDs. Apparently soil erosion, deforestation and rangeland degradation were stressed more by men participants than women participants. The reason could be because men are more active in crop farming and livestock rearing; they tend to focus more on issues of soil fertility and grazing land availability. In contrast, women were more vocal on problems of water shortage and forage scarcity. The reason is that women are more active on coffee and cash crops production on their homesteads; and forage production and harvesting to feed milking cows and calves. Besides, problems of market for NTFPs such as coffee and honey were important problems raised by most women participants and some men participants.

The above statements by KIs and FGD participants reveal important messages with respect to the interdependence of the highland-midland-lowland communities in natural resources use and the complex trade-offs of unsustainable and non-integrated NRM and use across the agro-ecologies. Apparently, farmers and agro/pastoralists in lowland areas are more susceptible to soil erosion and micro-climatic stresses. The more lands and forests are degraded in the highlands lowlanders are paying the highest prices for mismanagement of land resources in the highlands (detailed analysis of reasons and factors affecting adoption of each LMP is presented in the MSc thesis reports).

3.3.2 Land management strategies and effect on farm productivity and local livelihoods

In order to measure and compare the contributions of different LMPs to local livelihoods, estimation of key indicator variables at farm and HH levels was computed for adopters and non-adopters of LMPs in the different agro-ecologies. The results are summarized in table 8 (note that the MSc report has made detailed analyses of factors affecting adoption of LMPs by HHs and regression coefficients (marginal effects) of each LMP per farm unit.

Keeping in mind the influence of many external variables apart from adopting specific LMPs on HH farm income, the analyses presented in table 8 provides some notable indications and trends between adopters and non-adopters of the LMPs included in the analyses. In the highland of BER, adoption of the indicated LMPs was related with relatively higher crop yield and income from crop production per ha with average values of 44 quintal (barely) and 7,863 Birr/ha respectively. Compared to the adopters, non-adopters of the indicated LMPs in the highlands of BER have lower crop yield and cropping income per ha with average values of 36 quintal (barely) and 6, 489 Birr/ha respectively.

However, income from livestock production per year has shown considerable variation between adopters and non-adopters in the highlands of the BER. This is due to the advantage that the LMPs have increased livestock feed availability especially hay making. As a result, the total gross income per HH per year from the farming practices between adopters and non-adopters of the LMPs has shown sizable variations as shown in table 7.

Table 7. Land management strategies and effect on farm productivity and household income

	Agro-ecologically significant land management practices					
	Highland		**Midland**		**Lowland**	
	Manure &compost		Inter-cropping		Rotational grazing	
	Modern terracing		Traditional terracing		Traditional terracing	
	Hay making /fallowing		Agro-forestry		Cut and carry	
Economic variables of farming	Adopters	Non adopters	Adopters	Non adopters	Adopters	Non adopters
HH size	8.35	9.68	8.2	8.1	5.91	5.88
Crop land in ha	2.64	2.78	1.61	1.54	1.89	1.35
Grazing land in ha	0.57	0.72	0.59	0.54	0.45	0.69
Total landholding ha	3.54	3.52	2.31	2.13	2.45	1.78
*Crop yield/ha in quintal	44.2	36.1	21.5	21.6	18.21	11.70
Cropping income Birr/ha	7,863	6,489	5,918	5,850	9,350	6,585
*Total cropping income in Birr/HH/Year	20,818	17,962	9,534	9,020	17,637	8,872
Livestock holding in TLU	13.5	11.6	10.8	7.5	5.83	5.84

*Livestock income per TLU	681	627	951	1328	1386	878
Total Livestock income in Birr/HH/Year	9,233	7,330	10,345	10,065	8,087	5,133
Off-farm income in Birr/HH/Year	9,004	7,716	1,486.111	940	1,888.364	1,388.889
*Total gross income in Birr/HH/Year	40,970	33,425	21,504.03	20,025	28,621	17,316

*Significantly different between adopters and non-adopters in the shaded agro-ecologies at α = 0.05 (i.e. 95% CI)

In the mid altitude zone, adoption of LMPs was related with negligible variations both in crop yield and income from crop production per ha with average values of 21.5 and 21.6 quintal/ha (sorghum) and 5,918 Birr/ha and 5850 Birr/ha for adopters and non-adopters respectively. Even more indifferent are incomes from livestock production and the total gross income per HH per year between adopters and non-adopters of the LMPs. When tested for statistical significance (at α = 0.05), both crop yield per ha and income from crop production as well as income from livestock production and total farming income per HH/year (all average values) have shown no significant difference between adopters and non-adopters of the indicate LMPs in both agro-ecologies. The above results obtained from analyses of combined effects of more than one LMP may potentially undermine the effects of each LMP on crop and livestock yield and on total HH income from farming. Nevertheless they still provide some important indication on the level of effects of current LMPs being promoted on local livelihoods in the highlands and mid lands of the BER.

In contrast, the differences in farm productivity and income between adopter and non-adopter HHs of the LMPs in the lowlands were much bigger and more significant compared to the same in high and mid altitudes. As shown by table 7, adopters of the indicated LMPs were matched with average crop yield of 18.21 quintal (maize), and average income of 17,638 Birr/ha/Year while the average income from livestock production was 1,386 Birr/HH/Year and total gross income per HH per year for the same HHs (adopters) was 28,621 Birr/HH/Year. On the contrary, non-adopters of the LMPs in the lowlands of BER produce 11.70 quintal/Ha/Year for the same crop and generate cropping income of 8,872/Birr/ha/Year. The average income from livestock production for these HHs was 878 Birr/HH/Year and total income was 17,316 Birr/HH/Year.

The above results reveal that introduction and dissemination of improved LMPs has substantially contributed to the improvement of local livelihoods of adopters in the lowland agro-ecology. In particular LMPs applied for addressing challenges of livestock feed scarcity and poor range management vis-a-vis combating soil erosion and moisture stress have played important roles in improving farm and livestock productivity for improved local livelihoods in the agro-ecology. Moreover, LMPs such as rotational grazing of rangelands and control of traditional free grazing through joint Korree (PRM arrangement), and promotion of cut and carry system of grass with the help of PFM is effectively helping locals to use rangelands more productively. Similarly, traditional terracing and agro-forestry practices are helping local HHs in the lowlands (and in the mid-altitude as well) to improve soil moisture and productivity amidst the challenges of the dry climatic conditions of the lowlands.

3.3.3 Land management strategies and effect on environmental quality and sustainability

Along with the assessment of economic contributions of adoption of the LMPs discussed above, effects of the indicated LMPs on Environmental Performance Index (EPI) of the land use system was carried out from the participatory assessment and rating of key environmental quality indicators (See annex IX for detail of the EPI assessment indices). Major environmental quality indicators assessed were soil quality; tree diversity, vegetation cover and land degradation. The EPI values of the indicators were measured from 5 points (5 = highest and 0= lowest).

Table 8. Table 8: Environmental effects of land management practices by agro-ecology

Environmental quality indicators	**Highland**		**Midland**		**Lowland**	
	Adopters	Non adopters	Adopters	Non adopters	Adopters	Non adopters
Awareness on land degradation	2.74	2.41	2.65	1.36	1.88	1.22
**Soil fertility status	2.08	2.01	2.69	2.03	2.98	1.82
**Soil moisture/water	2.61	2.40	2.53	1.36	1.56	1.15
**Tree and vegetation cover	1.51	1.34	3.14	2.13	2.14	1.37
**Livestock feed/ forage and grass availability	1.66	1.14	1.29	1.13	1.88	1.01
**Range/grazing land quality	1.74	1.44	0.89	0.85	2.76	1.42
Soil erosion and degradation	1.68	1.86	2.04	2.55	2.03	2.73

**Significantly different between adopters and non-adopters in the shaded agro-ecologies at $\alpha = 0.1$ (i.e. 90% CI)

According to the results of the environmental quality assessment shown in table 8 above, except in the highlands most of the environmental quality indicators assessed have shown significant differences between adopters and non-adopters both in the mid-altitude and lowland agro-ecologies. For HHs in the highlands the only environmental quality indicator found significantly different was livestock feed due to the increased availability of hay for HHs adopting hay making compared to those who depend more on grazing lands.

Consistent to the results in the crop yield and income assessments made above for the highland of the eco-region, LMPs being promoted in highlands have shown little effect in improving soil fertility, vegetation cover and sustainability of land resources use. These results may indeed appear in clear contradiction to reports of District and zonal agriculture offices who argue that current LMPs being promoted by the government are significantly improving the productivity and environmental sustainability of the areas (BoARD, 2012). Aside the contradictions, the findings of this study unveil important implications to SHARE and the BER with regard to the little contributions of current LMPs especially in reducing the pressure from free grazing, agricultural expansion and forest degradation on the BER.

In contrast, LMPs in the mid-lands and lowlands were associated with significant differences on the environmental sustainability, and soil and vegetation quality indicators. Interestingly, LMPs that showed insignificant contributions to crop yield and livestock income in mid-altitude areas (table 7) were found significantly related to higher EPI value for soil fertility, soil moisture and vegetation cover (table 8). These positive EPI results by adopters in the mid-altitude could be linked to the ecological contributions of agro-forestry, conservation agriculture, terracing and intercropping practices. One possible reason for the yet insignificant effect of the LMPs on economic returns of land uses in mid altitude could be due to the relative homogeneity of land in the mid agro-ecology and greater influence of other factors (as rain) on farm productivity than the positive effects of the LMP seen on soil quality and vegetation.

