Final Report (Version III) On:

Comparative Analysis of the Cost-Effectiveness of Natural Resource Management Actions with and without Family Planning Interventions as a Means of Achieving Sustainable Resource Use in the Bale Eco-Region

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Abstract

Population growth places unsustainable pressure on natural resources, particularly where communities are usually dependent on natural resources. Thus, the objective of the study was to compare natural resource management with and without family planning interventions in the Bale Eco-Region (BER). The comparison focused on the cost-effectiveness of increased contraceptive prevalence (ICPR) and its implications for sustainable resource use. For this study, retrospective longitudinal and desk studies, and satellite imageries analysis were employed to assess the spatial and temporal trends of natural resources. Moreover, SPECTRUM model i.e. DemProj, RAPID and FamPlan modules were used to predict future population and correlated with land use dynamics under three scenarios. The result of the study indicated that current average contraceptive utilization in BER was about 41.5%. The main barriers of family planning were husband opposition (38.8%), religious principles (17.7%), fear of side effects (14.8%) and others (18.1%). The population size of BER in 2007 (1.6 million) were projected to 7.71 million (with annual growth rate of 3.81%), 6.75million (with annual growth rate (2.96%), and 5.58 million (with annual growth rate 1.82%) in 2050, if total fertility rate (TFR) remain constant, if TFR reduced to 4.1 and 2.5 scenarios, respectively. Economic benefit analysis revealed that investing 1 USD to reduce TFR from 5.7 to 2.5 can save about 53.42 USD costs of health and education. Additional, GDP per capita will rise by 44.3% whereas new job required and youth dependency will fall by 44.3% and 55.7%, respectively. ICPR to 66.7% will reduce annually required new land to attain major crops demand for consumption under constant scenario by 52%. Land use population dynamics analysis shows that if current scenarios kept constant, about 59%, 41%, 47% of forest, grazing and shrub land would be converted in to farmland until 2050 but ICPR to 66.7 alone can reduce this figure to 35%, 24% and 28%. ICPR to 66.7% alone will reduce crop consumption, house hold water demand and agricultural density of constant scenario by about 30.31%. Current annual deforestation rate by fuel wood (4720 ha/year) would reduce by about 73% if CPR increased to 66.7% and combined with reduced fuel wood demand. ICPR to 66.7% will reduce annual average loss of carbon stock from 2.05 to 1.19 million t/ha due to conversion of forestland into farmland. Investing on FP can potentially reduce population growth impact on natural resources and improve socioeconomic of BER. Thus, family planning must be considered as a cross multiple sectors issue.

Key words: Population growth, Family planning, SPECTRUM, Land use dynamics, Bale Eco Region

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List of Abbreviations

BER	Bale Eco-Region
CBA	Cost Benefit Analysis
CCPR	Constant Contraceptive prevalence
CGIAR	Consultative Group for International Agricultural Research
ETDHS	Ethiopia Demographic and Health Survey
FAO	Food and Agricultural Organization
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
FP	Family Planning
GIS	Geographic Information System
GPS	Global Positioning System
ICPD	International Conference on Population and Development
ICPR	Increased Contraceptive Prevalence
KII	Key Informant Interview
masl	meters above sea level
Mini EDHS	Ethiopia Mini Demographic and Health Survey
MoH	Ministry of Health
NPV	Net Present Value
NRM	Natural Resources Management
PHE	Population, Health, and Environment
POA	Programme of Action
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RFWC	Reduced Contraceptive Prevalence
UNDESA	United Nations Department of Economic and Social Affairs
UN	United Nations
UNEP	United Nation Environmental Program

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WFEDO	Woreda Finance and Economic Development Office
WHO	World Health Organization

1. Introduction

1.1. Background and Justification of the Study

The world population is estimated to increase to 8.1 billion by 2025 and to 9.6 billion by 2050 (UNDESA, 2013). Most of this growth is going to take place in the less developed countries. Natural increase often places unsustainable pressure on natural resources. When it is available, more forestland is cleared for cultivation; and harvesting of natural resources increases to support the livelihoods of a growing population - unless technology interventions and education change livelihood patterns. Moreover, several risks and development obstacles arise from high population growth including, lack of food security, pressure on the health and education systems and overburdening of the infrastructure (Barbier, 2010; Sinding, 2009)

Population growth leads to changes in land-use patterns: rural areas become more intensively farmed, grazed, or logged, while at the same time urban growth absorbs formerly rural areas. Population increase has led to natural resource degradation in developing countries (Carr *et al*., 2005; Rosero-Bixby and Palloni, 1998; Pan *et al*., 2007; Vanwey *et al*., 2007). Natural resource degradation leads to reduced crop production, fewer animal holdings, and less biomass. It also compels farmers to adopt more labor-intensive methods of crop cultivation and to travel longer distances to access water, fuel, construction material, and grazing sites, which leads to a progressive deterioration of farmers' standard of living.

Population growth and high birth rates cannot be fully attributed to the desire to have large families. Rather, they are in part due to the fact that women and couples lack effective birth control methods. The unmet need for contraceptives is still considerably high in the developing world. Singh *et al.* (2010) estimated that roughly six in ten pregnancies in South America and Southern Africa were unintended. Mohanty and Ram (2011) emphasize the need for improved access to contraception and family planning centres to decrease the number of unwanted pregnancies.

In the developing world, local communities often suffer from ill health because they have poor access to modern health services, including family planning. These factors pose particularly serious consequences for the health of women and children. These communities are often some of the least economically prosperous (Mulangoye and Chape, 2004) and are usually dependent on natural resources and small-scale agriculture for their livelihoods and well-being. In addition, people may be forced to use natural resources unsustainably because of underlying causes, such as rapid population growth.

In 1993, a summit of the world's scientific academies in New Delhi concluded, "if current predictions of population growth prove accurate and patterns of human activity on the planet remain unchanged, science and technology may not be able to prevent irreversible degradation of the natural environment and continued poverty for much of the world" (Graham-Smith, 1994). The world's scientific academies, including the American Academy of Sciences and the British Royal Society, stated that, "In our judgment, humanity's ability to deal successfully with its social, economic, and environmental problems will require the achievement of zero population growth with the lifetime of our children." The academies saw humanity "approaching a crisis point with respect to the interlocking issues of population, environment, and development."

The Programme of Action (POA) from the landmark 1994 United Nations International Conference on Population and Development (ICPD) in Cairo endorsed principles of sustainable development, including balancing resource availability and population growth as well as integrated population and environmental policies and programs (Germain A, Kidwell J, 1999; Report of the International Conference on Population and Development, 1994; UNFPA, 2009). The ICPD POA also offered a new emphasis on the central role of women’s sexual and reproductive health and rights in achieving sustainable development.

Integrated programming to address both social and environmental challenges dates back to the mid-1980s, when integrated conservation and development projects were started. A subset of these programs have employed an integrated approach referred to as Population, Health, and Environment (PHE), designed to simultaneously improve communities’ access to primary health care services, particularly family planning and reproductive health, while improving natural resources management (NRM) in ways that help secure livelihoods and conserve the critical natural resources upon which humans depend (D’Agnes Leona, 2009).

PHE approaches are most often implemented in areas of high biodiversity and serve populations living in or around conservation areas that often are highly dependent on those resources for their livelihoods. These same populations also have poor delivery of and access to health services. Poor health may affect their ability to engage in good conservation or resource use practices (Pollnac R.B. and K. Dacanay, 2011). Another common assumption of and justification for PHE projects is that integration of FP and environmental management activities results in "value-added" benefits. Value-added refers to synergistic results whereby greater environment and human welfare outcomes are achieved by taking an integrated multi-sector versus a single sector approach (Finn T., 2007). Proponents of such integrated approaches argue that they can be more effective and more efficient than single sector programs for many reasons (Honzak Oglethorpe and Carr, 2012). Examples of benefits includes: building trust in communities and buy-in to conservation activities; addressing unmet need for family planning and slowing population growth; improved health outcomes; empowering women; reducing operational costs or reducing pressure on natural resources (Oglethorpe *et al*., 2008; Pielemeier, Hunter, and Layng, 2007).

Family planning is an essential basic health service and one of the most cost-effective health interventions for developing countries (Bongaarts J and Sinding SW, 2009; Prata N, 2007) positively impacting the health of women, children, families, and communities (Marston C, Cleland J, 2004; Smith R.et al., 2009). It is relatively simple to provide, and can be added to other health interventions (e.g., malaria prevention and treatment) or serve as an introductory step to strengthening local health services. Importantly, it can be integrated with or serve as an entry point to other development interventions, especially regarding female empowerment (Cleland J. *et al*., 2006). Population initiatives on the other hand aim to balance a country's population size, economic and social development needs, and resource availability, including natural resources (UNFPA, 2009).

The Oromia Region has an average fertility-rate of 4.4 children per family compared to a national average of 4.1 (Mini EDHS, 2014). For families, having a large number of children is regarded as beneficial, since children from an early age help out in the household, farming and income generating activities and can support their parents when they are old. However, population pressure is seen as one of the main driving forces to environmental degradation in the Bale Eco-Region. At the same time, the region has an enormous stock of ecosystem services which benefit many people living in the area (Farm Africa and SOS Sahel, 2007). Agro-pastoralism being the dominant livelihood in Bale, increasing population is likely to increase cattle population, which adds pressure on natural resources. Agro-pastoralist societies always aim to maximize their cattle stock, due to its socio-cultural importance and because it considered an important economic investment strategy.

Despite population growth often being seen as having a negative impact on the environment, this may not always be the case. There has been cases where population growth has pushed agricultural innovation and productivity while reducing pressure environmental degradation, e.g. in Machakos District, Kenya (Tiffen and Mortimore, 1994).

This study proposes a comparative analysis of NRM actions with and without a family planning component, drawing from evidence in the Bale Eco-Region and elsewhere. The comparison was focus on the cost-effectiveness of family planning and understanding its implications on sustainable resource use in the Bale Eco-Region.

1.2. Study objective

To assess and compare the cost-effectiveness of interventions in NRM, family planning and NRM and family planning combined with regards to sustainable natural resource use in the BER.

1.3. Research questions

This study was aimed to address the following research questions.

1. What empirical evidence exists on the cost and effect (success) of family planning programmes (interventions) on the actual reduction in fertility rate, globally and in Ethiopia?
2. What are the estimated costs of family planning interventions to get fertility rate from current 4.64 to world average 2.5?
3. What are realistic scenarios of population–land use dynamics in the Bale Eco-Region given historical trends and current and likely future government policies?

4. To what extent could a reduction of fertility-rates in the BER population contribute to a reduction of pressure on natural resources in the BER for each one of the above scenarios?

1.4. Objectives

- ✓ To understand the socio-economic determinants of fertility and determine the factors that reduces fertility-rates in Ethiopia, based on existing empirical evidences from Ethiopia and developing countries.
- ✓ To estimate the costs of family planning interventions needed to get fertility rate down to world average
- ✓ To assess the cost and economic benefits in terms of investment in reducing fertility and parallels with NRM investment.
- ✓ To predict future populations in BER and calculate the required land (for agricultural, and degrees of agro-pastoralist and pastoralist livelihoods) needed to sustain their livelihoods.
- ✓ To assess the relative contribution of a reduction of fertility-rates to a reduction of pressure on natural resources in the BER, by assessing the correlation in historical and current trends between land conversion rates and fertility rates.

2. Literature Review

2.1. Population Growth and Land Use Dynamics

Land is the major natural resource on which economic, social, infrastructure and other human activities are undertaken. Thus, changes in land-use have occurred since the time of immemorial (Lambin *et al*., 2006). Studies conducted in tropical regions showed that LULC changes link with changes in the size of the population and the rate of growth (Lambin *et al*., 2003). In developing countries, particularly in Sub-Sahara African countries, yield gaps, rapid population growth, changing diets and structural poverty are the main driving forces of LULC changes (Wood *et al.*, 2004). Consequently, agriculture land has continued to expand at the expense of forestland, particularly in tropical and subtropical regions (Lambin and Meyfroidt, 2014). On average, over the past 50 years, deforestation progressed at a rate of 13 million ha per year (FAO, 2012). Lambin (2012) indicated that at the global level, food security will increasingly require trading-off food for nature.

In Ethiopia, the population which were 39.9M in 1984 rose to 53.5M in 1994, 71M in 2004, 67.6M in 2009 and 94M in 2015. This significant population growth has in turn led to increasing demand for cultivated land and other land-related natural resources. As a result, the area of cultivated land was increased to 7297M ha in 1994, 8910M ha in 2004 and 10432M ha in 2009. the numbers of people gain a living from each km^2 of arable land in Ethiopia is projected to increase from 35 in 1950 to 270 in 2050 (Teshome, 2014). Hence, with a greater dependence on natural resource based livelihoods, this can have a profound impact on the bio-physical and socio-economic situation of the rural community (CSA/ICF, 2012; Teshome, 2014).

The average land-to-person ratio in Ethiopia showed a decreasing trend from 0.508 in 1969 to 0.252 in 1999 (Teshome, 2014). Sixty and forty percent of smallholder farmers in Ethiopia cultivate less than 0.90 and 0.52 hectares of land respectively (Gebresellassie, 2006; Teshome, 2014). Farmers therefore forced to convert natural forest and woodlands into croplands in order to sustain their source of livelihood (Asmamaw *et al*., 2011; Belay *et al*., 2014). Estimates for Ethiopia suggested that the rate of conversion of forest into alternative land uses is approximately 1400 km^2 per year (WBISPP, 2004). Between 1990 and 2005 Ethiopia lost approximately 21,000 km^2 of forest, and reduced to less than 3% of the total land occupied by forest in 1990 (Dessie and Kleman, 2006; Garedew, 2010; WBISPP, 2004). Even in the highlands, people are encroaching to very steep slopes and marginal lands in order to expand cultivated land (UNESCO, 2004).