In the lowland agro-ecology of the BER however, increased economic returns from adopting LMPs were matched with higher environmental qualities of farm and rangelands. Evidently, farm and rangelands of adopters of LMPs in the lowlands of the BER have shown significantly higher EPI rating values for soil fertility, soil moisture content, livestock feed availability, rangeland quality and reduced soil erosion and land degradation. The implications are direct and understandable. Farmers and pastoralists in the lowlands of the BER are more vulnerable to land and forest degradation and unsustainable use of rangelands from within or outside of the agro-ecology. Hence improving land management and use through suitable LMPs is fundamental both for the improvement of livelihood activities and sustainability of the BER.

3.4 Bio-economic optimality analysis of major land-use/farming systems in BER

Many of the findings discussed in the preceding sections of this report have shown that small-scale crop production and livestock rearing or alternative combinations of the two represent the dominant land use/farming systems of the vast majority of the rural population of the BER. As a result, agricultural expansion, settlement and unregulated grazing including forest and woodlands conversion into grazing/rangeland have contributed to the significant decline and degradation of woodlands and forests of the BER (fig 2). However these important livelihood sources of the rural population in BER have also been most affected by the environmental consequences of the traditional unsustainable land use and resultant land use/land cover changes discussed in section 3.3. Against the growing challenges of NRs degradation and deforestation from the multifaceted environmental costs of the traditional farming systems; the Ethiopian government and its development partners have been introducing new agricultural development strategies, alternative farming systems, improved land management practices and agricultural production technologies and market, credit and other social services to rural HHs in the country and BER alike.

Indeed some of the introduced and improved land-use/farming systems may appear promising in increasing farm yield/income or reducing the environmental costs of the traditional production systems. However, it does not necessarily mean that the new land-use and farming systems are effective in bringing significant positive impacts on the three pillars of sustainable and optimal land use i.e. increased economic return/farm income, improved environmental sustainability, and enhanced social and institutional capacity of local livelihoods. Given the fact that land and natural resources are not only the basis of the rural livelihoods but also integral part of the socio-cultural fabric of communities in the BER, the new agricultural and rural development strategies, improved farming systems vis-a-vis the traditional land use systems should be tested with respect to their benefits and costs against the three triangles of optimal land use i.e. economic, socio-cultural and environmental sustainability effects. Above and beyond analysing the bio-economic and socio-cultural optimality of the improved and traditional land use systems, one has to also critically assess underlying biophysical, economic, socio-political and institutional determinants of the decision making behaviour of rural HHs in BER for implementing or rejecting a given land use system or farming practice more than the other.

In essence, conducting a comprehensive assessment of the bio-economic optimality of existing land use and farming systems in line with the key determinants influencing the decision making behaviour of rural farm units (households) regarding land use, helps to understand the synergies and trade-offs of each land use/farming practice to the sustainable management and optimal use of land and biodiversity resources in the Eco-region. Findings and lessons of the analysis could provide valuable information to make necessary policy, technological and institutional changes for enhancing synergies and reducing trade-offs between the livelihood improvement, efficient resource use and environmental sustainability objectives of optimal land use in the BER.

In view of this, the bio-economic optimality of major land use systems of rural HHs in BER was analysed with respect to their economic performances and environmental sustainability effects separately and simultaneously. Accordingly, a farm household level static bio-economic model (Farm DESIGN model, Groot et al., 2012) was used to quantify and empirically analyse the farm level production processes and interactions between the economic process (input-outputs) and environmental effects (soil quality, forest, biodiversity, etc.) of major land uses and farming systems of rural HHs in BER.

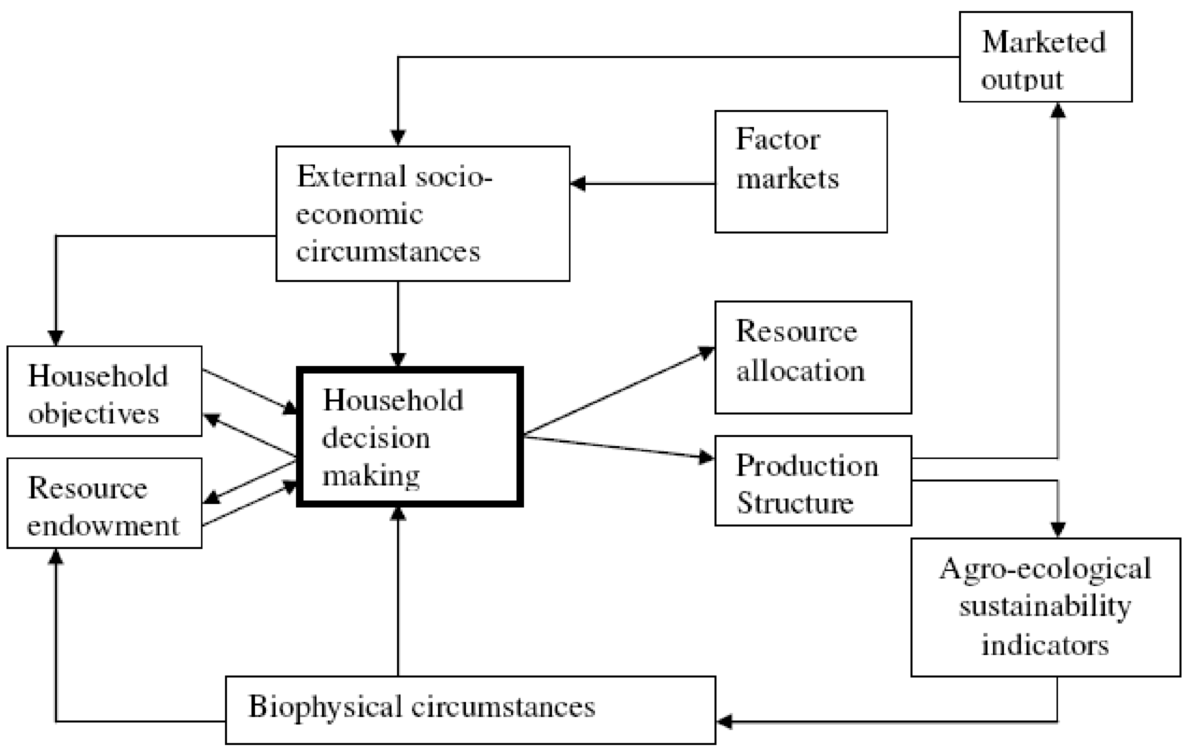

Figure 12. Household decision making of land use/farming system (adapted from Kruseman (2000)

3.4.1 Major land use/farming systems of rural Households in BER by agro-ecology

As shown in table 9, five major farming systems/land use practices are currently being used by rural HHs of the BER. In the highlands of the Eco-region cereal food (mono) cropping of crops such as barley, wheat, and potato is the dominant farming practice followed by Crop-livestock mixed farming. The average total landholding size of cereal croppers was 3.6 ha/HH while it was 4.35 ha/HH for mixed farmers. The difference in landholding size was matched with the higher livestock holding of crop-livestock mixed farmers with an average size of 9.2 TLU/HH while the figure is 3.95 TLU/HH for cereal cropping farmers.

In mid altitude areas, tree-crop agroforestry (conservation agriculture) was the dominant land use type followed by agro-pastoralism and food crop production. Maize, sorghum and teff are the major food crops harvested while Coffee and Khat are important cash-crops produced in the agro-ecology especially by farmers practicing agro-forestry. In terms of total landholding size, rural HHs in all the three farming practicing found in mid-altitude agro-ecology appear to have significantly smaller holding sizes compared to the farmers in the highland. Among the three, tree-crop agroforestry farmers have relatively bigger total landholding size of 2.32 ha/HH while food crop producers have 1.71 ha/hh and agro-pastoral HHs have 1.72 ha per HH. The average livestock holding size of agro-pastoralists in the mid-altitude was 5.7 TLU/HH, for food crop producers 3.07 TLU/HH and for tree-crop agro-foresters it was only 1.73 TLU/HH.

In the lowlands of the Eco-region food crop production (mainly maize, teff and sorghum) and pastoralism were identified as the dominant land use/farming system types followed by tree-crop agroforestry (with khat and coffee production) respectively. The average total livestock holding TLU was expectedly higher for pastoral HHs with 9.32 TLU/HH while it was 4.99 TLU/HH for tree-crop agro-foresters and 1.19 TLU/HH for food crop producers. However, in terms of total landholding, HHs in the three farming systems have comparable holding sizes of ca. 2.4 ha/HH.

Table 9. Summary statistics of explanatory variables of studied land use/farming systems in BER

No	Agro-ecology	Farming system/ land use type	No. HHs	HH size	Av. landholding size in ha			Livestock holding per HH in TLU	Major crops grown by % of HHs
					Crop land	Grazing /other	Total		
1	Highland	Cereal mono-cropping	29	10.80	3.05	0.59	3.60	3.95	Barley (80.90%) Wheat (43.60%) Potato (27.4%)
		Crop-livestock mixed farming	20	9.83	3.40	0.95	4.35	9.20	
		Agro-eco total	63	10.31	2.57	1.26	3.82	8.91	
2	Midland	Crop-livestock mixed farming	12	9.67	1.67	0.04	1.71	3.07	Maize (94.01%) Sorghum (50.1%) Khat (46%) Teff (38.0%) Coffee (30.2%)
		Tree-crop-agroforestry	22	10.68	2.21	0.11	2.32	1.73	
		Agro-pastoralism	16	9.69	1.51	0.21	1.72	5.70	
		Agro-eco total	50	10.12	1.87	0.11	1.98	3.32	
3	Lowland	Food crop production	20	8.65	2.51	0.13	2.64	1.19	Maize (96.70%) Teff (56.90%) Khat (36.70%) Coffee (15%)
		Tree-crop-livestock	16	7.81	2.30	0.13	2.42	4.99	

		(Agro-silvo-pastoralism)						Sorghum (8.3%)
		Pastoralism	24	8.48	2.36	0.20	2.56	9.32	
		Agro-eco total	60	8.37	2.4	0.15	2.55	5.05	

Comparing farming systems by agro-ecology shows that, rural HHs in the highland agro-ecology have an average total landholding size of 3.82 ha/HH (the highest in the Eco-region some even holding as high as 8 ha/HH) followed by HHs in the lowlands with an average of 2.55 ha/HH while the average total landholding size of HHs in the mid altitude was 1.98 ha/HH. Similarly, the average total livestock holding of farmers in the highland was 8.91 TLU/HH (crop-livestock mixed farmers in the highland holding nearly twice the TLU size of agro-pastoralists in the mid-land). In contrast the average total TLU of a HH in the mid–altitude was 3.32 and in the lowlands it was 5.55. With respect to HH size, the average number of people per farm unit (HH) was 10.31 in the highlands, 10.12 in the mid-altitude and 8.37 in the lowlands.