Previous studies in Ethiopia and elsewhere showed that there was rapid LULC change, with cropland replacing forestland, woodland, grassland and heath lands (Alemayehu *et al*., 2016; Dessie and Christiansson, 2008; Ningal *et al*., 2008; Nune *et al*., 2015; Paré *et al*., 2008; Zhao *et al*., 2006). For example, Kidane *et al.,* (2012) reported that agricultural land area increased from 136.39 to 735.39 km^2 within 35 years in Bale Mountain Ecoregion. Moreover, Nune, *et al.* (2016) revealed that a total of 123,751 ha of forest, 93,078 ha of shrub land, 83,158 ha of grassland, 2,473 ha of Erica-dominated land, 3,601 ha of woodland, and 3,455 ha of Afroalpine vegetation were converted to farmland and settlement between 1985 and 2015. The same author reported that farmland gained about 292,294 ha during the same period. On the contrary, forests lost substantial area with an annual average deforestation of 4,661 ha in the same period. The forest area decreased from 20.8 to 17.5% while farmland increased from 15.4 to 23.2% during the same period. Likewise, shrub land decreased from 18.2% to 15.8% and grassland was lost 2.2% within the study period. Urban settlement gained 0.68%.

2.2. Effect of Family Planning Interventions/Programs on Fertility Rates

Family planning is an effective way of controlling fertility within a human rights framework by giving couples the ability to have their desired family size. Family planning is unique among health interventions in the breadth of its benefits; family planning decreases maternal and child mortality, empowers women, reduces poverty and it lessens stress on the natural and political environment (Prata, 2009).

Globally, more than 200 million women in the developing world want to avoid pregnancy but are not using a modern method of contraception. They face many obstacles, including lack of access to information and health care services, opposition from their husbands and communities, misperceptions about side effects, and cost. If these obstacles could be overcome and the demand for family planning met, 54 million unintended pregnancies, more than 79,000 maternal deaths, and more than a million infant deaths could be averted each year (John, 2012). Promotion of family planning in countries with high birth rates has the potential to reduce poverty and hunger and avert 32% of all maternal deaths and nearly 10% of childhood deaths. It would also contribute substantially to women's empowerment, achievement of universal primary schooling, and long-term environmental sustainability (UNFPA, 2015).

If individuals and couples, especially in the developing world, planned their pregnancies and families, with improved use of contraception, they are more likely to have fewer and healthier children which will reduce the socio-economic burden on them and allow more investment in each child's care and education, helping to break the cycle of poverty (Eliason et al., 2015).

The goal of implementing a family planning program is to reduce population growth through the increased use of contraceptives and reduced fertility. In the past few decades, FP programs have played a major part in raising the prevalence of contraceptive practice from less than 10% to 60% and reducing fertility in developing countries from six to about three births per woman (Askew, 2013).

Voluntary FP programs are highly cost-effective and have demonstrable poverty-reducing effects. Research showed that with high-quality voluntary family planning programs, governments are able to reduce fertility and produce large scale improvements in health, wealth, human rights, and education. But in countries where contraceptive use is still uncommon and attitudes can range from ambivalent to hostile, strong political commitment will be essential to achieve rapid gains in contraceptive prevalence. Substantial investments in promoting voluntary family planning programs and increasing access for all women should be a top priority (John, 2012). To operate more effectively, voluntary family planning programs can be integrated into national health systems and family planning communication programs—discusses the importance of behavior change communication campaigns to educate the general population and motivate potential users to adopt family planning (John, 2012).

The contraceptive use rate in Africa is low relative to other regions of the developing world. Only two countries showed a modern contraceptive prevalence rate of more than 30%: Zimbabwe (36% modern, 43% all methods combined) and Botswana (32% modern, 33% all methods combined) (Paschal *et al*., 2015). Ethiopia's fertility rate was estimated to be at 4.6 per woman in 2016 which was declined from 5.5 children per woman in 2000, to 5.4 children per woman in 2005, to 4.8 children per woman in 2011. About 36% of currently married women are using a method of family planning: 35% are using a modern method, and 1% are using a traditional method. Among currently married women, the most popular methods are injectable (23%), implants (8%), IUD, and the pill (2% each). This suggests that the use of contraceptive methods, especially the modern ones, still remain low in Ethiopia (DHS, 2011).

2.3. Investment Cost of Family Planning Provisions

Literatures on family planning demonstrated implication of family planning programs for health and economic outcomes (Kohler 2013; Shade *et al*., 2013; Singh *et al*., 2014; Smith 2009). They have emphasizes on the costs per birth averted, the costs of service and cost of different health outcomes associated with family planning program. Each dollar invested in family planning brings multiple benefits in terms of births averted and lives saved, making family planning cost-effective health intervention (Smith 2009; Jensen 1998).

Hughes and McGuire (1996) calculated cost of family planning in Philippines based on estimates of the labor, equipment, facility, and commodity costs of delivering contraceptives. Similarly, Jensen (1998) and Singh *et al*., (2014) reported that the cost estimate should include the costs of contraceptives (direct costs) and related supplies, health worker salaries and program and systems costs (called indirect costs). They also identified the indirect costs, such as staff supervision and training, information and education on family planning, construction and maintenance of facilities, development and maintenance of commodity supply systems, and other management functions.

The annual cost of providing modern family planning services to 603 million users in the developing world was about $3.1 billion (about $5 per women using family planning) and it increased to $4.1 billion with increased the number of users to 652 million in 2014 (Singh *et al*., 2010; Singh *et al*., 2014). Kennedy *et al.* (2013) also reported the direct service delivery costs of reducing unmet need by 2020 in Vanuatu would be $324,282 per year on average between 2010 and 2025, a total of $5.19 million over the next 16 years.

The average cost per year for contraceptive supplies was estimated to be about US$1.55. However, the program costs range on average from $2 to $35 per year of protection per person, depending on the mode of service delivery (Smith, 2009). The average total cost per user is $4.76 in Asia, $10.65 in Africa and $13.44 in Latin America and the Caribbean. These differences are due to variations in method costs, the mix of methods used and indirect costs. Costs are lowest in Asia, primarily because of the high prevalence of female sterilization and IUD use (Kennedy *et al*., 2013) and they are expensive in Sub-Saharan Africa, where a higher proportion of women use hormonal methods, compared with other regions (Singh *et al*., 2014).

The per-person cost of expanding service to women with unmet needs in developing countries is close to $17 (Smith, 2009). Kennedy *et al*. (2013) estimated the direct costs of reducing unmet need by 2020 to be $14 and $7 per user per year in Vanuatu and the Solomon Islands, respectively, with between $101 and $104 required averting an unintended pregnancy. Singh *et al*. (2009) also reported the required cost of $104 and $28-30 to prevent unintended pregnancy and $3,928 to avert death of a woman or infant. Similarly, the costs estimates for a sub-Saharan context range from $2.74 (IUD) to $13.42 (implant) per couple-year of protection (USAID, 2010$_a$). The above costs are higher than global estimates of the average cost of $3.40 per user of reducing unmet need in developing regions (Singh *et al.*, 2009; Singh and Darroch, 2012).

The cost of contraceptives and related supplies varies by method. Long-acting and permanent methods such as the IUD and sterilization incur higher costs up front than short-acting methods, but they offer protection from pregnancy for many years. Thus, for each user, average annual direct costs are lowest for IUDs ($0.58), male sterilization ($0.88) and female sterilization ($1.84). Annual costs per user are substantially higher for condoms ($4.07) and are highest for hormonal methods ($7.51–7.90). The average annual cost per current user in the developing world in 2014 is $3.18 in direct costs and a total of $6.35 when indirect costs are factored in (Singh *et al*., 2014).

2.4. Cost Effectiveness of Family Planning Utilization

Empirical studies have repeatedly confirmed that family planning ranks among the most cost-effective of all health services. Kennedy *et al*. (2013) reported saving of $45 million in health and $38 million in education, which resulted in a net saving of $82 million expenditure in Vanuatu. Similarly, they projected a saving of $30 million in which $16 million from health and $15 million from education costs if all unmet needs met between 2010 and 2025 (Kennedy *et al*., 2013). Moreover, studies revealed that increased funding for family planning would also result in significant public sector savings (Asante, 2013; USAID, 2010$_b$; World Bank, 2003). For example, every dollar spent to reduce unmet need by 2020 between $9-16 could be saved on health and education (Kennedy *et al*., 2013).

Reducing unwanted pregnancy and unwanted births through family planning would have considerable demographic and economic benefits. For example, in the Solomon Islands, estimates of a cost of averted unintended pregnancies and deaths events ranged between $78 and $126, and $2,071 to $3,452 per averted unintended pregnancy and death respectively (Kennedy *et al*., 2013). Moreover, for each additional dollar spent to provide modern contraceptives, $1.40 would be saved in costs of medical care because fewer women would have unintended pregnancies (Sigh *et al*., 2009).

Recent research findings and policy brief on family planning emphasizes the positive reproductive health outcomes associated with increased availability of contraceptives that allows women and couples to satisfy unmet need (Adesina *et al*., 2015; Asante, 2013; USAID, 2010_{ab};). Singh *et al*. (2010) arguing that in 2008 modern contraceptive use prevented 188 million unintended pregnancies, 1.2 million newborn deaths, and 230,000 maternal deaths and other negative health outcomes that would have occurred in the absence of any modern FP method use. Hence, decreasing unmet need can decrease youth dependency and resulted in households with fewer dependents, higher rates of school enrolment and increased wealth (Rallu and Robertson, 2009). Fertility decline and reduced dependency have been demonstrated to contribute to improved opportunities for women and both immediate and long term economic gains for households and countries (Bailey, 2006; Canning and Schultz, 2012).

Based on Demographic and Health Survey data from developing countries, Singh *et al.* (2014) and Singh *et al*. (2010) suggested that about one third of maternal deaths is preventable if the unmet need for family planning were satisfied. However, Ross and Blanc (2012) point out that, to date, SSA has experienced minimal declines in maternal deaths, resulting from the combined effect of increases in the number of women at risk and small declines in fertility and mortality. In addition to reducing maternal mortality, increased contraceptive use has been associated with reduced infant mortality, primarily as a result of reducing the frequency of relatively short birth intervals (Shade *et al*., 2013; Singh *et al*., 2014) and better child health outcomes (World Bank, 2003). Cleland *et al*. (2012) conclude based on a review of existing literature that the infant mortality rate would fall by about 10%, and mortality of children aged 1–4 by about 20%, if all children were spaced by a gap of at least two years.

2.5. Determinants of the Use of Family Planning

Several studies have been conducted on determinants of family planning use in Africa. In these studies strong associations have been established between family planning use and some socio-demographic, cultural and economic characteristics of women. In Ghana, lack of formal education among women, socio-cultural beliefs and spousal communication were found to influence modern family planning use. Furthermore, favorable opening hours of the facilities and distance to health facilities influenced the use of modern contraceptives (Eliason *et al*., 2015b).

Various types of barriers were reported for both the discontinued group and the non-users among Egyptian women. Infecundity, menopausal or had had a hysterectomy, or was not sexually active or had sex infrequently, wanting more children, had health concerns, fear of side effects were cited as determinants of modern contraceptive use (Amin, 2014). In Tanzania, women empowerment, male-female age difference, and child desire were important predictors for modern contraceptive use (Kidayi *et al*., 2015). In Malawi, factors that encouraged desire for large families included fear of loss of children to illness, desire to increase family income, and increased power and influence of clan/lineage. Economic and health factors were the most common drivers for small family sizes (USAID, 2012). Misconceptions regarding FP; value attached to children; gender inequality in decision making process regarding FP issues; and poor attitudes regarding FP amongst most members of community in the study were inhibiting use of FP in Kenya (Waweru Peter *et al*., 2016). In rural districts in Uganda, perceived side effects of female contraceptive methods, limited choices of available male contraceptives, preference for large family sizes which are uninhibited by prolonged birth spacing and concerns that women's use of contraceptives will lead to extramarital sexual relations were Barriers for contraceptive uptake (Kabagenyi *et al*., 2014) .

Educational status, knowledge on family planning, attitude towards family planning services and availability of family planning services were identified as factors affecting current utilization of family planning service in Benishangul Gumuz, Ethiopia (Amentie, Abera, & Abdulahi, 2015). Likewise, couple discussion, perceived husband's approval, discussion with health extension worker, and perceived cultural acceptability were the independent predictors of modern contraceptive use by married pastoralist women in Bale eco-region (Belda et al. 2017).

2.6. Natural Resource Management Approaches and Practices in Ethiopia

The Ethiopian government has for a long time recognized the serious implications of continuing natural resource degradation on agricultural development and as a result large national programs were implemented to mitigate environmental degradation. However the efforts of these initiatives were seen to be inadequate in managing the rapid rate of demographic growth within the country, widespread and increasing land degradation, and high risks of low rainfall and drought (Lakew *et al*., 2005).

In Ethiopia, planning the development of natural resource conservation has started in the 1980's (Gete, 2006; Lakew *et al*., 2005; Tongul and Hobson, 2013). It was concentrated on selected large watersheds located mainly in the highly degraded parts of the highlands of Ethiopia, aimed to implement natural resource conservation and development programs through watershed development. The major part of the initiative was supported by the World Food Programme (WFP) through its Food-for-Work Land Rehabilitation Project (Gete, 2006). The land rehabilitation project, with WFP Food-for-Work assistance aimed at addressing the problems of food insecurity through the construction of soil conservation structures, community forestry, and rural infrastructure works (Tongul and Hobson, 2013). Between 1976 and 1985, estimated 800,000 km of soil and stone bunds on croplands and about 600,000 km of hillside terraces were constructed, and some 100,000 ha of land was closed for natural regeneration (Hurni, 1988). Aside from the measures introduced for soil and water conservation, reports indicate that the interventions increased the farmers' awareness of problems related to soil erosion. However, the unmanageable watersheds and with the top-down planning methodology was less effective than had been hoped (Gete, 2006; Tongul and Hobson, 2013).

The lessons learned from this experience encouraged Ministry of Agriculture (MoA) and support agencies like FAO to initiate pilot watershed planning approaches on a bottom-up basis, using smaller units and following community-based approaches. As a result, the minimum planning and sub watershed approaches were introduced (Lakew *et al*., 2005). In 1993, the WFP and MoA produced a set of guidelines known as the Local Level Participatory Planning Approach (LLPPA). LLPPA was developed for Development Agents, as a practical approach focusing mostly on integrated NRM interventions, productivity intensification measures, and small-scale community infrastructure such as water ponds and feeder roads. With WFP support, the LLPPA was tested in various agro climatic and socioeconomic conditions before being scaled up in 1994/95 through large scale training of trainers and grass roots level development agents (DAs) in over 60 districts (Woredas). This was the first step in the evolution of the participatory planning approach to water and soil conservation.