3.4.2 Economic Performances of Major Land use/farming systems in BER

In order to examine the economic performances of each of the identified land use/farming system types in the three agro-ecologies, the data collected through HH survey on farm level production input outputs was quantified and analysed as shown summarized in table 10. Accordingly, estimations of important variables needed to measure the farm level production inputs, outputs, income and costs were computed (Note that the estimations were made based on the dominant crop varieties, regular inputs and costs, regular market prices, etc.).

Production inputs/costs

The direct production inputs measured were: inputs/costs for inorganic fertilizer, crop and forage seed (improved and common), weeding, management and harvest costs (daily labour paid in kind or money), insecticide and pesticides, livestock purchase, livestock feed costs, livestock disease management costs, crop and livestock transport and marketing costs, among other costs

The environmental (indirect) costs assessed were: soil fertility and quality at farm, soil moisture, tree species abundance and vegetation cover of farm, rate of soil erosion and land degradation on farmland, as well as availability of livestock feed/grazing parcel in the farmland.

Production outputs/benefits

The farm level production outputs/benefits measured include: crop yield per ha, net income from crop production per ha (estimated without considering consumptions by the respective HH), income from livestock production per TLU; total net income from crop production, livestock production and total farm level production per year; income from other resource uses from farm land among others.

Based on the above quantifications, the direct economic performance of each farming system (excluding environmental costs) in food and cash crop production, livestock production, and total farm level production was determined, analysed and compared by using the benefit-cost ratio (B/C) efficiency measure as shown in the last column of table 10.

According to the findings of the economic analysis, most of the farm production and economic variables measured have shown significant differences between farming systems within an agro-ecology and across agro-ecologies. In the highland, cereal food (mono) cropping has evidently shown an average crop yield of 23.83 quintals per ha while the average crop yield/ha from crop-livestock mixed farming was 21.62 quintals. In terms of production costs, the average total crop production cost for a cereal food cropping HH was 2,806 Birr per ha/year while it was 2,483 Birr per ha per year for mixed farming HHs in the same agro-ecology. Similarly, the total livestock production cost/TLU was 536 Birr per year for cereal food (mono) cropping HHs while the figure was 452 Birr per TLU per year for farm units practicing mixed farming in the same agro-ecology. These figures show that except for the slight increase of crop yield per ha in cereal cropping farm units, the marginal costs of crop and livestock production per ha and per TLU respectively are close between the two dominant farming systems in the highland agro-ecology.

However, the two farming systems were significantly different when the total net incomes from farming and benefit-cost ratio of the farming practices were computed. Apparently, the total net farm income per ha (without deducting the HH consumption) for cereal crop producer units was 9,427 Birr/HH/year while it was 11,466 Birr/HH/year for crop-livestock mixed farming units. Correspondingly, the economic efficiency measure (total direct benefit/total direct costs) of crop-livestock mixed farmers in the highland agro-ecology was 4.39 while the measure resulted 3.21 for cereal cropping units in the same agro-ecology. The relatively higher economic performance of crop-livestock mixed farming compared to mono crop production is largely due to the greater TLU (livestock holding) per HH by the first farm units thus increasing the total farm income of HH per year coupled with the advantage of lower marginal livestock production cost per TLU of the same farm units thus reducing the total marginal farm production costs per ha/year.

The results suggest that effectively integrating food crop and livestock production through mixed farming system in the highlands of Bale not only provides higher economic returns from farming but also brings multiple complementarities and synergies to the farm level production processes from manure of livestock to the soil and hay from cropping to the livestock as well as balanced nutrition to the HH among other co-benefits. For the sustainability of the BER, further improving and renovating mixed farming systems has the potential to reduce the pressure and trade-offs of sole cropping or livestock rearing for more cropping land or grazing land from BER respectively.

Table 10. Summary of farm level production inputs (costs), outputs (income) and economic efficiency of major farming systems in BER

Agro-ecology	Farming system/ land use type	*Crop yield in quintal/ ha/ Year	Food and cash crop production cost in Birr/ ha/ Year	Livestock production cost/ in Birr/TLU/ Year	Total farm production cost in Birr/ ha/Year	Net income from food and cash cropping in Birr/ha/ Year	Net income from livestock in Birr/ TLU/ Year	Income from forest & other sources in Birr/ha/ Year	*Total net farm income in Birr/ ha/ Year	Total net income in Birr/HH / Year	Economic Benefit – Cost ratio (B/C) of the farming
Highland	Cereal mono-cropping	23.83	2,806	536	2,933	8,054	2,454	153	9,427	34,090	3.21
	Crop-livestock mixed farming	21.62	2,483	452	2,610	9,411	2,483	10.43	11,466	49,876	4.39
Midland	Food Crop production	15.06	1,360	580.30	4109	3641	1286	73.40	5275	8,800	2.91
	Tree-crop-agroforestry	13.20	1,404	470.46	3880	2436	1550	1,284	8811	11,870	4.02

	Agro-pastoralism	8.81	925	695	3814	4303	805	834	4898	11,026	3.37
Lowland	Food crop production	10.50	892	628	1,136	2,691	1,797	285	3518	10,171	3.09
	Tree-crop-livestock farming (Agro-silvo-pastoralism	11.23	780	565	2,108	1,623	1,326	1,231	7194	11,854	3.41
	Pastoralism	8.62	483	613	3,405	1,304	2,357	769	16381	28,272	4.25

*Crop yield quantified in the highland were wheat and barley; in the mid-lands and lowlands barley, sorghum and maize per ha

Compared to the two farming systems discussed in the highland agro-ecology of the BER, the three land use/ farming practices of HHs in midland agro-ecology have shown remarkably lower crop yield per ha. As shown in table 10 above, the average crop yield/ha of a food crop producer farm unit in the mid agro-ecology was 15.06 quintals (sorghum or maize), while the average crop yield measured for the same crop in tree-crop agroforestry systems was 13.20 quintals per ha and it was only 8.81 quintals per ha for agro-pastoral HHs in the same agro-ecology. In terms of cash and food crop production costs, the average total food and cash crop production cost for a food cropping farm unit (HH) was 1,360 Birr/ha/year while it was 1,404Birr/ha/year for farm units practicing tree-crop-coffee agroforestry in the same agro-ecology. Parallel to the crop yield, the average total food and cash crop production cost of an agro-pastoral HH in the mid agro-ecology was 925 Birr/ha/Year.

When the marginal costs (MC) of crop production are computed for the three farming systems, the average total cost of production of a quintal of sorghum was 90.30 Birr for crop producer farm units. In contrast the MC of production of a quintal of sorghum was some 105 Birr for both tree-crop agroforestry and agro-pastoralist HHs of the same agro-ecology. On the other hand, the MC of livestock production/TLU was relatively higher for agro-pastoralists with average MC of 695 Birr/TLU/year while the same MC was 580.30 Birr/ha/year for food cropping HHs and 470.46 Birr/ha/year for tree-crop agroforestry farm units of the same agro-ecology.

Examining the total MC of cropping and livestock rearing between the three farming systems reveals that food crop production through tree-crop agroforestry and agro-pastoralism systems incurs more cost per unit of yield compared to the sole food crop production. This is perhaps due to the additional costs of cropping for the agro-foresters and agro-pastoralists associated with multiple use of a plot of land and the relative effect of lower economic scale of crop production coupled with additional costs of cash crop production as fruits, coffee and khat by these groups of HHs. On the other hand, the relatively higher cost of livestock production per TLU for agro-pastoralists suggests the high costs of availing livestock feed that are not well supported by the small crop residue. Compared to agro-pastoralists, food cropper and tree-crop agro-forester farm units appear to incur lower MC per TLU due to the co-benefits of crop residues and forage trees as livestock feed in the two farming systems respectively.

When the total net income and benefit-cost ratio of the three farming practices are compared tree-crop-coffee agro-forestry was found to produce the highest economic return of an average total net income of 11,870 Birr/HH/Year followed by agro-pastoralism with an average total net income of 11,026 Birr/HH/Year while food crop production in the mid altitude provides an average total net income of 8,800 Birr/HH/Year. Likewise, the economic efficiency (B/C ratio) of tree-crop agro-forestry system was the highest i.e. 4.02 followed by agro-pastoralism, 3.37 while the economic efficiency measure for crop production with 2.91.

Despite the relative good fertility of soil in the mid altitude agro-ecology, the results showed that tree-crop farming (agroforestry) and crop-livestock agro-pastoralism provide better economic returns and synergetic effects to farm level production process in addition to providing additional income from cash crops such as coffee, honey, fruits, khat etc.(column 9 of table 10). In the same line a related important reason for the higher economic performance of tree-crop agroforestry in the mid-altitude despite the small livestock TLU/HH was the higher marginal revenue (MR) from a TLU of livestock supported by livestock feed and forage from tree components of the system. In contrast the relative better economic return of agro-pastoralism compared to crop production in mid agro-ecology is partly due to the relative suitability of the agro-ecology for livestock rearing/ agro-pastoralism than for sole food cropping amid observable problems of moisture stress and soil erosion. It should also be noted that some of the farm units practicing tree-crop agroforestry and agro-pastoralism in the mid agro-ecology are directly and indirectly beneficiary of the PFM and PRM schemes and hence improvements in land management and natural resources use and resultant positive effects on HHs income were additional factors.

The results suggest that sole crop production is economically least rewarding in the mid-altitude of the BER even in the expense of deforestation and land degradation. In contrast integration and diversification of tree and livestock-based farming practices and income generation activities provide better economic returns on top of environmental sustainability co-benefits. In particular, strengthening tree-crop-coffee agroforestry for high economic efficiency could prove positive synergy to the sustainable management of the BER. However, one should note that tree-crop agroforestry supported by cash cropping in the mid-altitude is not yet an economically optimal land use system when compared to crop-livestock mixed farming in the highland of the BER.

In the lowland agro-ecology of the Eco-region, the three most dominant land use/farming system types identified were pastoralism, tree-crop-livestock mixed farming (Agro-silvo-pastoralism) and food crop production. Estimations of average crop yield per ha among these farming systems has shown an average crop yield of 10.5 quintals per ha per year for food crop producer HHs, 11.23 quintals per ha per year for tree-crop-livestock mixed farming HHs and 8.62 quintals per ha per year for pastoral HHs. In terms of food and cash crop production costs, the average total crop production cost for a food cropping farming unit was 892 Birr/ha/year and for tree-crop-livestock mixed faring unit it was780 Birr/ha/year while the average total crop production cost for pastoral HHs was 483 Birr/ha/year. Likewise, the marginal cost of production of a quintal of the same crop verity was 85 Birr/quintal, 70 Birr/quintal and 56 Birr/quintal for food cropping, tree-crop-livestock mixed farming and pastoral HHs respectively.

However, estimations of average MC of livestock production/TLU has shown little variations among the three farming systems with average MC of 628 Birr/TLU for food cropping HHs, 565 Birr/TLU for tree-crop-livestock mixed farming HHs and 613 Birr/TLU for pastoral HHs. The relatively lower MC of livestock rearing for tree-crop-livestock mixed farming HHs was due to the additional advantages of the tree and crop components of the system in providing livestock feed and forage thus reducing the MC cost of livestock rearing for the farm unit. In contrast, the relatively higher MC of livestock rearing for crop producing HHs was due to the apparent extra costs of securing livestock feed for by products from cropping does not suffice the livestock feed requirements of the farm unit.

In spite of the seemingly close marginal costs of both crop and livestock production in the three farming systems; estimations of net incomes from food/cash cropping, livestock production, total farm income and benefit-cost ratio of each land use system have shown significant differences as shown in table 10. Evidently, the average total net income per ha of land used for food and cash crop productions was expectedly higher for the food cropping farm units with an average net income of 2,691 Birr/ha/year. Estimation of the same income from crop production for tree-crop-livestock mixed farming units has resulted in net income of 1,623 Birr/ha/year while the average net income from crop production for pastoral HHs was only 1,304 Birr/ha.

However, when net incomes per TLU of livestock are estimated, the highest income is earned by pastoral HHs with an average net income of 2,357 per TLU/year while the same estimate has resulted in 1,797Birr for crop producers and 1,326 Birr for tree-crop-livestock mixed farmers. An important question to ask here is why the average net income per TLU of livestock for tree-crop-livestock mixed farming HHs is smaller than the same income for crop producer HHs when the MC of livestock rearing/TLU is smaller for the tree-crop-livestock mixed farmers? One possible explanation is the relative productivity of livestock rearing (with small holding sizes) in the crop producer HHs due to the advantage of the slightly higher landholdings and increased amount of family labour invested per TLU of livestock in the same HHs. According to some key informants, some local crop producing HHs in the lowlands are practicing livestock husbandry and fattening with small holdings thus earning higher income per TLU of livestock.

Compared to the crop producer HHs, tree-crop-livestock mixed farmers have higher livestock holdings per HH but the productivity per TLU of livestock is low due to competition for land and family labour from other components of the farming system. Other reasons could be due to differences in access to market and consumption behaviours of livestock products potentially reducing the quantity of livestock products sold by mixed farmers. In contrast, the income of tree-crop-livestock mixed farmers from additional sources such as NTFPs, coffee, and Khat was higher, estimated at 1,231 Birr/HH/year, compared to HHs using the other two farming systems.

Summing up the total net income of HHs per ha per year for the three farming systems above has shown remarkable variations. Noticeably, pastoral HHs earn a total average net income of 16,381 Birr/ha/year, while the same income for tree-crop-livestock mixed farm units was 7,194 Birr/ha/year and for crop-producer farm unit it was 3,518 Birr/ha/year; the latter was even less than ¼ of the net income of pastoral HHs in the same agro-ecology. As a result the economic efficiency of land use (total benefit/total costs) under pastoralism has shown the highest ratio 4.25 followed by tree-crop-livestock (agro-silvo-pastoral) mixed farming with economic efficiency measure of 3.14 and lowland crop production has shown the least ratio of 3.09; the latter is comparable to the efficiency of the same crop production system in the mid-agro-ecology of the Eco-region.

The above results reaffirm the trends observed in the mid altitude agro-ecology in that sole crop production is by far an economically inefficient land use system in the mid and lowlands of the Eco-region. Conversely, pastoralism and tree-crop-livestock mixed farming can and do have the potential to provide higher economic returns for rural HHs in the lowlands of the BER. This implies that strengthening and improving pastoralism and tree-crop-livestock farming through efficient and sustainable range management and use practices and alternative income generation activities from NTFPs along with improving access of HHs to market not only provides better livelihood development opportunities for rural HHs but also provides critical synergy to the sustainable management of the biodiversity of BER from avoided and reduced local economic dependencies and pressures on the Eco-region.

3.4.3 Environmental Effects of Major Land Use/Farming Systems in BER

The farm-household level economic performance analyses made in the preceding section of this report has shown that the various farming systems and land use practices currently being used by rural HHs in BER have significant variations with respect to economic returns both from within and among the agro-ecologies. In light of the economic analyses, participatory farm/rangeland level assessment and score ranking of environmental performances/ effects (both positive and negative) of each farming system was carried out through adapting the farm level Environmental Performance Index (EPI) assessment matrix developed by Moore et al., (1973) (See section 3.2.3 and annex IX for detail of EPI assessment methods and tools used).

Accordingly, three environmental quality indicators were assessed for each farm/rangeland i.e.

1) Soil quality (fertility, texture and moisture content, yield/ha),

2) Land management status/ level of degradation (erosion and gullies, terraces and bunds, etc.)

3) Tree and vegetation cover and diversity (Number of trees/ha, No of plant *spp*on farmland, % of land covered by vegetation/grass, abundance of wildlife in the area etc.) among others.

Table 11. Average and aggregate EPI values of studied farming systems in BER(0 = low and 5 = high)

Agro-ecology	Farming system/ land use practice	Soil quality index	Land manage index	Tree and biodiversity index	Aggregate EPI index value	Economic efficiency (B/C)	Bio-economic optimality ratio (0 < r <1)
Highland	Cereal mono-cropping	1.45	1.44	1.00	1.297	3.21	0.404
	Crop-livestock mixed farming	1.93	1.79	1.86	1.860	4.39	0.424
Midland	Crop production	0.95	1.35	1.06	1.120	2.91	0.385
	Tree-crop agroforestry	2.95	3.09	3.55	3.197	4.02	0.795
	Agro-pastoralism	1.46	1.53	2.18	1.723	3.37	0.511
Lowland	Crop production	0.52	0.95	1.11	0.860	3.09	0.278
	Tree-crop-livestock mixed farming	1.81	2.08	2.64	2.177	2.90	0.751
	Pastoralism	1.23	1.52	2.5	1.750	4.25	0.412

3.4.4 Bio-economic optimality of major land-use/farming systems in BER

Based on the findings of the economic performances and environmental performance indicators (tables10 &11), the combined bio-economic optimality function of each farming systems was constructed by modelling average farm income/ha/year (Y_i) against aggregate EPI values of the farmland (X_i, I = 0.5 ….5.0). The resultant bio-economic optimality function curve was drawn and compared to the ideal optimal LU curve in each agro-ecology based on the farm HH design model adopted. Consequently, the coefficients of interactions between the dependent variable (farm income) and the explanatory variables (Environmental qualities) were produced.

Based on the bio-economic optimality curves drawn for the two farming systems in the highland agro-ecology of the BER (fig 13), crop-livestock mixed farming system has a maximum EPI index value, 2.0 (X- axis) while cereal food cropping has a maximum EPI value of 1.5. In the same fashion, for crop-livestock mixed farmers the highest average farm income/ha (25,000 Birr per) was obtained when farmland is managed at better environmental quality (at X = 2.0). On the contrary, the average highest farm income per ha for cereal food cropping HHs (19,000 Birr) was obtained at low environmental quality index values (at X= 0.5).