Towards the end of the 1990s, the concept of "sustainable livelihood" began to emerge, with a focus placed on better understanding of household dynamics, livelihood sources and coping strategies used within the rural community (Gete, 2006). This background paved the way, in 2002, for the fourth phase of the Food-for-Work based environmental rehabilitation program, under the name MERET (Managing Environmental Resources to Enable Transition to More Sustainable Livelihoods) that strengthened the people centered focus on participatory natural resources management and income generation (Barry *et al*., 2005). Within the MERET design, special effort was exerted on enhancing the capacity of rural communities to organize them to plan, manage and implement broad based, community wide activities. In comparison to previous land rehabilitation initiatives strong emphasis was placed on household income generating activities. The focus on household and community asset building proved to be an important stage in the evolution of the project itself and the thinking behind integrated watershed management (Gete, 2006).

In 2005, the Productive Safety Net Programs (PSNP) was launched across 262 "chronically food insecure" Woredas (districts) in the rural areas of the regional states of Amhara; Oromia; Southern Nations, Nationalities and Peoples; and Tigray to builds community-level assets through the rehabilitation of natural resources, and through soil and water conservation. The soil and water conservation activities practiced under Ethiopia's PSNP are implemented in an integrated manner, following the watershed approach (Chisholm and Tassew, 2012). MoA (2013) also indicated that soil depth can be effectively increased by soil and water conservations implementation through preventing soil loss (Fig 1 and 2).

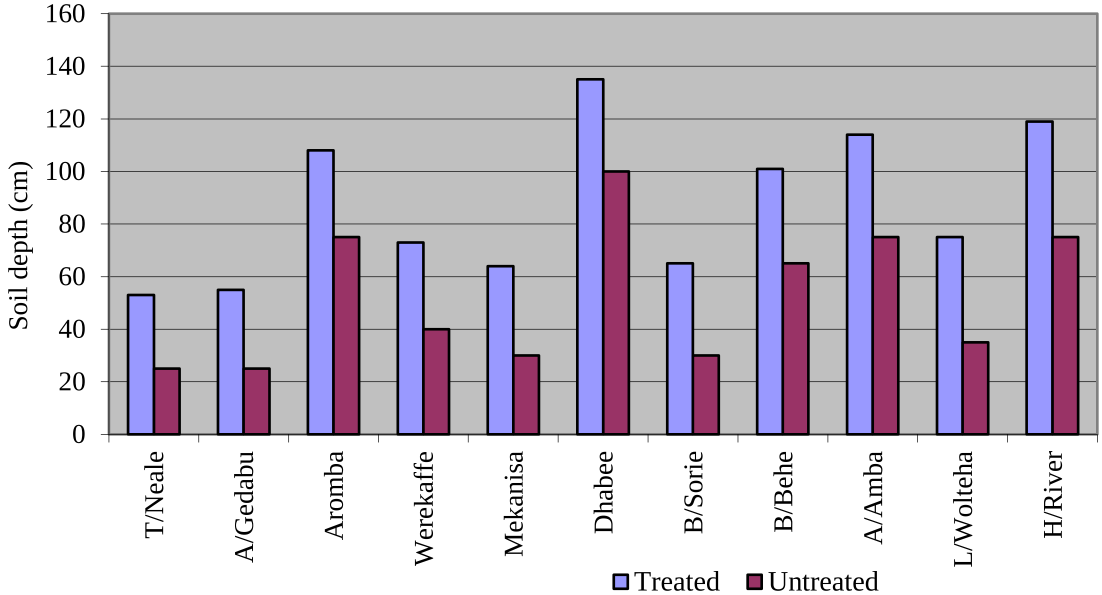

Figure 1: Soil depth increased by Soil erosion control & reduction of its on-site and off-site impacts (from 11 watersheds) (Source: MoA, 2013)

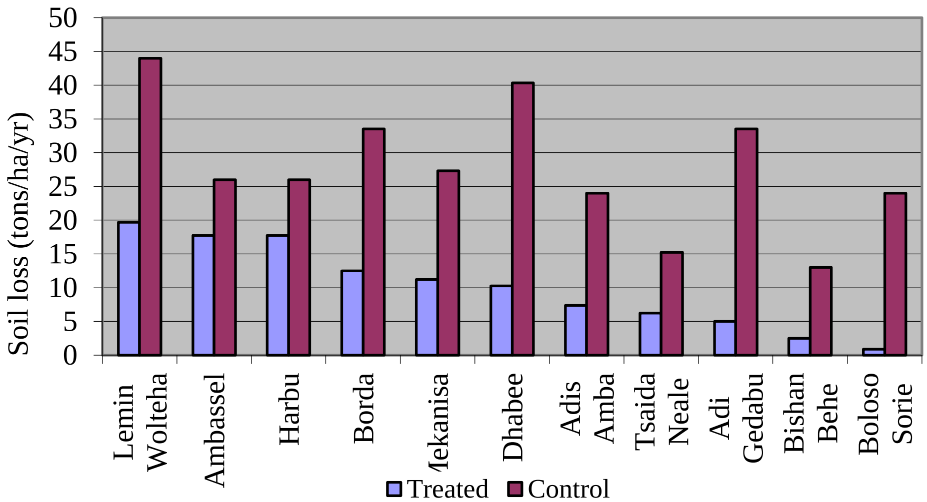

Figure 2: Soil loss reduced by soil and water conservations. (Source: MoA, 2013)

The PSNP aims to achieve sustainable livelihoods over the long term, while reducing food insecurity in the short term. With its large-scale operations, the PSNP has the potential to have significant development impacts. Initial expenditure in 2005 was 674M Ethiopian Birr (ETB) (USD 39 million); in 2009, it was ETB 2 billion (USD 115 million). Experiences with pilot projects such as the Tigray watershed management project have helped to promote greater development effectiveness in the scaling-out of the PSNP.

The Sustainable Land Management Program (SLMP) is one of the instruments designed under the long-term Ethiopian Strategic Investment Framework (ESIF) for Sustainable Land Management adopted by the Government in September 2008. ESIF is the framework that underpins domestic and foreign support for addressing issues related to the pervasive challenges to land and water resources. Similarly, SLMP is being implemented by the Ethiopian Ministry of Agriculture (MoA) through its decentralized agencies at regional, zonal, woreda and kebele levels since October 2008.

3. Methodology

3.1. Study Area Description

Location: The BER is found in Oromia Regional State in Southeast Ethiopia. It is bounded by Arsi zone in the North; Gedeb Asasa and Kofele in Northwest; South Nations, Nationalities and Peoples Region in the West; Guji Zone and Mada; Gura Damole in the Southeast; Dawe Kitchen and Ginir in the East, and Sawena and Laga Hida in Northeast. The BER covers fourteen politically defined woredas of West Arsi Zone and Bale Zone. The Ecoregion includes Kokosa, Nensabo, Dodola and Adaba woredas from West Arsi Zone, and Gololcha, Gasera, Sinana, Agarfa, Dinsho, Barbare, Goba, Goro, Madda Walabu, Gura Dhamole, Harena Buluk and Delo Mena woredas from Bale Zone (Figure 3).

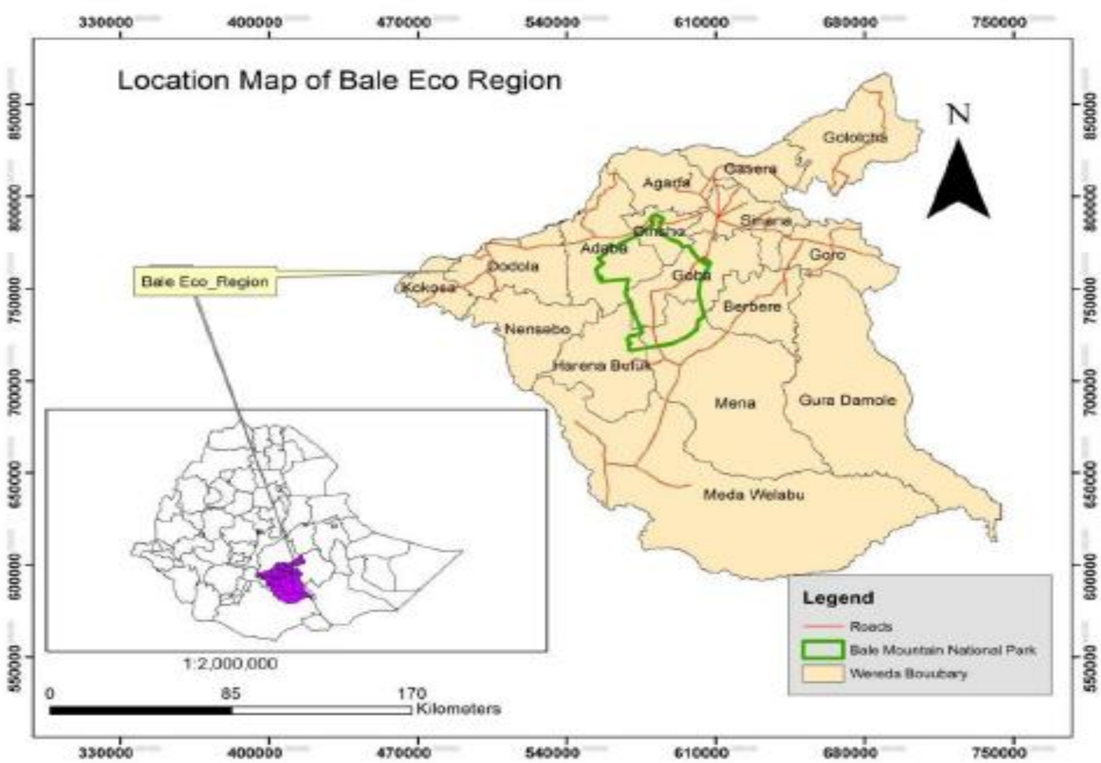

Figure 3.Location of the study area (Source: SHARE Bale Eco Region, 2017)

Population: According to the 2007 population and housing census of Ethiopia, it is estimated that about 1,402,492 people live in Bale zone and currently estimated to about 3 million (SHARE Bale Ecoregion, 2017). Among the total population, bout 713,517 and 688,975 were male and female, respectively. Around 1,235,734 people live in the rural areas that are mainly dependent on agricultural activities and the rest 166,758 people are live in the urban areas.

Climate: The climate of BER ranges from tropical in the Southeastern lowlands to alpine in the Northwestern highlands, the altitude varying between 400 and 4,377 meter above sea level. Climate variation within the eco-region shows an interesting pattern. At high elevations, such as the Sanetti plateau, the annual average temperature is less than 7.5◦C, whereas at the lower altitude (500–1000 m) it reaches an annual average of more than 27.5 ^{0}C (WBISPP, 2005). The western part of BER receives a unimodal pattern of rainfall while the remaining part experienced a bi-modal rainfall. The annual rainfall in the area ranges from 600 to 1400 mm (WBISPP, 2005).

Vegetations: According to Atlas (2004), the common natural vegetation that found in the selected woredas are Coniferous Forest, Juniperus Forest, Podocarpus Forest, Broad Leafed Forest and Wood land and Savanna forest. The BER covers 576,856 hectares (ha) of tropical dry and moist forest. The moist forest comprises The Herenna forest, the second largest stand in Ethiopia. The forests are host to globally unique and diverse fauna and flora, including a significant number of rare and endemic species. The forests in BER are threatened by the largely unregulated subsistence livelihood needs of the population, with forest being cleared to procure land for crops and livestock grazing, as well as for timber and firewood (BERSMP, 2006, BMNP, 2007). Between 2001 and 2009 the average annual deforestation rate in the eco-region was 3.44%, ranging from 1 to 8% (Dupuy, 2009). The Afro-alpine area of BER is the origin of four major rivers, which are the only sources of perennial water for the arid lowlands of the East and Southeast of Ethiopia, and for its unique and diverse fauna and flora (Yemiru Tesfaye, 2011).

Livelihood Mechanisms: Various livelihoods mechanisms serve as income source and/or domestic consumption by local communities. Inhabitants of the Eco region is mainly dependent on both crop and livestock production. Moreover, forest coffee harvesting; honey production, timber and non-timber forest products production are also used as alternative livelihood mechanisms (Tadesse and Feyera, 2008). However, the importance of the different livelihood mechanisms keeps changing over time due to social and environmental factors.

Land Use and Socio-economic Characteristics: According to OFW (2014) cultivated lands in the BER covers about 15-20% of the land. In the lower altitude areas, typically below 1,500 masl in the Southern fringe of the eco-region pastoralism and agro-pastoralism is the typical land use system. The highland farming system comprise at least three sub-types depending on crop-livestock combinations viz livestock-barley subsystem; livestock– wheat/pulse mixed system; livestock- maize/teff subsystem. The livestock- barley sub-system is typical of the cool and humid high altitude areas above 3, 000 masl with a mean temperature of about 14 ^{0}C. Barley, horse, sheep and cattle were the major component of the farming system. The livestock-maize/teff sub-system is typical of the warm and humid lower altitude area near transition to the hot arid and semiarid lowlands. It is typically practiced in the altitude range between 1, 500-2, 000 masl. The livestock-wheat/pulse occupies intermediate altitude range (2, 000-3, 000 masl). The crop system in turn provides the major supply of feed (OFW, 2014). Owing to declining grazing land, in most part of the Northern section of the eco-region crop residues supply at least 50 % of the annual feed requirements.

Family planning service: Based on Bale zone health office report, Bale zone has 715 health facilities (4 hospitals, 84 health centers, 351 functional health posts, and 179 private clinics). Out of 715 health facilities, 1 hospital, 54 Health centers, and 221 Health posts are located in BER and are owned by the government. All health facilities provide family planning and maternal health services and the services are provided free of charge in all public health facilities. Modern contraceptive methods (Injection, Pills, Implants, Male condoms) are available in the health centers and health posts. In addition, Intra Uterine Devices (IUDs) are available in the health centers and Hospital, and permanent contraceptive methods (surgical sterilization) are available in the Hospital.