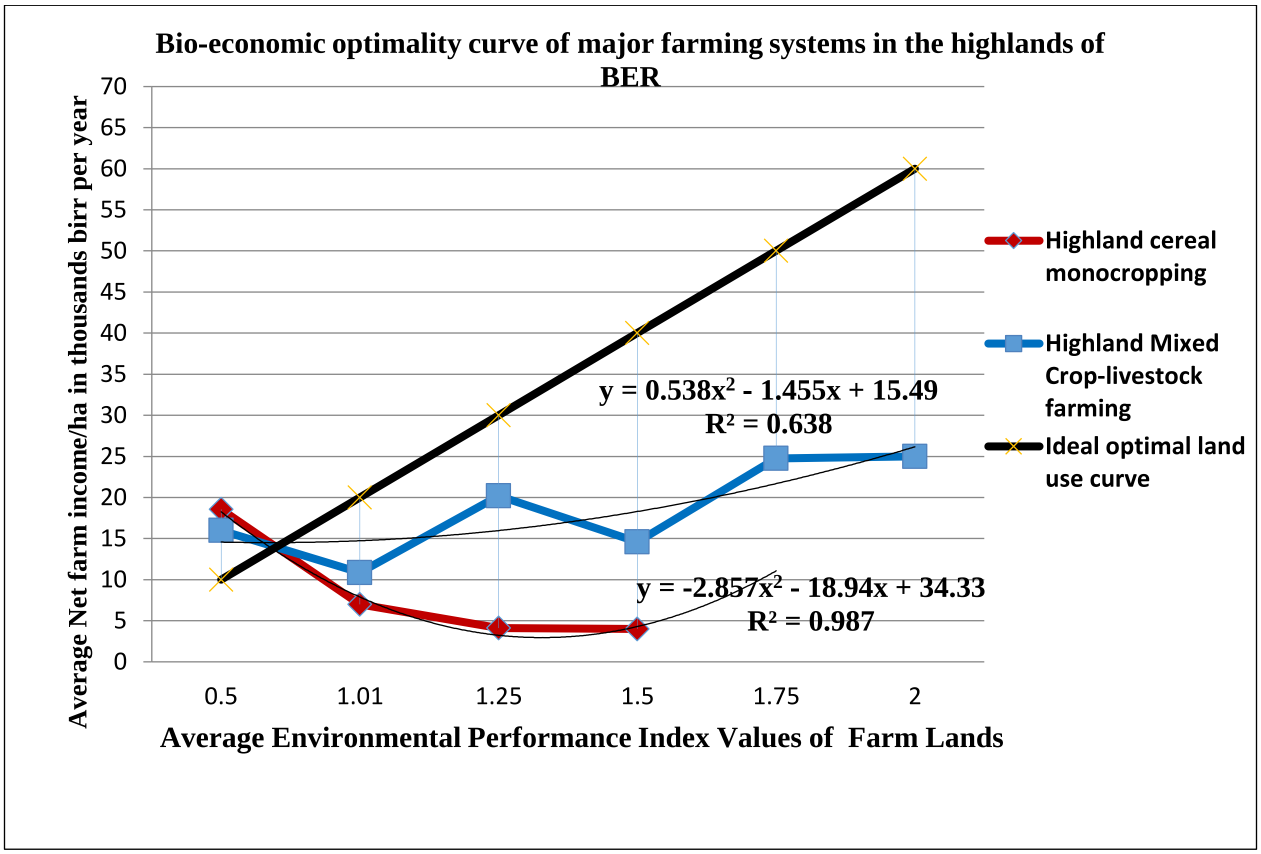

Figure 13. Bio-economic optimality curve of farming systems in the highlands of BER

Closer examination of the trends of the bio-economic optimality of the two farming systems in the highland Eco-region reveals that, as the environmental quality of the farm increases the economic performance of cereal (mono)crop production sharply decreases resulting in large gap (loss of income) shown by the long disparity line with the optimal land use curve (at x = 1.5). However, the rate of decline of farm income steadily falls as the environmental quality of land increase eventually stabilizing and moving up gradually.

In contrast, the economic return of crop-livestock mixed farming first falls but progressively increases as the environmental quality increases, showing a more stable increasing rate at higher EPI values.

The steadily increasing trends of both economic returns and environmental qualities in the crop-livestock mixed systems does indicate the potential of the mixed systems for environmentally balanced agricultural intensification in the highland agro-ecology. Yet, the gap between the ideal optimal LU curve and the mixed farming optimality curve also widens as the environmental quality improves. This implies that despite its relatively higher EPI value, crop-livestock mixed farming in the highlands is still not leading to bio-economically optimal land use though the magnitude of disparity (non-optimality) and amount of lost farm income/ha is much higher and sharply increasing for mono-cropping system in the highlands of BER.

The coefficients of interaction between environmental quality (X) and farm income (Y) in the optimality equations of the two farming systems were also consistent with the above trends. Evidently, the primary coefficient of interaction between environmental quality (X) and farm income (Y) in the crop-livestock mixed farming curve was a = 0.538indicating the positive interaction and synergy between environmental management and economic return. However, the magnitude of synergy gradually falls as increased environmental management competes and costs the economic performance of the farm production from land taken by trees, costs of environmental conservation, and associated lost benefits from cropping. Conversely the big negative coefficient of interaction between environmental quality (X) and farm income/ha (Y) in the optimality function of the cereal mono crop farming (a= -2.857) indicates the large trade-offs between the economic efficiency and environmental sustainability of the farming practice.

The results suggest that current farm production activities and land use practices in both farming systems in the highlands of the Eco-region are non-optimal and unsustainable when measured from the objective of achieving win-win scenarios of increased economic returns and sustainable environmental management. Nevertheless, the magnitude of non-optimality of land use and trade-offs between the two objectives is significantly higher from cereal food cropping compared to the mixed farming in the same agro-ecology. Apparently, cereal mono cropping in the highlands of BER is being made at higher environmental costs such as loss and decline of tree and forest covers, intensive exploitation of soil, and poorer management of land and biodiversity resources. Compared to cereal crop production, integrating food cropping with livestock production has shown positive synergy and considerable complementarities between economic and environmental optimality and sustainability of the land use.

From the stand point of improving the local livelihoods of communities without compromising the sustainable management and use of biodiversity resources in the highlands of the BER, strengthening the current synergies in crop-livestock mixed farming practices has plausible potential for optimizing the economic and environmental benefits of land use. One way to enhance the current synergies and minimize the trade-offs is to look for better integration and intensification of current crop and livestock production systems within the ecological carrying capacity of the land.

In mid-altitude of the BER, bio-economic optimality modelling of the three farming systems has shown remarkable variations both in economic optimality and environmental sustainability of the land uses. As shown in fig 14, tree-crop agroforestry (involving some level of income generation from NTFPs, cash cropping and few livestock) has shown highest environmental performance index (X = 3.5) both in the mid-altitude and entire BER. Next to agroforestry, traditional crop-livestock mixed farming (agro-pastoralism) has shown a max environmental performance of 2.0 while the maximum environmental performance index for food cropping in the same agro-ecology was 1.5. In terms of farm income per ha, the highest income (15,500) for the agroforestry farm units was obtained at moderate environmental quality (X=2.0) but lower than its maximum EPI (X= 3.5). Similarly the maximum income/ha (5,500) for agro-pastoral HHs was obtained at low (1.25) environmental quality index, lower than its maximum environmental quality index (2.0). And for midland food cropping, the maximum farm income per ha (14,000) was made at the lowest environmental sustainability index (0.5).

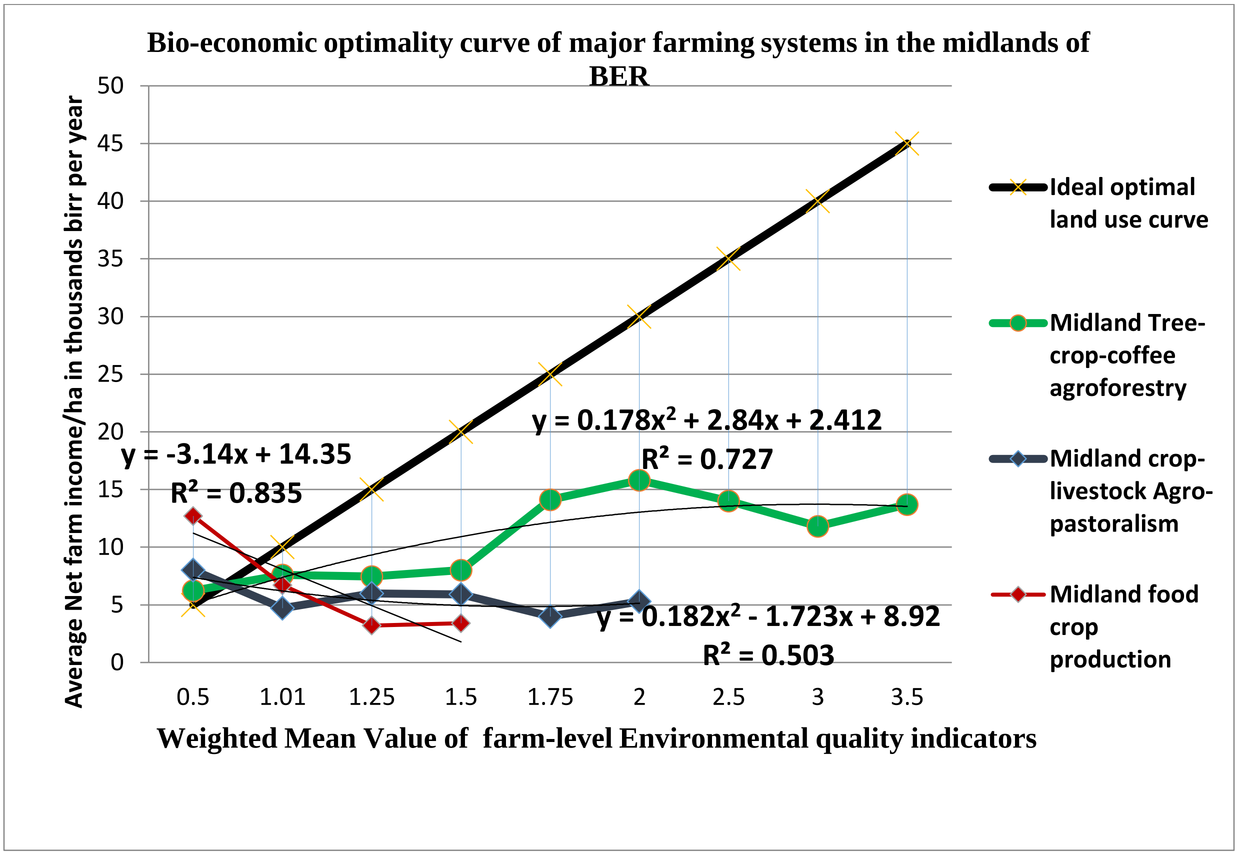

Figure 14. Bio-economic optimality curve of major farming systems in the midlands of BER

Looking at the trends of the bio-economic optimality curves together with the coefficients of interactions between the environmental quality(X) and farm income/ha (Y) reveals that in midland agroforestry (also considered as conservation agriculture practice), income/ha from farming is positively influenced by increased environmental sustainability (a = 0.178). But the increasing positive synergy between the two slowly weakens as the environmental quality significantly increases as shown by fig 14. The possible reasons for the weakening positive synergy between the environmental and economic performances could be due to the increasing cropping space taken up for maintaining trees, increased production costs of multiple products on a small plot of land coupled with declining yield of food and other crops due to increased competition for nutrients and water beyond the carrying capacity of the land.

In the same fashion, the bio-economic optimality function for midland agro-pastoralism shows positive coefficients of interaction (a = 0.182) between environmental quality and income from the farming system. Alike the trend in the agroforestry system, the complementarities between environmental sustainability and economic performance in the agro-pastoral land use steadily decline as the environmental quality increases. However, the rate of decline in the economic optimality of agro-pastoralism along the X axis is much higher than the same in agroforestry as shown by the big disparity line with the optimal land use curve at EPI value of X =2.0. The possible explanation could be due to apparent increase in actual and opportunity costs of crop and livestock production when much of the small farm and rangeland are used to maintain tree and grasses in a time where traditional access to productive rangelands and abundant fallow lands is no more available due to swelling human population, resource competition, resources degradation and effects of climate variability among other stressors.

For midland food crop production however, the trend of the bio-economic optimality curve and coefficients of interaction between the environmental and economic performances of the land use both show large trade-offs. Evidently, an increase in a unit of cropping income is matched with a large decline in environmental quality (a =-3.14). More pronounced than the trade-offs in highland mono-cropping, the income/ha from mid-altitude food cropping sharply falls below 5,000 Birr/ha/year when farm production is carried out at better land/ecosystem conditions.

Analysing the results of the bio-economic optimality functions of farming systems in mid-altitude from the context of sustainable NRM and land use in the BER suggests that, sole crop farming as a major land use is not only environmentally costly but also provides much lower economic returns to HHs. The relative high income (though small when compared to highland cropping) matched with poor environmental quality index (as crop lands from recently cleared forests/woodlands with little or no land management) indicate the substantial environmental trade-offs and poor sustainability of land use under such practices in the mid-altitude. As it was also substantiated by many of the KIs in Hawo, food cropping in mid-altitude especially under little vegetation cover and poor land management is matched with higher vulnerability to soil erosion and agro-climatic stresses such as aggravated soil moisture stress and low yield.

Summing up, the results of the bio-economic analyses in mid altitude of the BER have shown that all the three farming systems and land uses are hardly optimal and sustainable. However, the two integrated farming systems (agroforestry and agro-pastoralism) have shown higher positive synergies and lower trade-offs for achieving optimal land use. In particular, integrating food and cash crops with perennial and forage trees on farm level production (agroforestry) has demonstrated higher economic and environmental optimality. Though to a lesser extent, agro-pastoralism has also shown significant potential for optimal land use with positive synergies between crop and livestock. However, the economic and environmental optimality of agro-pastoralism is challenged by diminishing productive rangelands and scarcity of livestock feed, poor management and competition over access for the already shrinking rangelands coupled with the effects of local climatic conditions on economic efficiency of cropping.

This implies that promoting such integrated farming systems with more effective technologies and social services could lead to a more sustainable land and natural resources use in the agro-ecology. If such systems are especially complemented by innovative and productive additional income generation activities from participatory PNRM schemes; substantial improvement of local livelihoods and build-up of more positive synergies between HH economic activities and sustainable biodiversity management is highly foreseeable. On the contrary, current food crop production in the mid agro-ecology is alarming and potentially destructive to the sustainability of the BER. This is for the reasons that current crop production in the mid agro-ecology is characterized by high rate of deforestation (more land cleared for agricultural extension every year as opposed to sustainable intensification), low yield and large trade-offs between the economic returns and environment qualities of the land use. This implies that aggravated degradation of the fragile soils and loss of valuable biodiversity resources in the mid agro-ecology of the BER is inevitable unless targeted remedy actions are taken sooner than later.

In the lowlands of the BER (fig 15), bio-economic optimality modelling of the three major farm and land use systems (food crop production, tree-crop-livestock mixed farming and traditional pastoralism) has shown significant variations both in terms of synergies and trade-offs for optimal and sustainable land use. As shown in fig 15, the environmental performance index for the tree-crop-livestock mixed farming system (agro-silvo-pastoralism) has shown the highest index value (X = 2.5) in the lowlands, and the second highest EPI value in the Eco-region. Following agro-silvo-pastoralism, traditional pastoralism (with some periodic food cropping) has shown EPI value of 1.75 while the environmental quality index of lowland crop production was 1.25, the latter is the lowest EPI among all farm/HH level land uses in the entire BER.

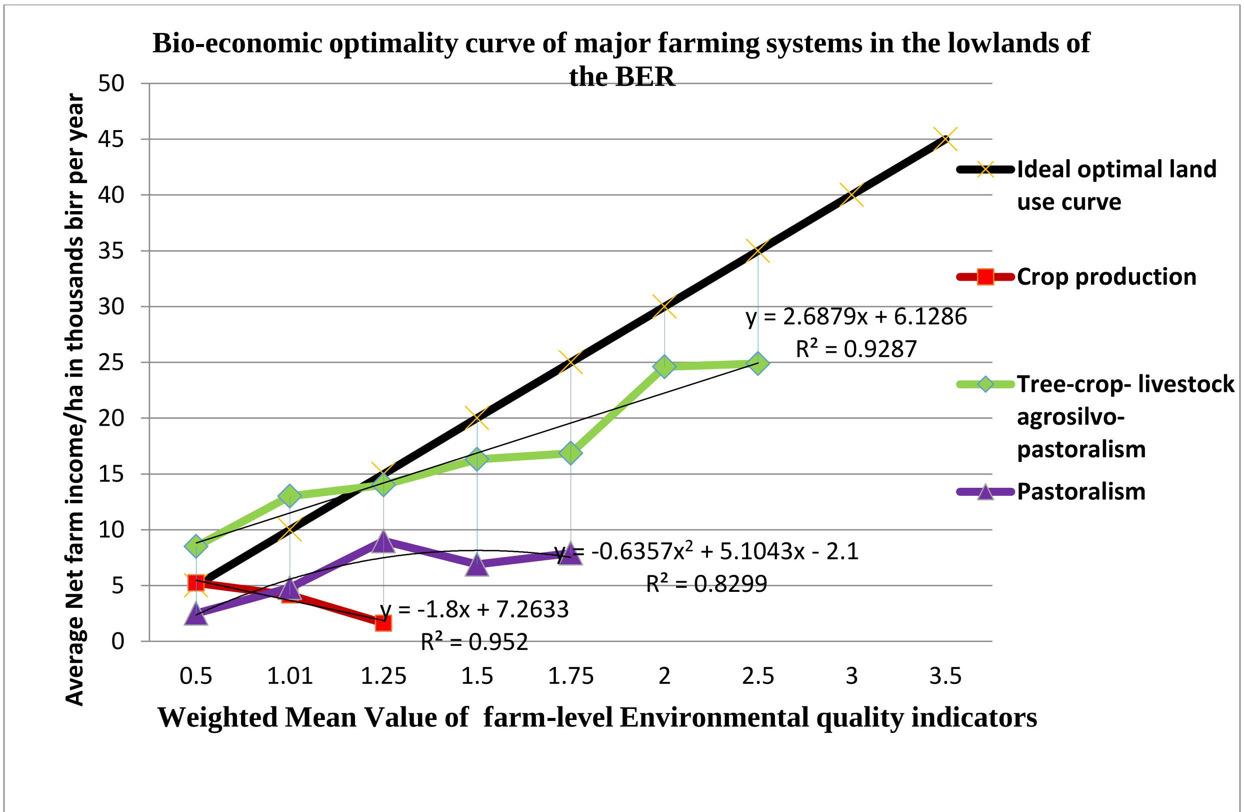

Figure 15. Bio-economic optimality curve of major farming systems in the lowlands of the BER

In terms of farm income, the highest average farm income/ha (25,500) for tree-crop-livestock mixed farmers is made at the highest EPI value (X=2.5), the only farming system in the BER where both the economic and environmental performances of land use simultaneously increase with very strong positive interaction and relatively little fluctuation.

However, for the traditional pastoral HHs the maximum income/ha (9,500) is obtained at low environmental quality(X = 1.25), lower than the maximum observed EPI value by the system (X=1.75). In contrast, the highest average income/ha under food cropping system (5,000) was made at the lowest environmental quality (0.5); a trend almost identical to crop production in mid-altitude agro-ecology but with much more reduced income per ha of a crop land.