3.2. Research Design

Both qualitative and quantitative study design techniques were employed to address the study objectives. The choices of the approaches were based on the unique utilities of the design. Among quantitative research designs, field survey, and retrospective longitudinal study design were employed to assess the spatial and temporal trends of natural resources. Family planning models of SPECTRUM i.e. DemPro, RAPID and FamPlan modules were also used to predict future scenarios. Moreover, satellite image analysis was used to estimate the natural resource condition and trends of land use dynamics in the study area in the past 30 years. Exploratory research designs were used to exploit information about fertility rate and natural resource condition in the study area.

3.3. Sample Size and Sampling Procedures

3.3.1. Sample size

The sample size required for household survey was determined by using single population proportion formula:

$$n = \frac{(Z_{\alpha/2})^2\, p\,(1-p)}{W^2},$$ with considering the following assumptions:

Where: p = proportion of maximum sample size 50% (p=0.5), Margin of error to be 4% (d = 0.04); $Z\alpha/2$=Critical value for normal distribution at 95% confidence level (z = 1.96). With the above assumptions the formula yields six hundred. Adding non responses rate of 10%, the total sample size of 660 households were selected (annex 4).

FGD Participants selection technique: a total of 24 FGD i.e. eight with male elders, eight with women of reproductive age, four with youth and four with experts at woreda level were made. The average number of FGD participants were ten. FGD participants were selected based on their experience, participation and knowledge on FP in the study area.

Key informant interview: For KII, three KI were arranged from each kebeles (totally 36 KIs) based on the need of the study.

3.3.2. Sampling procedures:

Household survey: Study districts (here after woreda) were first stratified into three agro ecologies namely; highland (Dega), midland (Weyina dega) and lowland (Kolla). From each stratum, two representative woredas from each agroecology were selected by simple random sampling technique. As a result, Barbare and Madda Walabu from lowland, Harena Buluk and

Delo Mena from midland, and Goba and Dinsho from highland districts were selected. A total of 12 kebels (two kebeles from each district) were selected randomly. At kebele level, a family folder (list of HH) was used as a sampling frame to select representative sample household by systematic random sampling techniques. The calculated sample size was proportionally allocated based on the number of households in the kebele (Annex 4). Both husband and wives were participated in this study. However, in female headed HHs women were asked the natural resource questioner parts only.

3.4. Source and Type of Data

In this study, both primary and secondary data from different sources were collected. Primary data were gathered from HH survey, FGDs and KII whereas secondary data were obtained from Bale zone government offices for the purpose of projections. Base-year data for over 40 indicators of demography, health, determinants of fertility, family planning usage and costs, economy, and education were collected. The indicators were population size, annual population growth rate (%), total fertility rate, adolescent fertility rate (births per 1000 women aged 15–19), proportion of women aged 15–49 married or in union (%), median months postpartum insusceptibility (months), proportion of unwanted pregnancies ending in induced abortion (%), proportion of women aged 45–49 who have never given birth (%), contraceptive prevalence rate, methods mix(%),modern methods (%), proportion of women aged 15–49 and married or in union with unmet need for family planning (%), proportion of births with any avoidable risk (%), maternal mortality ratio (deaths per 100,000 live births), infant mortality rate (deaths per 1000 live births), total gross domestic product of BER, annual expenditure per secondary student, annual health expenditure per capita. Assembling of secondary and primary data for all inputs required by the model was done.

3.5. Data collection techniques

Primary and secondary data were collected as follows.

Questionnaire Survey: Semi structured questionnaires with two parts were developed to collect the necessary information on (i) past and present trends of natural resources (grazing land, water, forest and livestock) and their utilization, (ii) data on family planning (awareness, utilization and challenges) and type of family planning services. Then the questionnaire was translated in to Afanoromo and pre tested on 10% respondents. The questionnaire was revised. Trained enumerators collected information using the questionnaire from sampled household heads of selected Kebeles.

Key Informant Interviews: Key informant interviews were made with different elders, women and stakeholders in BER using pre developed interview guide. They were interviewed on the trends of population growth, its pressure on natural resources issues, access to FP commodities and services, contribution of FP for natural resource managements, health and natural resource conservation effect of FP, and determinants of FP. In addition, government and nongovernment officials were also interviewed about FP services, contribution of FP, gaps of population policy, future population growth rate, attempts to extend FP coverage and contraceptive availability.

Focus Group Discussion: Twenty-four FGD were conducted, eight with male elders, eight with women of reproductive age, four with youth and four with experts The average number of FGD participants was ten. This was based on the assumption that rural women's and men's have different tasks and responsibilities in NRM and FP and they have different needs, priorities, and concerns for NRM and FP. The natural resource status and trends in the past 20-40 years and present thus clearly discussed past by key elders status on natural resources in relation to population growth in their kebeles. They were also participated in valuing non-marketable benefits and costs of NRM and cost effective NRM options. The information discussed in Each FGD was recorded by tape recording and note taking by reporter.

Secondary Data: Secondary data were also collected from different published and unpublished sources. The sources were Woreda Agricultural, Rural Land and Environmental Protection Offices, Ethiopian Mapping Agency, Woreda Finance and Economic Development Office, Woreda Water, Mines and Energy Resource Office, Ethiopian Demographic and Health Survey reports, Ethiopian Central Statistical Agency, Ethiopian Pharmaceutical Fund and Supply Agency. Other non-government and private providers as well as out-of-pocket family planning expenditure were included. In addition, the main sources of data were the census (CSA 2007); the Demographic Health Survey (EDHS 2011 and 2016); the Welfare Monitoring Surveys (1996 and 2000) and the household income, consumption, and expenditure surveys (2015/16).

3.6. Desk Study

Thorough studies of secondary literature were made before collecting primary data using interviews, FGD and PRA. The desk review were provided solid background information on the general context of the BER, including information related to institutions and policies; livelihoods, key factors related to family planning and NRM, and basic assumptions for the spectrum model especially for the variables not locally found in the BER. The review, in general, revealed what are already known and information gaps.

3.7. Method of Data Analysis

3.7.1. Population Projection by DemProj Module of Spectrum Model

Based on interpolation of 2007 TFR by FamPlan module of SPECTRUM, the current TFR of Bale Zone is 5.7. Population predictions were made based on three assumptions/scenarios (Table 1). Scenario A and C were used to detect dynamic change in reduction of pressure on natural resources due to family planning. This desire was based on three facts. First, by assuming that Ethiopia will reach middle income by 2025 (World Bank, 2016) and thus TFR can potential decline to 2.5 of the world average (http://data.worldbank.org/indicator/SP.DYN.TFRT.IN) (Annex 5 and 6). Secondly, UN projected that Ethiopia's TFR will fall to 2.52 by 2050 (SPECTRUM DemProj 5.1 version country default data, 2016). Thirdly, Ethiopia has maintained 2.6% annual increase of CPR until 2011 (MoH, 2011). Thus, those ICPR (58%, and 66.7%) by 2050 could most likely achieve through effective implementation of FP (Table 1).

Table 1. Scenarios/ assumptions made for DemProj, RAPID and FamPlan module projections

Assumption/Scenarios	
Scenario A	If current TFR (5.7) and CPR (41%) of BER remain constant until 2050
Scenario B	If current TFR (5.7) and CPR (41%) of BER decreased to 4.1 and increased to 58% by 2050, respectively.
Scenario C	If current TFR (5.7) and CPR (41%) of BER decreased to 2.5 and increased to 66.7 % by 2050, respectively.

Estimates for method mix were calculated from household survey in percentage for scenario A then assumed to remain constant. Secondly with increased contraceptives, local peoples are assumed to shift toward long term methods mix percentage of the world average since MoH has set plan to shift from short term to long term FP methods. Proximate determinants percentages were extracted from countries default data of SPECTRUM.

3.7.2. Cost Benefit Analysis

Economic benefits of investment NRM with and without reduced total fertility rates were projected as follows.

1. Estimation of Family planning cost effectiveness

DemProj of Spectrum package were used for population projection. The first year for 2007 and final year of the DemProj projection was 2050 which was considered as the span of the projection. Projected populations under the three scenarios were analyzed using percentage of growth and annual growth rate and tested for its significance. Family planning projections were prepared after DemProj since these projections is based upon a common demographic projection. One will serve as a baseline against which changes in the population over time resulting from changes in the level of intensity of family planning programs were measured. Most recent year on which FamPlan date available were entered into the model and considered as ‘base year’ since it is typically the most recent year for which all necessary sectorial data are assumed to be available and 2050 were the target year in which all parameters reach their target values.

Both government and non-government direct costs of providing family planning for short-acting methods and per acceptor for long acting methods were calculated from cost estimates of: commodities, supplies and equipment procurement; transporting, storage and distribution; and staff costs for counseling, method provision and follow-up (including staff costs).

2. Long Term Cost effectiveness of NRM with and without reduced fertility rate analysis

The first step of NRM cost effectiveness procedure was damage assessment and significance analysis (using household survey and secondary data from desk study and images of LULC) and secondly determined primary restoration options (house hold survey and FGDs) and thirdly select identified and measured the costs of primary restoration options based on their cost effectiveness (FGDs and in-depth interview with experts of the districts. Benefits and outcomes sustainable NR utilization with and without FP were conducted under several scenarios. In order to make projection and convert into monetary value, the following scenarios and average prediction were computed for major natural resources utilization:

A. Fuel wood

From house hold survey data average current fuel wood consumption per week were computed. Then converted in to area of forest based on above ground average volume of selected tree biomass per hectare of land. Study conducted by Moge et al (2010) and Ugalde and Pérez (2001) indicated Eucalyptus can give about 30m3/ha- 36.9 within 3 to 5 years whereas *Cupressus lucitanica* can potentially yield 132.1 ha/year within seven years. By assuming these two selected trees as the major source of fuel wood, average amount of land required for fuel wood supply in relation to population increment and fuel wood demand changes in the future were computed based on the following assumptions:

- Scenario I: If current amount of fuel wood demand for HH cooking energy remain constant in the coming 30 years combined with CCPR
- Scenario I: : If current amount of fuel wood demand for HH cooking energy remain constant in the coming 30 years combined with ICPR to 58%
- Scenario III: If current amount of fuel wood demand for HH cooking energy remain constant in the coming 30 years combined with ICPR to 66.7%
- Scenario IV: : If current amount of fuel wood demand for HH cooking energy reduced by 35% until 2050 combined with CCPR
- Scenario V: If current amount of fuel wood demand for HH cooking energy reduced by 35% until 2050 combined with ICPR to 58%
- Scenario VI: If current amount of fuel wood demand for HH cooking energy reduced by 35% until 2050 combined with ICPR to 66.7%

B. Forest carbon stock

Economic benefit of reduced deforestation from conversion into farmland by family planning in BER were analyzed by considering 1) weighted average forest carbon stock estimate of 195 tC/ha of BER (Watson, 2013) was used to predict carbon stock conserved because of reduced deforestation through implementing FP, 2) emission reductions were calculated from the difference between reduced deforestation in scenario B and Scenario C as compared to Scenario A and 3) The price of emission reductions of US\$3/tCO_2e (UNIQUE, 2010) proposed by buyers of RED project BER was used to calculate the mean and total economic benefit of reduced deforestation from farmland expansion because of reduction in total fertility to 2.5.

The assumptions for estimating economic value of reducing total fertility to 2.5 on deforestation/ forest resource conservation were:

1. The forest in BER sequestered equal amount of carbon in ton/ha, which was homogenized by using weighted average value of previous studies.
2. The carbon sequestered by 1 ha of forestland in the next twenty year is assumed constant.

C. Water Resource

The water demand of the population in the coming 34 year was projected in the three scenarios by assuming (i) the per day per person water demand in BER would be 20 liters of countries with basic drinking water systems (World Health Organization 1996; UNICEF and WHO, 2011), (ii) the cost of 50 litters water is $0.14 (Wateraid, 2016) and (iii) water demand in BER would be uniform until 2050.

D. Land requirement

In order to feed future projected population, major crop production should have to increase either through increasing productivity of land or expansion of arable land (FAO, 2009. Land required for production of major crop to attain future consumption and its conversion rate was projected until 2050 for the three scenarios with assumption of:

- The major food crops would be produced in expense of forestland, grazing land, and shrub land;
- Rural peoples produced major corps for consumption with average annual consumption rate computed from house hold survey will remain constant
- The average rate of conversion of forestland (42%), shrub land (30%) and grazing land (28%) into farmland which was deduced from different studies between 1985 and 2016 will remain constant;
- The current productivity per hectare remains constant and productivity throughout BR is the same until 2050. This is based on fact that more than eighty percent of increased productivity will be achieved by land expansion and twenty percent by inputs to attain future crop demand for consumption (FAO, 2009; Degefa, 2002),

- Average amount of compost required under scenario A, B and C were calculated and compared based on different studies of optimum compost rate conducted in different agro ecology of Ethiopia. The costs and benefits of NRM options identified under the above scenarios were valued in monetary terms using production loss and replacement cost approaches. This was allowed us to a direct comparison of the different costs and benefits under each NRM options.

4. Result and Discussion

4.1. Socio-Economic and Obstetric Characteristics of Respondents

From the total of 660 HH, 636 HHs were included in the survey which made the response rate of 96.4%. Of the total sampled respondents, (86.6% and (13.8% were male and female household head respectively (Table 2). Most (94.6%) of the study participants were Muslim which was followed by orthodox (5.1%). About 46% of the respondents (males) have practiced polygamy in which most of them have more than two wives and which has been practiced by Muslims. This results in family size of 1-6 and greater than 6 by 53% and 47% of the respondents respectively.

Table 2: Socioeconomic Characteristics of Sample Respondents

Variables	**Description**	**Total**
No. of respondent		636(96.4)
Sex of HHH (%)	Male	86.6
	Female	13.4
Religion of HHH (%)	Muslim	94.6
	Orthodox	5.1
	Other	0.4
Educational status of HHH (%)	Illiterate	40.48
	Only read & write	19.22
	Primary education	30.50
	Secondary education	8.50
	Above secondary education	1.29
Polygamy (%)	Yes	46
Family size (%)	1-6	53.14
	7-10	33.95
	>10	12.92
Main livelihood strategies (%)	Farming (Crop production)	17.29
	Pastoralist (Livestock production)	1.25
	Mixed farming	75.04
	Off-farm activities	6.42
Income in USD	22-440	41.10
	441-2200	53.85
	>2200	5.05

***Source**: Household Survey data, 2016*

The result in Table 2 depicted that about 40.5%, 19.2%, 30.5% and 8.5% of the sampled household heads were illiterate, can read and write, and studied primary education and secondary education, respectively. Most of sampled household heads had low level of education, which have significantly influenced introduction and diffusion of technologies such as family planning, climate smart agriculture, sustainable natural resource management interventions etc that improve their livelihoods and sustainable use of natural resources. Dreze and Murthi (2001) also ensured that uneducated women have less likely to have knowledge of and access to means of preventing unwanted pregnancies. These imply the needs for improving literacy level of farmers in BER to enhance their capacity for adopting technologies and minimizing impacts of population pressure on natural resources.

Around 75% of the respondents have practiced mixed farming as livelihood mechanisms which is followed by farming (17.3%) and then by livestock rearing (1.25%). The higher value of mixed farming was attributed to shift of most the pastorals in the lowland areas into agro-pastoralist by participating in both crop and livestock production. Crop production has been carried out through clearing natural forest or woodlands, which might have significant influence on sustainable use of the forest resource and other natural resources.

The annual income of 53% and 41% of the respondents were in the range of $441-2200 and $22-440 respectively (Table 2). Considerable numbers of peoples in BER have earned below the average annual income of a person ($470) in Ethiopia and $816 in least developed countries (UNDEP, 2015). These people may have little access to the financial capital necessary to intensify resource use through technological or physical inputs, and invest in new agricultural products and techniques in response to ever-increasing population and natural resource degradation. Similarly, MEA (2005) having low annual income can also increase vulnerability of the poor to further declines in ecosystem services as their livelihood strategies are significantly more likely to be dependent upon the natural resource base. This results revealed that the need for different livelihood improving interventions that can boost economic of residents in the Ecoregion to reduce their dependency on natural resources and improve their ability to use FP.

A total of 567 married women of reproduction age were successfully interviewed by enumerators during the HH survey. The mean age of the respondents were 30.52 (± 7.36 SD). Among the total study participants, the average number of children women were 4.7, but 24.6% of women were grand multiparous (had more than seven deliveries). Two hundred thirty three (41.1%) of women had more than seven pregnancies in the eco-region. In addition, nearly half of (47.7%) participants responded that their current pregnancy was unplanned (Table 3).

These findings indicate that women should be encouraged to use family planning method so as to reduce fertility rate in the Eco-region. Carr (2008) and Davis (1963) also reported that being poorness may also increase the probability of young women from poor households to marry early and have less education, which are associated with higher fertility in most contexts.

Table 3. Obstetrics characteristics of women in Bale eco-region, Ethiopia, 2016 (n=567).

Eco-region		**High land**	**Middle land**	**Low land**	**Total BER**
Parity	<= 3	52(29.9%)	60(33.7%)	71(33.5%)	183(32.4%)
	4 – 6	87(50.0%)	68(38.2%)	88(41.5%)	247(41.6%)
	7+	35(20.1%)	50(28.1%)	54(25.0%)	139(24.6%)
Gravida	<= 3	47(27.1%)	56(31.2%)	54(25.4%)	157(29.5%)
	4 – 6	65(37.2%)	47(26.3%)	64(30.2%)	176(29.3%)
	7+	62(35.6%)	76(42.5%)	95(44.6%)	233(41.1%)
Status of current pregnancy(n=197)	Planed pregnancy	14(13.1%)	48(44.9%)	45(42.1%)	107(54.3%)
	unplanned pregnancy	14(15.6%)	36(40.0%)	40(44.4%)	90(47.7%)

Source: Household Survey data, 2016

4.2. Current Family Planning Utilization and its Determinants

4.2.1 Family Planning Utilization

The household survey indicates 235(41.5%) of respondents were using modern contraceptive methods. Of the total contraceptive users, 55.4%, 35.4%, and 35.2% of women were from highland, midland and lowland residents in BER, respectively (Figure 4). This contraceptive utilization rate was comparable with Bale zone health office report where CPR was 52.54% in

2013, 37.14 in 2014(*Bale zone health Office 2015).* However, it was higher than the national averages (35%) and a study reported by Belda *et al* among pastoralist women in the Bale Eco-region (EDHS, 2016, Belda et al. 2017). It was also higher than the Middle Africa (23%), Western Africa (17%) and Sub-Saharan Africa (28%) in 2015 (UN 2015). However, the utilization rate was lower than modern contraceptive utilization rates reported in Ilu Aba Bora Zone of Oromiya regional state (69%) (Birihanu and Tesfa, 2014), Southern (69.5%) and Northern (66.2%) parts of Ethiopia (Eshete A, 2015, Tigabu, *et al*., 2014), and lower than the contraceptive utilization prevalence world average (64%), Northern Africa (53%) and Southern Africa (64%). Relatively higher utilization family planning methods by women in BER could be due to the physically available family planning service in the area and the contribution of SHARE Bale Eco-Region project as the project was giving capacity building training on FP for women in the last one year. In addition, it might also due to the commitment of Bale zone health department and magnificent effort of health experts (especially HEWs).

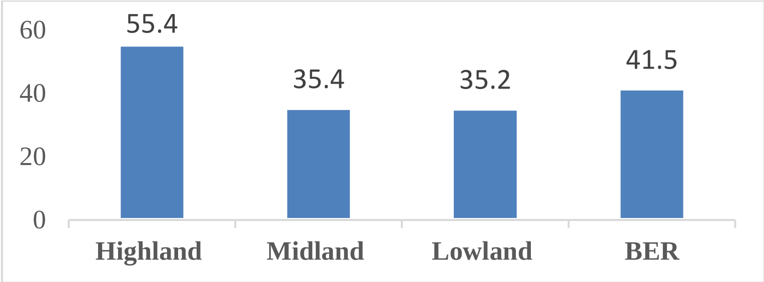

Figure 4: FP utilization prevalence of reproductive age women in BER ***(Source:** Household survey data, 2016)*

The findings of our study revealed predominantly used contraceptives; injectable (48.1%), implants (22.6%) and pills (20.0%) (Figure5). Similarly, EDHS (2016) reported that injectable (23%) and implants (8%) were the most popular FPM methods used in Ethiopia in 2016. UN (2015) also reported that the pill, injectable and male condom were more commonly used methods than other methods in Eastern Africa, Southern Africa and South-Eastern Asia. However, utilization prevalence of sterilization (1.3%), condom (0.4%) and IUD (1%) is very low in the study area (Figure 5). CSA (2016) revealed that few married women used IUD and pill (2 percent each). In contrary, Amin (2014) reported IUD (36%), pills (12%) and injectable (7%) were the most commonly used modern FP method in Egypt. UN (2015) also pointed out female sterilization (19%) and the IUD (14%) were the most common, and pill (9%), male condoms (8%) and injectable (5%) were less common contraceptive methods used by married women worldwide in 2015.

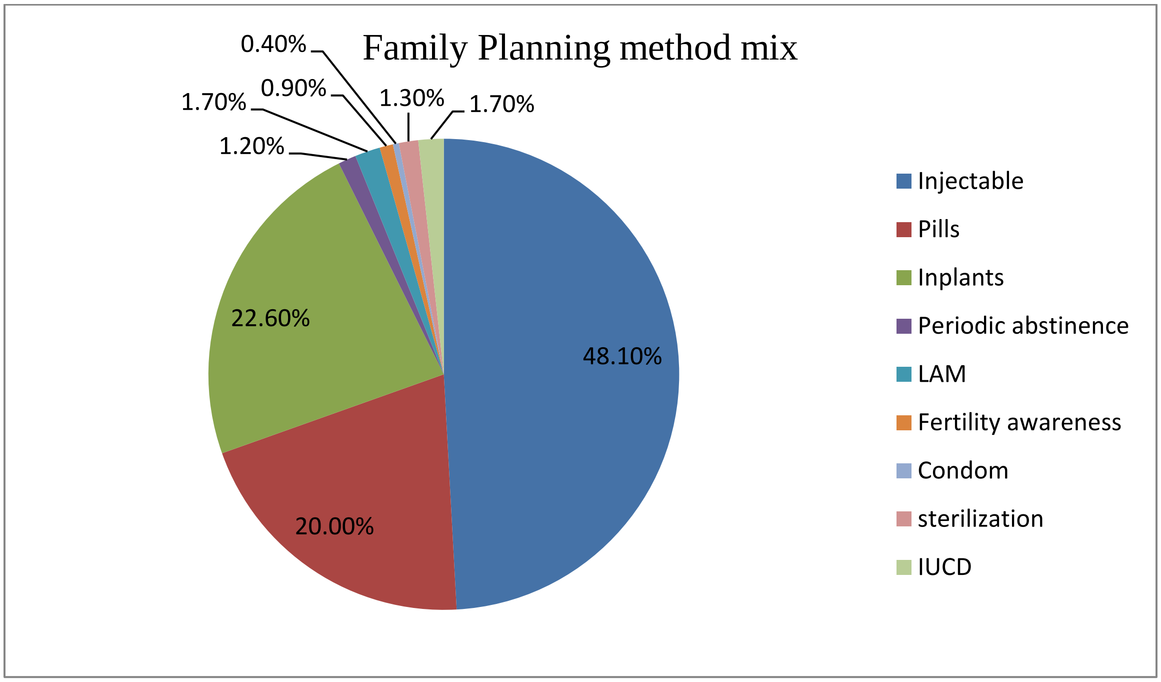

Figure 5. FP method mix used by women in BER (*Source: Household Survey data, 2016)*

The largest contraceptive prevalence in BER might be due to provision of injectable, implants and pills by Community Health Extension Workers working in health post and interventions and awareness created made by NGOs on family planning. This finding agrees with USAID (2010) who reported increased contraceptive utilization in Ethiopia due to increase in utilization of injectable provided by Community Health Extension Workers. The relatively higher prevalence of implants in BER reflects shifting of women of reproductive age towards long-lasting method that can increase cost effectiveness of the FP.

4.2.2 Determinants of Family Planning Utilization

This study revealed that religious principles(*Sheeria Law)* (17.7%), husband opposition (38.8%), fear of side effects (14.8%), long distance of FP service centers from home (5.9%), lack of awareness about the method and service (7.4%) and health related problem (4.8%) were reported as a reasons for non-use of FP (Figure 6). For instance, FGD participants from Daleomena district in Oda Dima Kebele disclosed that:

'Mothers traveled on average 1.5 hours in order to get family planning and health care services. For example, a mother from Chiilankoo (Zone 3) needs to travel for about four hours to Sefera (Zone 1) in order to get FP services.'

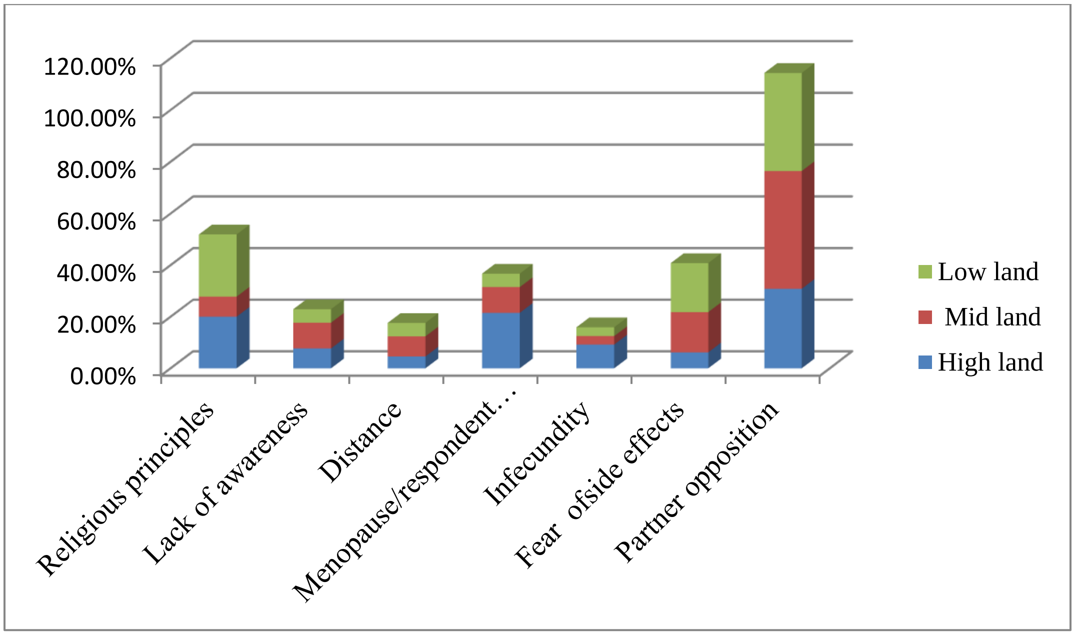

Figure 6: Barriers of FP utilization in the lowland, midland and highland of BER (*Source: Household Survey data, 2016)*

Moreover, a female key informant from Goba district (R 7) said that*:*

"We are reluctant to use FP methods because of fear of *side effects. For example, a woman in my neighbor stopped Depo injection because of irregular bleeding''.*

FGD participants also mentioned insufficient training/supervision and lack of participation of husband during FP training/consultancy as barriers for limited utilization of FP methods in the study area. For example, FGD participants of Mi`o kebele of Dinsho district (G5) reported that:

"The training was given only for a wife even it is not until she understood and convinced about importance and utilization of family planning. While her husband observed she is participating in family planning training, he do not let her to participate the training and prohibits her to use family planning as he has no knowledge and not informed about and women are economically dependent on male".

This result is in agreement with Belda et al report where religious-opposition (55.9%), desire for more children (28.3%), fear of side effects (25.5%), and husband's opposition (17.5%) were the common reasons for non-use of modern contraceptive methods (Belda *et al* 2017). Similarly, knowledge and fear of side effects (Bongaarts et al., 1995; USAID, 2012), social and familial disapproval (Bongaarts *et a*l., 1995; Sidhu *et al*., 2015), and religious and cultural factors (Sidhu et al., 2015; USAID, 2012) were the reasons reported for non-use of FP. Shaikh *et al* (2013) also reported the influence of Islamic and Hindu religion on contraception utilization. This indicates the need for further interventions that build capacity of HEW, and empowers women economically; create awareness on FP and reduction of influence of religious principles and other cultural barriers on FP usage.