Looking at the coefficients of interactions between the environment performances (X) and farm incomes (Y) from the optimality functions shows that, the bio-economic optimality curve of the agro-silvo-pastoral integrated farming system is the closest to the ideal optimal land use curve not only in the lowland but also among all land use systems in the BER. In particular, the large positive coefficient of interaction between the economic returns and environmental sustainability index (a = 2.687) in the agro-silvo-pastoral system clearly shows the strong synergies between the economic outputs and ecological sustainability effects of the production system. Evidently, the higher bio-economic optimality of land use in the tree-crop-livestock mixed farming is not only the highest among exiting HH level land uses systems in the lowland agro-ecology but also among all HH level land use systems in the BER.

On the other hand the bio-economic optimality function for the traditional pastoralism in the lowlands of BER has shown some degree of complementarities between environmental quality and income from the farming system as the environmental sustainability moves from X= 0.5 to X= 1.25. However, the complementarities gradually weaken and trade-offs begin to outweigh the synergies as the environmental sustainability of the farming system increases shown by the significant negative coefficients of interactions (a = - 0.635). The main reason for the slowly widening economic trade-offs as the environmental condition of land improves is due to the increased competition for water and soil nutrients between livestock feed/grass and perennial trees resulting in forage scarcity for livestock in rangeland that is already stocked beyond its carrying capacity amid growing loss of productive rangelands due to bush encroachment and agricultural expansion especially in rangelands managed by regional land administrations.

However, the trend shown by the bio-economic optimality curve and coefficients of interactions in the food crop production system is distinct and in need of attention by concerned stakeholders.

Noticeably, there exists a large disparity (trade-off) between the economic and environmental performances of the land use that is sharply widening its gap with the optimal land use curve as shown in fig 13. The coefficients of interaction between the economic returns and environmental sustainability effects crop production in the lowlands of BER is negative and large (a = - 1.8). This shows that current food crop farming in the lowland agro-ecology of BER especially when practiced as the sole farm production system is not only an environmentally costly production system but also is not economically helpful. Apparently, revenues of HHs from crop production and other economic benefits of land use in sole food cropping did not even pay off (balance) the labour and time costs of the HHs apart from the enormous environmental costs from clearing of forest and woodlands for crop land as well as from soil erosion and degradation of land.

From the perspective of optimizing current land uses in the lowlands of the BER for improved rural livelihoods and sustainable NRM; integrated actions of strengthening the positive results from the tree-crop-livestock mixed production system is critical. As the analyses above plainly show, further enhancing the economic efficiency of integrated farming systems in the lowlands of BER have the potential not only to improve the ecological integrity of the land use but also could greatly reduce the pressure on the biodiversity of the Eco-region from increasing demand of rural HHs for more cropping land, forest products and grazing land. In particular, actions aimed at improving the productivity of the tree, crop and livestock components of the farming system through knowledge-based integration and combinations of the components within the limit of the carrying capacity of the land and socio-cultural setting of the people is vital.

Likewise, the traditional pastoral production system in the lowlands has shown good potential especially in its economic benefits to pastoralists. However, the ages-old means of livelihood that was known for its environmental sustainability and effective natural resources management systems is now seriously challenged by multiple problems/setbacks. The main stressors include: swelling population, immigration from other areas and the associated conflict and competition for resource; rangelands shrinkage, fragmentation and conversion to agriculture coupled with poor range management, bush encroachment and effects of climate variability.

Despite these eminent and formidable challenges however traditional pastoralism if supported with appropriate range management and alternative livelihood sources, has the proven potential for achieving an economically and environmentally optimal land use that is well suited to the deep rooted and extensive indigenous knowledge and social-cultural setting of rural HHs in most parts of the lowlands with pastoral way of life. On the contrary, current use of land under food cropping as a major farming system by its own in the lowlands of the BER is economically least efficient, environmentally highly degrading and resource-wise most unsustainable. The very low economic performance and large trade-offs of sole food cropping in the lowlands is further complicated by the fragility and vulnerability of the soil for erosion and other land degradations thus compelling cropping HHs to constantly look for additional crop land by clearing natural forests and woodlands to increase crop yield as opposed to improving productivity of the land through intensification. All of which are aggravated by climate variability, population growth and institutional setbacks.

3.5 Major Challenges for Optimal Land use and Sustainable NRM in BER

The empirical evidences and contextual analyses made hitherto in this section of the study have demonstrated that among the eight farm/HH level land use/farming systems in the three agro-ecologies; only three have shown fairly good optimality (≥ 0.5) both in economic efficiency and environmental sustainability namely: tree-crop agroforestry and agro-pastoralism in the mid-altitude and tree-crop-livestock mixed farming in the lowlands of the Eco-region. A fundamental question that needs to be addressed here is why are rural farmers and HHs in BER then practicing the other five farming systems/land use practices if they are not environmentally sustainable? More intriguing is why are rural HHs practicing farming systems that are not even economically rewarding such as crop production in mid and lowlands of the Eco-region? What is driving the decision of rural HHs in BER to adopt certain types of land use or farming practices?

The answers to the above questions are not simple and straight forward. But one thing is clear, many rural HHs in BER do take conscious decisions on whether to adopt or not a certain land use practice on the grounds of several endogenous and exogenous factors. The endogenous determinants include: HHs need to fulfil food crop requirement for consumption, livelihood traditions, gender, family labour, education and economic status. However, most determinants are exogenous to the HH and are strongly linked to: local agro-climatic conditions, market demand of farm produce, government policy/development packages, among others. In -depth discussions on major factors affecting the decision making behaviours of rural HHs in BER to adopt and engage in each farming systems or land use practices are presented in the MSc reports.

For this report however the most important determinants of farming practices can be summarized as:

- Market demand for some food crops and the associated HH income from crop-based farming practices as evidenced by mono-cropping in highlands
- Relative better yield (short-term) and economic efficiency of some farming systems in the expense of deforestation and land degradation
- HHs consumption needs for food crops or livestock products and the economic decision to avoid purchase of crop/livestock products from other areas (highlands)
- Limitation/lack of locally suitable improved land management practices, farm production and value-addition, market and other social services coupled with poor effectiveness of land use and livelihood interventions to bring the intended positive effect
- Poverty and lack of alternative livelihood sources for the HHs compelling them to adopt the farming system to earn for a living even though it is not economically efficient
- Ineffective institutions, land use policies/strategies and NRs use right arrangements to bringing meaningful local benefits and livelihood improvements to the rural HHs
- Gaps and differences in capacity, awareness and knowledge among rural HHs to implement suitable land management and farming practices and technological inputs
- Influence from existent challenges of population growth and immigration, climate variability, strong ties of some means of livelihoods with the local social-cultural setting

4 Conclusions

Findings of this study have shown that over the last three decades several convoluted problems have been driving the current land use/land cover changes, deforestation and environmental degradation in BER. The key problems hindering the sustainability of land and natural resources management and use in the Eco-region are strongly linked to setbacks in policy and institutional arrangements, economic trade-offs of new and alternative land use systems, inadequate positive effects of improved land management practices and technologies on local livelihoods, aggravated by existent problems of population growth, resource scarcity, and climate change and variability related impacts on local livelihoods. Albeit these challenges and setbacks, recent interventions of participatory NRM and improved land resources use through PFM and PRM schemes and to a lesser extent from improved land management and rural development strategies of the federal and regional governments have shown positive outcomes especially over the last decade.

In this regard findings of the LU/LC change analysis and field EPI assessments in this study have shown that the rate of deforestation, land use conversion and environmental degradation all have significantly declined over the last few years particularly in parts of the BER that are managed through PFM and PRM institutional arrangements. Although exact quantitative measure could not be produced on how much of the improvements are exclusively due to the PFM/PRM interventions, many of the findings in this study have manifested that PFM and PRM interventions are bringing substantial positive results to the sustainable management of the BER. At the core of the positive results were; improvements made in the participation and benefit sharing of local communities from the joint NRM, increased access and income of HHs from alternative green income generation activities, improvements in local livelihoods from increased productivity and economic returns of more sustainable range management approaches (through local government-customary integrated taskforces or “Koree”) and promotion of bio-economically more optimal farming systems such as conservation agriculture.

As a result, the awareness, ownership feeling and commitment of local HHs for sustainable use and management of forest and biodiversity resources of the Eco-region has positively increased amid worsening impacts of climate change and variability as witnessed by the locals in mid- and lowlands of the Eco-region. The above positive roles of PFM and PRM have contributed to the considerable improvements observed in the management and use of land and natural resources today in areas under PFM and PRM institutions.

In contrast, the rate of deforestation, agricultural expansion, and environmental degradation all have remained unabated and existent threats to sustainable natural resources management and use in parts of the Eco-region administered by the federal government (Bale Mountains National Park) and the Oromia regional government. As discussed in details in the preceding sections of this study report, illegal encroachment and collection of forest products, uncontrolled access and use of rangelands and biodiversity resources, overexploitation of soil resources and the associated land degradations as well as widespread conflicts and inequities in access and use of natural resources are not uncommon in most parts of the Eco-region under these institutions.

However, the study has also shown that PNRM (PFM or PRM) is not a panacea by itself for all problems of unsustainable land and NRs use in the Eco-region. Evidently, for the local HHs the short-term economic returns of land and natural resource use through PFM and PRM have been low when compared to the significantly higher incomes of rural HHs in the federal and regional government institutions. In contrast, HHs landholdings, land tenure security, farming income and economic efficiency of land use vis-a-vis access to market and social services all have shown higher results for rural HHs under federal and regional government administrations. However, the relative economic advantages in the later institutions are largely gained in the expense of loss and degradation of the valuable natural resources of the Eco-region. This implies that, PFM and PRM schemes still need to prove their economic competitiveness and optimality to balance lost benefits and minimize economic trade-offs PNRM for local communities in the BER.