4.3. Future Human Population of Bale Eco-Region

Population growth in BER was projected based on Scenario A, B and Scenario C. The population in BER would increase from 1.42 million people in 2007 to 7.71, 6.75 and 5.58 million in 2050 with Scenario A, B, and C, respectively (Figure 7). By 2050, the population of BER would increase by 495.69%, 434.14% and 358.70% in Scenario A, B and C respectively. The annual population growth rate would increase from 3.53 to 3.81 in Scenario A but would decrease from 3.56 and 3.55 in 2008 to 2.96 and 1.82 in Scenario B and C until 2050 respectively (Table 4). The paired t-test result ($t = -8.46$, $df = 42$) depicted that increase in CPR can significantly ($P<0.05$) reduce the annual population growth rate and the resultant population in BER. As a result, Scenario B would decrease the size of population by 12.4% from the population size projected by Scenario A while Scenario C would result in decrement of the size of population by 27.6% and 17.4% as compared to Scenario A and B in 2050 respectively. Scenario C would reasonably decrease the size of population in the Ecoregion by decreasing total fertility annually on average by 0.09 as compared to Scenario B. Therefore, considering biodiversity conservation, hydrologic, environmental and socioeconomic roles of BER, and implementation of Scenario C through participating potential stakeholders has paramount importance.

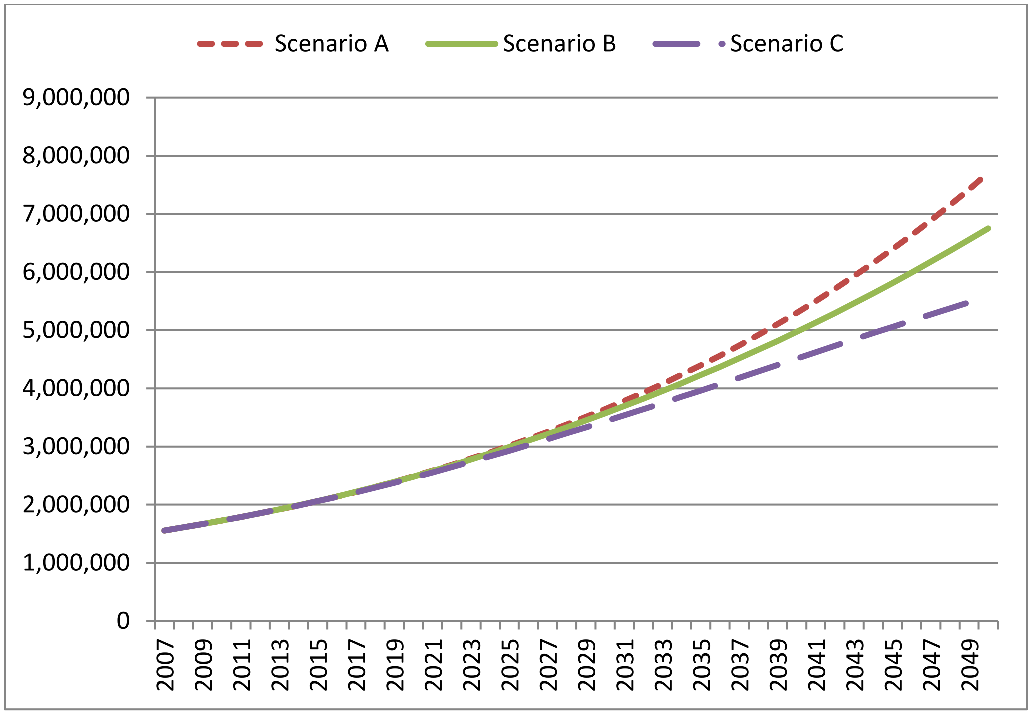

Figure 7: Projection of future populations of BER with Scenario A, B and C (Source: Projected Output: 2016)

Table 4 showed that the percent of women with the age from 15-49 projected in Scenario A (18.08%) and Scenario B (18.93%) is lower than its equivalent (20.83%) projected in Scenario C by 2050. This implies that increase in utilization of modern contraceptive can improve life expectancy of women due to decrease in mother mortality. Scenario B and C would avert 1.2 and 1.4 times both unintended pregnancies and unsafe abortion by 2050, respectively. This might be resulted because of averting additional 23,241 and 40,836 unintended pregnancies and 6,916.37 and 12,153 unplanned births every year in Scenario B and C. Investing in family planning in scenario C would reduce maternal deaths due to unintended pregnancies and unsafe abortions. Similarly, Hughes and McGuire (1996) confirmed that the most realistic means of achieving a reduction in the number of unplanned pregnancies and unsafe abortions is using contraception. They also pointed out that a high up take of contraceptive services requires proper advice concerning the use of contraception and adequate provision of these services. Moreover, Scenario C would significantly reduce the under-five and infant mortality rates (U5MR and IMR) by 2050.

Table 4: Projected population outcomes of scenario A, B and C by 2050

Population indicators	Scenario A	Scenario B	Scenario C
Annual population growth rate	3.81	2.96	1.82
Total fertility rate	5.7	4.1	2.52
% of 0-14 age population	44	38	31
% of 15-64 population	53	58	65
% of population with age $\geq$65	3	4	5
Total pregnancies	302,821	208,693	127,253
Unintended pregnancies	92,096	87,381	82,166
Averted unintended pregnancy	102,376	125,616	143,211
Averted unsafe abortion	30,466.97	37,383.34	42,619.67
Child dependency ratio	54.28	40.44	30.09
Maternal death/1000 live births	1.13	0.82	0.51
Percent of females 15-49	18.08	18.93	20.83

Source: Projected Output, 2016

4.4. Cost of Family Planning for Reducing Total Fertility Rate

Increasing investment in FP would be required over the next 34 years to achieve the above outcomes. The projected costs of FP in BER (Table 6) were $1.71, $1.91 and $2.03 million in 2050 with average annual increment of 0.80, 0.89 and 0.96 million USD in Scenario A, B and C respectively. Scenario B and C would increase the cost of FP by $0.197 and $0.318 million in 2050. Average costs of family planning per user would be $1.23, $1.49 and $1.74 under scenario A, B and C in 2050 (Table 6). As direct cost of contraceptives varies by method (Table 5), it is economical to select methods that can reduce the cost of FP and its effectiveness in Scenario C. The annual cost of each user or cycle year of protection (CYP) of sterilization ($1.19) would be least costly, followed by implant ($1.99) and Depo Provera ($2.03) in Scenario C by 2050. In 2050, CYP for short acting methods such as condoms and pills would be $8.20 and $7.04, respectively. The cost of IUD would be $12.84 in 2050. IUD, condoms and pills would become costly contraceptives as compared to others. Therefore, the high intention of women to use implant and the lower CYP of sterilization and implant would indicate preference to shift to long-lasting methods that could be the most appropriate and cost effective FP methods in BER.

Table 5: Cost of modern contraceptives per cycle of year protection in 2050

Scenarios	FP Methods					
	Male condom	Female sterilization	Depo Provera	Jadelle/ implant	Pills	IUD
A	10.03	1.50	2.45	2.41	8.23	15.35
B	8.88	1.33	2.19	2.16	7.48	13.89
C	8.20	1.19	2.03	1.99	7.04	12.84

Source*: Projected Output: 2016*

The cost of Depo Provera (2.03) and IUCD (12.84$) projected for 2050 by this study were significantly lower by $1.97 and greater by $ 12.54 than a study reported by USAID (2010), in that order. This difference might be due to difference in the cost of commodity and personnel costs.

4.5. Cost and Economic Benefits of Investment on Total Fertility Reduction

4.5.1 Health and Education

Table 6 indicated that the annual expenditure in health and education under scenario A, B and C were 143.83, 111.80 and 90.41 million USD respectively. Shifting from scenario A to Scenario B would save investment costs of 21.29 million USD, 10.73 million USD and 32.02 million USD in health, education and both in 2050. On the other hand, Scenario C would save investment costs in health, education and both health and education services of 35.34 million USD, 18.08 million USD and 53.42 million USD in 2050 respectively. This would result in saving of cost of investment by 22.26% and 37.14%, and cost saved per $1 investment in FP of 0.74 and 1.15 USD in health and education under Scenario B and C respectively. Similarly, various studies also revealed that the investment in FP was result in saving of money spent for investment in health and education (Kennedy et al., 2013, Singh et al., 2014). Sigh *et al*. (2009) also reported that each additional dollar spent to provide modern contraceptives would save $1.40 of costs of medical care because fewer women would have unintended pregnancies. The result of this study was smaller than the $9-16 that could be saved for every dollar spent for investment in health and education in Solomon Islands by 2020 (Kennedy *et al*., 2013).

Table 6: Effect of family planning on investment cost of health and education (in Million of USD) in Scenario A B and C in 2050

Investments	Cost of scenario A	Cost Scenario B	Cost Scenario C	Cost saved in scenario B	Cost saved in C	Cost saved per $1 investment in FP In scenario B	Cost saved per $1 investment in FP in scenario C
Health	103.80	82.52	68.47	21.29	35.34	0.49	0.76
Education	40.02	29.29	21.94	10.73	18.08	0.25	0.39
Health and Education	143.83	111.80	90.41	32.02 (22.3%)	53.42 (37.1%)	0.74	1.15
Family planning	1.71	1.91	2.03				
Cost added to shift from scenario A (%)		12	19				

Source: Projected Output: 2016

In 2050, estimates for averted events of unintended pregnancies were 102 376, 125 616 and 143 211 with a cost of $56.1, 51.0 and $47.6 per averted unintended pregnancy in Scenario A, B and C respectively (Table 7). This indicates that households will have fewer dependents and the cost that would be incurred for averting unintended pregnancies will become less costly in Scenario C. The cost of averted pregnancy (252.1USD) in Scenario C was higher than the results of Kennedy *et al*. (2013) in the Solomon Islands (126 USD) and Vanuatu (130 USD) in 2025. The difference might be due to difference in projection time, variation in the size of population and assumption considered.

Table 7: Cost of family planning and cost saved per averted pregnancy

Population indicators	Scenario A	Scenario B	Scenario C
Cost of FP (million USD)	1.71	1.91	2.03
Average Annual increment of Cost of FP (million USD)	0.80	0.89	0.96
Cost of family planning per user in USD	1.23	1.49	1.74
Cost per averted pregnancy	56.10	50.98	47.56

Source: Projected Output: 2016

The above results depicted that Scenario C can save more cost that would be expended in health and education services because of decreased number of population who will use the services and improving maternal and children health. Therefore, investing in family planning would result in significant public sector savings to the extent making other development goals more attainable and more affordable in BER.

4.5.2 Child Dependency

Improving prevalence of family planning has its own implication in reducing child dependency through reducing the number of unintended pregnancies and unwanted births, which would have considerable demographic and economic benefits. Child dependency would decrease to 54.3%, 40.4%, 30.1% in Scenario A, B and C (Table 4 and Figure 8). The relatively higher decrease rate in value of child dependency in Scenario C (Figure 7) indicates that increasing investment in FP would decrease the time mothers spent to care children and maximize their productivity. Moreover, reduced child dependency have been demonstrated to contribute to improved opportunities for women in both immediate and long term economic gains for households and countries (Bailey, 2006; Canning and Schultz, 2012). It also reduced the cost for expansion of health centers and schools for additional youth in Scenario A. In addition, reducing youth dependency in BER could reduce population pressure on natural resources due to increased wealth, higher rates of school enrolment (decreased illiteracy) and high opportunity for employment outside the BER. Since the 1960s, some analysts have argued that fertility decline leads to economic opportunities for developing countries—through lower dependency ratios, greater investments in children, and increased savings and investment (UN, 1996)

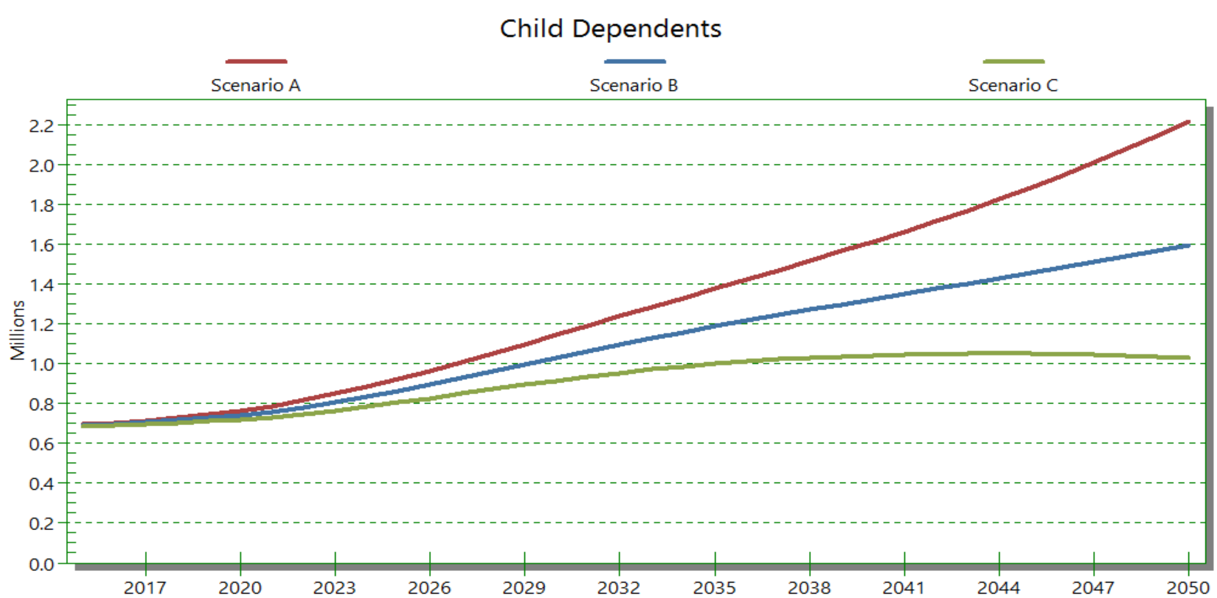

Figure 8: Child dependency percentage in the coming 33 years under CCPR and ICPR scenarios (*Source: Projected Output: 2016)*

4.5.3 GDP Per-capita and New Job Required

Scenario C can potentially raise GDP per capita under scenario A by 44.3% (Figure 9). Reduced TFR will boost economic growth in BER due to rises of working age population. Economists expect consumption related to children to retard household savings, increase government expenditure and ultimately cut into the growth of GDP (Cincotta and Engelman, 1997).