In nutshell, this study has demonstrated that PFM and PRM interventions by SHARE and its partner organizations can and do have significantly improved the environmental optimality of NRM and land use in the Bale Eco-Region. However, both the PNRM and the Eco-region at large are yet faced with key challenges notably from swelling population, institutional setbacks and economic trade-offs of PNRM and alternative land use systems. Hence sustaining the current positive outcomes and achieving lasting impacts towards optimizing the economic, and social optimality and sustainability of NRM and land use in BER entails addressing the trade-offs and problems through locally fit, participatory and holistic yet targeted intervention actions some of which are suggested hereunder.

5 The way forward/recommendations

No	Suggested recommendations/measures	Responsible
1	**Maximize current synergies and minimize economic trade-offs between PFM/PRM and local livelihood activities/ demand for more natural resource uses**	
	– Improve access to market outlets and market networks for products from alternative income generation activities and NTFP uses by local HHs in PFM/PRM institutions such as honey, fruits, coffee etc.,	SHARE OFWE Reg. Gov.
	– Improve the productivity and economic competitiveness of Eco- smart land uses such as conservation agriculture, tree-crop mixed agroforestry, tree-crop-livestock integrated farming, &agro/pastoralism particularly in areas under PFM and PRM through provision and facilitation of: – More integrated farm production technologies/systems – Provision of improved crop varieties and production inputs – Promotion of fewer but high-value livestock rearing models – Introduce fast growing and productive grass and forage species – Introduction of improved forage storage and management systems to reduce dependence on the BER for grazing,	Federal Gov. Reg. Gov. SHARE OFWE Research centers MoA NGOs
2	**Further build the entrepreneurial skill, business capacity and higher value farm production by HHs in PFM/PRM**	
	– Improve the entrepreneurial capacity and business organization of HHs on existing or new green business activities such as modern bee hiving.	SHARE OFWE
	– Promote value added production of NTFPs and livestock products such as organized coffee and honey wholesaling in big cities, milk processing and marketing etc. for higher economic gains from NRs use.	SHARE OFWE Reg. Gov.
	– Create other viable green alternative livelihood sources such as CB ecotourism, CB controlled hunting buffer zones, small-scale souvenir shops by local communities themselves inside and around the BMNP.	SHARE OFWE
	– Focus on the poor and youth for more economic impacts as these groups appear to engage more in illegal logging, encroachment and charcoaling for economic reasons.	SHARE OFWE
3	**Strengthen the effectiveness of the PFM/PRM institutions**	
	– Improve the confidence of rural HHs in PFM on their land tenure security through land certifications and other binding agreements if not issued or carried out to all rural landholders in the PFM Kebeles.	SHARE OFWE
	– Build the trust of HHs to PNRM institutions esp. in the highlands of the BER who appear to perceive the BMNP and PFM (to a lesser extent) as threats to their livelihoods (agricultural expansion) and NRs use rights.	SHARE BMNP
	– Incorporate some important roles of the customary institutions as proven helpful in the case of PRM through empowering and effectively integrating customary leaders and rules in the joint NRM.	SHARE OFWE
	– Encourage the true participation of rural HHs in joint forest and biodiversity management through strengthening the taskforces and joint Koree/block/ committee in a more genuine and democratic processes.	SHARE OFWE
	– Support the establishment and implementation of local NRM and use bylaws and joint government/PFM-community forums in areas where such informal institutions have not been created.	Reg. Gov. SHARE OFWE
	– Conduct successive experience sharing visits and capacity building trainings especially for influential members of the communities both on success stories of PNRM and end results of unsustainable resource uses.	SHARE OFWE

	– Ensure the sustainability of the PFM/PRM by building more synergies between biodiversity conservation and local livelihoods through strengthening the three pillars: Participation and ownership of the NRM activities by local communities, improved well-being of local HHs from increased benefit sharing and income from the PNRM; and development of local livelihoods from higher-value and productive farming practices and maintenance of ecosystem services.	Fed. Gov. Reg. Gov. SHARE OFWE
4	**Create and influence higher level (federal, regional, inter-regional) policy dialogues and prospective land use and development plans in Bale Zone**	
	– Influence federal, regional and local government policy makers, implementing agencies and political administrators to increase their support to the PNRM initiatives through multi-stakeholder fora.	SHARE OFWE
	– Most importantly influence government agencies to align local and regional development objectives such as large-scale investments with sustainable biodiversity conservation objectives of the BER.	SHARE OFWE
	– Produce a comprehensive land use plan for the BER based on thorough land evaluation and grass roots participation of local people that clearly sets the road maps and boundaries for future land use in the Eco-region.	Reg. Gov. BMNP OFWE
	– If such land use plans are prepared, implement current and future land uses as private investment, settlement or others based on the plan.	Reg. Gov.
	– Improve the relationships and collaboration between the BMNP and the local communities through meaningful incentives and participations which appears to be wiry according to many HHs in the highlands.	Federal Gov BMNP Reg. Gov.
5	**Enhance the bio-economic optimality and contribution of current land use and land management technologies for Sustainable Biodiversity Conservation**	
	– Prioritize the effective land management practices in each agro-ecosystem such as mulching, manure; modern terracing, agroforestry, rotational grazing, cut and carry etc. as opposed to uniform promotion of all land management technologies/practices in BER regardless of their agro-ecological effectiveness and social acceptability.	Reg. Gov.
	– Improve the productivity of environmentally better optimal land use and farming systems such as crop-livestock mixed farming, tree-crop mixed farming, tree-crop-livestock integrated farming and agro/pastoralism through improved farm production technologies, improved crop varieties, improved water storage and use systems etc.	Reg. Gov. SHARE
	– Look for the best integration of farm components (tree, crop, livestock, labor) for optimal land use within the carrying capacity of the land and agro-ecosystem.	Reg. Gov.
	– Encourage integrated farming and discourage mono-cropping especially in mid and lowlands of the Eco-region through improving the economic returns of integrated farming practices and creating awareness of rural HHs on environmental impacts of such farming practices.	Reg. Gov. BMNP SHARE OFWE
	– Introduce and support climate-smart farming practices and coping mechanisms such as asset transfer and risk aversion during times of drought or rainfall shortage.	Reg. Gov.
6	**Harness the pressure from human population growth and immigration on sustainable use of land and NRs in the Eco-region.**	
	– Further mainstreaming family planning education in the daily life of the local people through religious leaders and consent of HH heads.	Reg. Gov. SHARE
	– Establish inter-regional and inter-zonal human immigration monitoring, controlling and managing taskforce especially between the Oromia and Somali regional states; and respective adjacent zones in both Oromia and Somali.	Fed. Gov. Reg. Gov.

6 References

Abera K. and Kinahan A.A. 2011. Factors Affecting Fire Extent and Frequency in the Bale Mountains National Park. Walia-Special Edition on the Bale Mountains.

Belayneh, A., Yohannes, T., &Worku, A. (2013). Recurrent and extensive forest fire incidence in the Bale Mountains National Park (BMNP), Ethiopia : Extent, Cause and Consequences, 2(1), 29–39

BMNP 2007. Bale Mountains National Park General Management Plan. (Frankfurt Zoological Society, eds.), Ethiopia.In Anteneh, B. Temesgen, Y. and Adefires, W. (2013) Recurrent and extensive forest fire incidence in the Bale Mountains National Park (BMNP), Ethiopia: Extent, Cause and Consequences.

Bureau of Agriculture and Rural Development (BoARD). 2015. Office of Agriculture and Rural Development; annual report of Goba district, Oromia, Ethiopia

Green , S.B. 1991. How many subjects does it take to do regression analysis? Mutiviarite behavioral researches 26, 499-510.

Groot J.C.J., Oomen G.J.M., Rossing W.A.H. 2012. Multi-objective optimization and design of farming systems. Agricultural Systems, vol. 110, p. 63-77.

Kruseman G., Bade J. 1998. Agrarian policies for sustainable land use: bio-economic modelling to assess the effectiveness of policy instruments. Agricultural Systems, vol. 58, n. 3, p. 465-481. http://www.sciencedirect.com/science/article/pii/S0308521X98000419

Kruseman, G. 2000. Bio-economic Household Modelling for Agricultural Intensification. PhD dissertation, Wageningen University, Wageningen.

Pallas P. 1986. Water for animals. Land and water development Division. Food and Agricultural Organization of the United Nations (FAO), Rome, Italy.

Teshome, E., randall, D. &kinahan, A.A. 2011. The Changing Face of the Bale Mountains National Park over 32 years: A study on land cover change. Walia Journal of the Ethiopian Wildlife and Natural History Society, 118-130.

UNIQUE 2008.Sustainable Financing Mechanisms for the BESMP. Part II: Carbon Finance Opportunities. Freiburg, Germany: UNIQUE Forestry Consultants.

Wakjira D.T., Fischer A. Pinard M.A. 2013. Governance change and institutional adaptation: a case study from Harenna forest, Ethiopia. Environmental Management. 4:912-25. doi: 10.1007/s00267-013-0017-9.

World Bank 2007.Measuring the Economic Impact of Climate Change on Ethiopian Agriculture: Ricardian Approach. Washington DC: World Bank.

Yalden, D.W. & Largen, M. J. 1992.The endemic mammals of Ethiopia. Mammal Review, 22, 115-150.

Yimer, F., Ledin, S. &Abdelkadir, A. 2006. Soil organic carbon and total nitrogen stocks as affected by topographic aspect and vegetation in the Bale Mountains, Ethiopia. Geoderma, 135, 335-344.