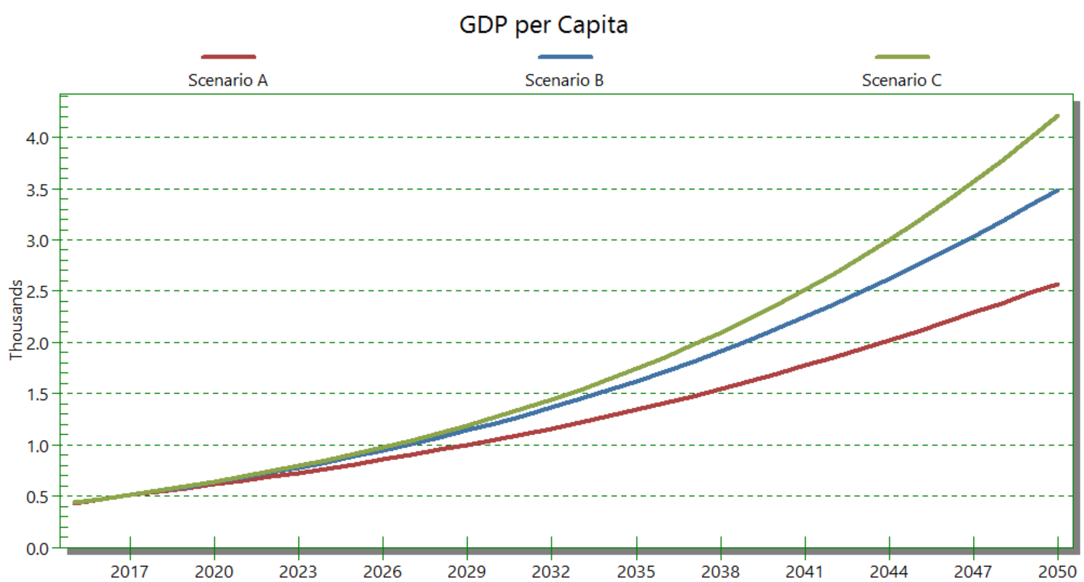

Figure 9: Pattern of GDP per capita growth pattern under CCPR and ICPR scenarios **(***Source: Projected Output: 2016)*

Given current trends, it is likely that reduced TFR to 2.5 will reduce dependent children and new job required under scenario A by about 53.4% and 55.7% in BER (Figure 9). The growth will be high if other socio-economic policies support the education and employment of young people of the Bale eco-region. The Growth and Transformation Plan II of Ethiopia anticipates sustained economic growth at current and higher levels to transform into a middle-income country by 2020. One important way that family planning contributes to economic growth is by facilitating changes in a country's age structure. In scenario C will reduce 55.7% of new job required in Scenario A (Figure 10). In many developing countries, continued population growth has resulted in pressure on natural resources, upon which their livelihood is mainly depending. In addition, with rapid population growth, many new jobs must be created each year in order to support the numbers of youth entering the labor force.

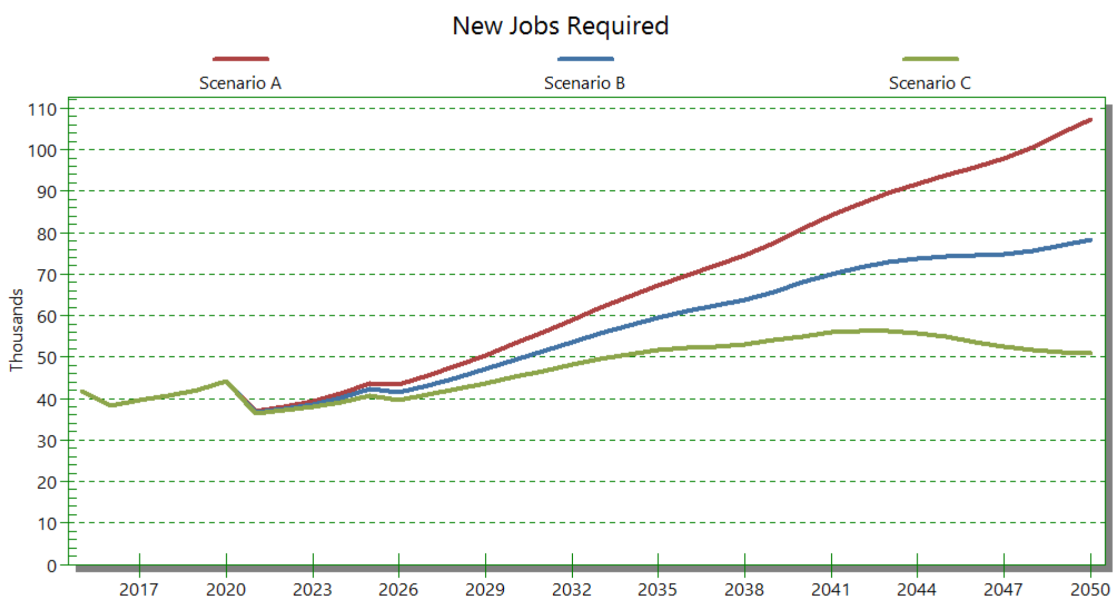

Figure 10: New jobs required projection under the two scenarios **(***Source: Projected Output: 2016)*

4.6. Scenarios of Population–Land Use Dynamics in the Bale Eco-Region

4.6.1 Historical and Current Trends Population-land Use Dynamics

A. Farm Land Size Trends

Discussants in the lowland and midland revealed that, "from Emperor to middle age of Derg regime, they were mainly dependent on collection of honey and livestock. Thus, they used to cultivate in average only about 0.5ha plot of land. For example, FGDs discussants in Harena said maize and barley production began in 1960 and 1972, respectively. Increasing cultivated land was the main copping mechanism of population growth impact on livelihood in BER. UN (2001) also remarked that for most of history, food production has been increased mainly by expanding the area cultivated in sub-Saharan countries. They also indicated that at present, there is no land to allocate for youths. Another discussant said ''Death of father is a VISA for current generation landless''. Thus, family level conflicts for land up surged.

LULC image analysis indicated that agricultural land increased by about 9 % (Annex 2 and 3) from 1986 to 2016. Similar study conducted by Nune (2016) indicated that arable land increased by 8% from 1985 to 2015. House hold land size has shrunk and unevenly allocated over time though agricultural land had expanded in the region. The main reasons were 1) population growth, 2) increased jobless and 3) impact of government land allocation policies. They said those who were actively engaged in Farmer Union ('Amrachi') during Derg regime has obtained up to 2.5-5ha and those who were not has acquired 0.25-0.5ha).

B. Agricultural Productivity Trends

Result from FGDs, key informant interviews and HH survey showed productivity of land or grain crop is lost by more than 50% if no improved technologies are applied (Table 8). They told production can only be obtained if fertilizer and other inputs are used. The study by Nandwa and Bekunda (1998) showed that constant declining of yields by over 70% in 17 years i.e., from 3.8 $t.ha^{-1}$ to 0.9 $t.ha^{-1}$ from no-input experiment (Ouedraogo *et al*., 2001)

Table 8: Trends of productivity loss in no inputs used

	Crop for	**Before 30 year**	**Current**	**Trends**
Highland	Barley	15-25 (20)	7-10 (8.5)	Decreasing (57.5%)
	Wheat	45-50 (47.5)	9-25 (17)	Decreasing (35%)
Lowland and Midland	Maize	30-60	15-25	Decreasing
	Sorghum	70-88(79)	15-30 (22.5)	Decreasing (28.48%)
	Coffee	10-20	5-10	Decreasing
	Barley	14-20	9-12	Decreasing
	Teff	3-7 (5)	0.5 – 2 (1.25)	Decreasing (30%)

Source: Survey Result of 2016

Reports from BZFD office (Figure 11) and other researcher (Nune et al, 2016) indicated as livestock number is increasing over time. But, they have not showed the decreasing trends of livestock number per HH. FGDs and KII revealed that average number of livestock per HH were decreased (Table 8).

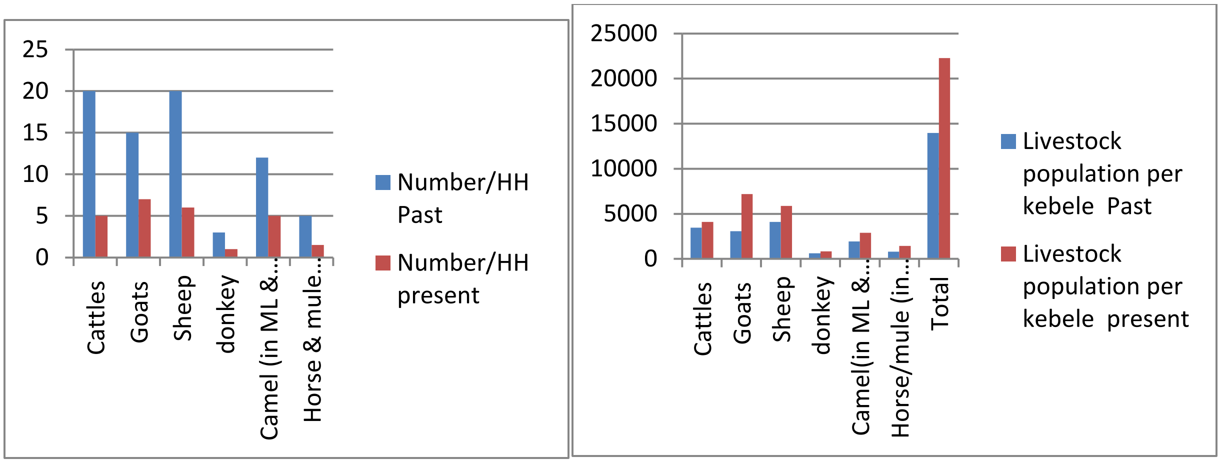

Figure 11: Average livestock number pear HH and total livestock population in each kebele of BER (HH Survey, 2016, BZEFD Bureau report, 2011).

C. Grazing/rangeland Crop residues and livestock feed trend

Satellite image analysis indicates that grass land was reduced by 17 % to 8.3 % in the past 30 years (Annex 2 and 3) in BER. Before thirty years one single HH of local people kept livestock over about 1,000ha without any interference. They said those invasive species are not important for honey production and not edible by livestock. FGDs discussants agreed that crop residues should left on farm but not practiced due to livestock feed shortage (89% of respondents from house hold survey, 2016). Not only in the study area, other researcher also indicated, and livestock in most part of Ethiopia primarily depend on crop residues (Wondatir *et al*, 2011). In the study area, crop residue were used to be burnt in the past and not used as livestock feed.

Increased human population aggravates encroachment of pastoralists in to grass and forest land for settlement and cultivation. This was due to most of the land is occupied by local peoples and unable to keep large livestock and difficult to move from place to place. This result is parallel with report of Bale Zone Pastoral Office. The report indicates that in Dallo Manna, Harena Buluk and Madda Walabu districts mean pastoralist percentage have reduced to 11.67% whereas agro-pastoralist, mixed-farming system and others increased to 47.67%, 38.83% and 2.83%, respectively. Unlike the past, they have gradual shifted toward more cultivation of land (shifted from more livestock to more crop production '*horsiissuu irraa qonnatti*'). Currently, only some of them travel with their livestock toward unoccupied areas (what they call '*Bada*' areas) during dry season and return back.

D) Water Resources Trends

At present, percentage of respondents travel less that 30 min to obtain water dropped from 45.6 to 33.6 comparing to the past 20 years whereas percentage of HH travel 1-2hr increased from 14.3 to 25.40. FGD and KI and majority of HH survey indicated drought or luck of water is affecting their livestock production. Water quality has been severely deteriorated and discussants of FGDs particularly in the mid and highland has said a number of seasonal springs have dried out since the past 30 years. Even they said natural ponds and springs where abundantly found before 30 years but now gradually disappearing. Source of domestic water have been gradually shifted from more rivers and springs to more hand dug well and harvested water (Table 10). For example, currently source of water from river and spring dropped from 50.2 to 35.7% and from 26.5% to 12.8% in the past 20 years, respectively. The main reasons stated for this were increased cultivated land and deforestation due to population growth.

Table 9: Response of household heads in % on water sources accessibility and availability for domestic uses

Sources	Before 1990s	Last year	Time taken to fetch water	Before 1990s	Last year
Spring	26.50	12.80	less than 30min	45.60	33.60
Hand Dug well	8.90	21.80	30min-1hr	35.80	35.80
River	50.20	35.70	1-2hr	14.30	25.40
Pond	5.20	12.80	more than 2hr	4.20	5.10
Tap water	2.90	13.20			
Spring and well	5.10	2.40			
Spring, well and pond	1.20	1.30			

Source: *Household survey result of 2016*

E) Forest products trend

Satellite image analysis also depicts that forest cover of the area has reduced by 10.6% in the in the BER (Annex 2 and 3). Shrubs and bush land has only decreased by 4.8% due to slight increase of invasive bush and shrubs (bush encroachments) in the low land by about 6.7% (At Madda walabu district). FGDs discussant in Madda Walabu District said the main land cover in the past was savanna grassland and herbaceous plants, but now reduced due to agriculture and shrubs or. In addition to farm land expansion, deforestation has exacerbated by fuel wood. Consumption of FW increased from 2-3 to 3-6 bandle/week (Table 11) within 30 years. This is due to 1) main food in the past were milk/milk products and honey which do not need cooking, 2) family size increased, 3) high quality FW tree species are disappearing and 4) honey production is decreasing since flowering tree and herbaceous plants decreased/disappearing. For example in Harrena before 30 yrs; it was possible to obtain 1-3 fe'aa/yr of Honey (1fe'aa = 120 kg) but now they can only collect up to 10kg/year.

Table 10: Forest Products Trends and Accessibility

Source (%)			**Accessibility (%)**		
	>1990	Last year		>1990s	Last year
Natural forest	93.9	78.8	<15min	57.4	5.4
Plantation	0.2	8.4	15-30 min	32.6	19.7
Wood Land	2.8	7.8	30min-1hr	6.9	31.7
Market	0	0.9	1hr-2hr	1.5	20.3
Forest + plantation	3.2	4.1	> 2hr	1.7	22.8
	Charcoal		Fuel wood		
Availability (%)	>1990s	Last year	>1990s	Last year	
Sufficient	60.7	13.4	89.5	7.8	
Not sufficient	9.3	77	9.9	83.9	
Not available	29.9	9.6	0.6	8.3	

Source: Survey Result, 2016

4.6.2 Effect of reducing TFR on Future Land Requirement and Land Use Conversion

The land required to produce 2,181, 1,840 and 1,521 thousand Mt of major crops demand for consumption would be 1254, 1057 and 874 thousand hectares by 2050 under scenario A, B and C, respectively (Table12). Annually about 42,814, 27,226 and 13,770 ha of new land is required under scenario A, B and C to attain future major crops consumption demand increased by population growth in 2050. This means that cultivated land should have to increase by 3.55%, 3.10%, and 2.6% annually under scenario A, B and C. This means that scenario B and C will reduce annually required new land to produce major crops under scenario A by 21% and 52% respectively.

Table 11: Major crops consumption and farmland required for production of major crops for consumption in thousands

Variables	Scenarios	2011	2020	2030	2040	2050
Major crop consumption (Mt)	A	560	746	1,076	1,540	2,181
	B	560	738	1,030	1,400	1,840
	C	560	730	983	1,262	1,521
Land required (ha)	A	322	429	619	885	1,254
	B	322	424	592	805	1,057
	C	322	420	565	725	874
Annually required additional land (ha)	A	0	15	22	31	43
	B	0	14	19	23	27
	C	0	13	16	16	14

Source: Projected output 2016

The FGD result and analysis of past research findings revealed that farmland was increased in expense of forestland, shrub land and grazing land in BER. The scarcity of arable land emanated from population pressure enforces local peoples in BER to cultivate even steep slope areas and protected areas that are not recommended for agriculture to sustain their livelihood, inducing more degradation and damage to the ecology (field observation and FGD). Currently, forestland, shrub land and grassland covers 24.6%, 33.5% and 7% of the total area of BER 37457 km^2, respectively. Result in Figure 11 indicates that about 391,301 ha (59%), 309,001ha (47%) and 232,071 ha (35%) of forestland would be converted in to farmland until 2050 under scenario A, B and C, respectively. Moreover, the current deforestation rate (0.71%) would rise to 2.72%, 1.73% and 0.88% under scenario A, B and C respectively. Thus, deforestation rate due to expanded land for major crop production for consumption would reduce by 40.3% and 69.7% under scenario B and C. Annually shrub land would be decreased by 2.16%, 1.38% and 0.70% and it would result in total shrub land of 260,867 ha (47%), 206,000 ha (37%) and 154,714 (28%) converted into farmland due to Scenario A, B and C. On the same manner, about 279,501 ha (41%), 220,715 ha (32%) and 165,765 ha (24 %) of current grazing land would be converted into farmland up to 2050 under Scenario A, B and C (Figure 11).

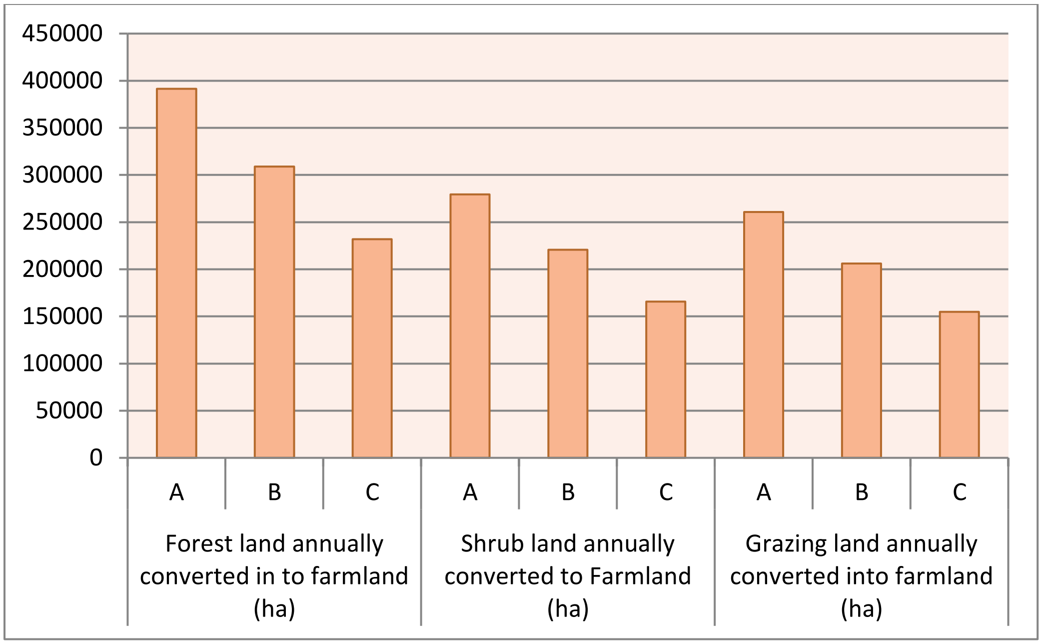

Figure 12. Forestland, Shrub land and grazing land converted in to Farmland until 2050 in BER

(Source: Projected Output: 2016)

Alike to the above findings, of the total 58,403 ha land use in Mandura District of Metekel Zone, 90.1% was converted to farmland and has significantly decreased forest land (Taye, 2014). A study by Garedew (2010) revealed that 54% woodland cover were lost from 1973-2000 in the semi-Arid areas of central rift valley of Ethiopia, which increased cropland by 28%. Dereje (2007) found that 67% decrease in forest cover between 1973 and 2005 in the southwestern rainforest with annual rate of deforestation of 2.1%. The study by Fite (2008) also showed 1.3% annual rates of forest decline for agriculture.

The above results revealed that population pressure has resulted in land use change through conversion of forestland, shrub land and grazing land into cropland. Similarly, Geist and Lambin (2002) confirmed that forest clearing for agricultural expansion is the most significant land conversion happening in the tropics. LULC change might associate with the low annual income, absence of effective institutions and weak law enforcement in BER as the poor have relayed on to utilize the natural resources. World Bank (2007) also pointed out that there is a strong nexus between land degradation, population growth and poverty in Ethiopia.

4.7. Contribution of Reduced Total Fertility-rates for minimizing pressure on natural resources

4.7.1 Effect of Reduced Total Fertility Rate for Land management

Population growth will remain as a major determinant factor for food crop demand in BER. The result revealed that comparing with scenario A, scenario C will save about 30% of major crop consumption requirement (Figure 13), though still other socio-economic interventions are required to feed the growing food requirements of the BER.

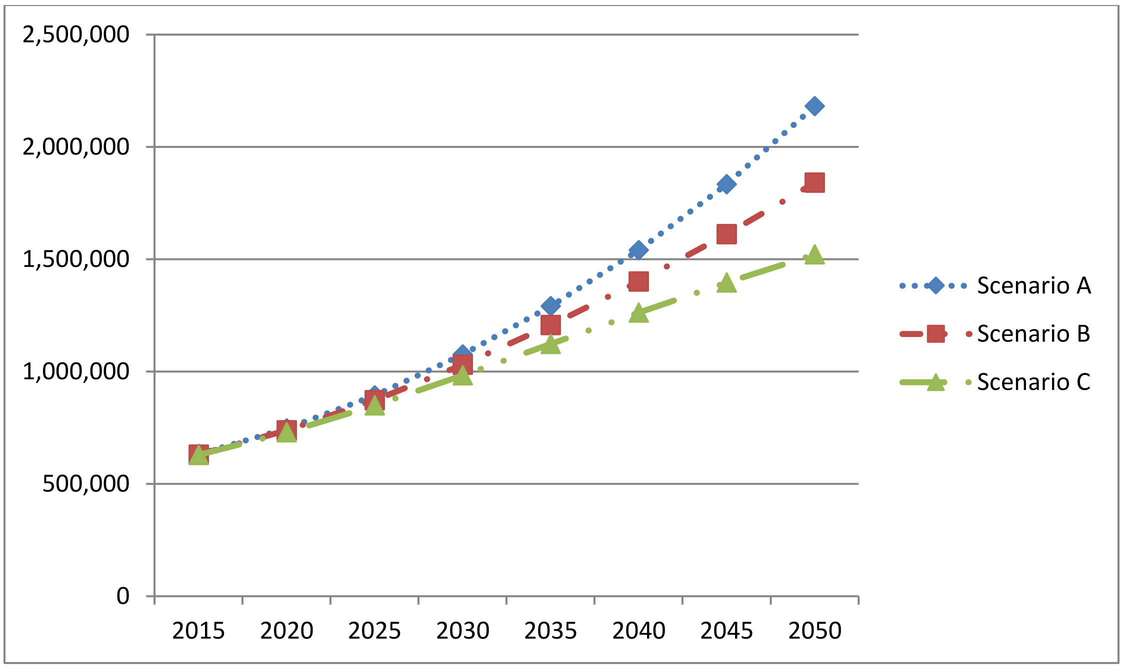

Figure 13: Projected major crop consumption under scenario A, B and C (Source: RAPID module of SPECTRUM output, 2016)

If current productivity per hectare and cultivated land remain constant, required major crop for household consumption alone is higher than the current total crop production (733,700 Qt)), and likely affect food security and livelihood. In order to feed future BER population, productivity of land should increase annually by 13% under scenario C, however more than 20% annual productivity growth required under scenario C to meet future major crop consumption demand. Similar study conducted by UN (2012) indicated that in sub-Saharan Africa, reaching a total fertility rate of 2.1 in 2050 would reduce the size of the projected gap between the region's demand for food and crops produced by approximately 25 percent. Slower population growth, as achieved by voluntary family planning use that addresses unmet need, can improve food availability by reducing total demand for food while helping women to achieve their stated fertility desires. About 20% of the growth in crop production in developing countries is expected to come from higher yields and increased cropping intensity, with the remainder 80% coming from land expansion (FAO, 2009; Degefa, 2002). Thus, required productivity growth under scenario C can significantly reduce pressure on land resource of BER by reducing required inputs and/or land expansion.

4.7.2 Effect of Reduced Total Fertility Rate on Agricultural Density

Agricultural density is one of major indicators of population pressure on arable land. The current agricultural density will significantly decrease from 10 to 7.2 without and with reduce TFR to 2.5 (Figure 14). Thus, scenario C will potentially reduce agricultural density by about 30% or by equivalent to the current density (2.7) from 2016 to 2050 if others (like cultivated land and rural to urban population ratio) remain constant. As most of BER population relies significantly on agriculture for employment and income generation, reduction of TFR would improve food security and livelihood for those remaining and depending on the land. This finding indicates that investing on family planning can also have a role in addressing the issue of sustainable natural resource utilization.

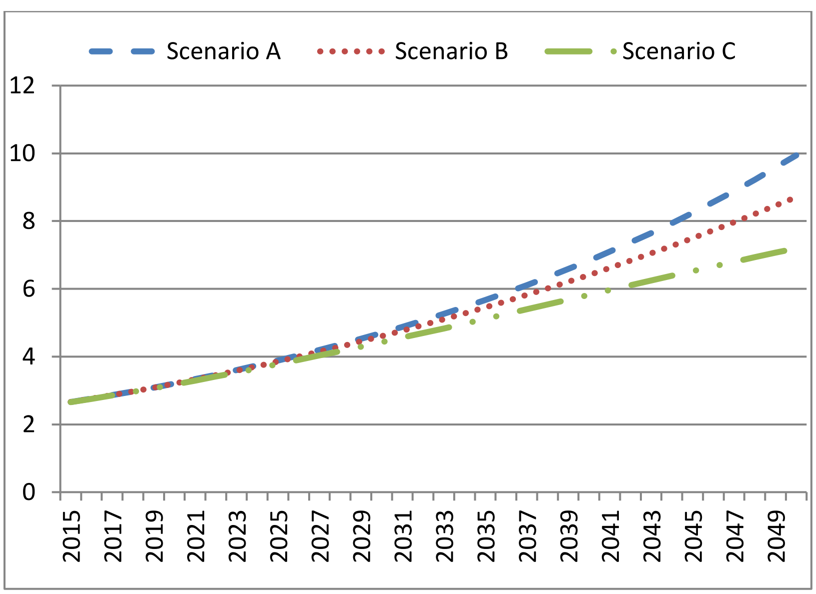

Figure 14: Agricultural density variation under the three scenarios (*Source***:** *Projected output, 2016)*

4.7.3 Effect of Reduced Total Fertility on Required Fuel Wood

Household survey indicated that mean consumption of fuel wood is about 3.1 bundles per week. In addition to deforestation due to farmland expansion raised under sub-section 4.6.2., fuel wood collection for cooking can potentially contribute to increased deforestation in the BER since fuel wood is a main driver of forest degradation in sub-Saharan countries (Skutsch, 2016; FAO, 2010). The study also revealed that biomass energy source covers 98% energy need of rural communities in the BER. Similarly, study conducted by Haile (2009) in Jima Woreda indicated that about 96% of the total energy need is met using biomass fuel. In Ethiopia, the energy for cooking primarily comes from burning fuel wood (Damte *et al*, 2012).

Under scenario VI, demand for fuel (12.7Mm^3) would be by far less than the demand under scenario I (26.9Mm^3). This indicates scenario VI would safe almost half of fuel wood demand by 2050 in BER. Current average rate of deforestation due to fuel wood in the BER is 0.2% with land expansion of farmland current rate of deforestation is 0.91%, i.e. 4720 ha/year. However, if current situation of CPR and fuel wood maintained as major source of household energy, it will cause deforestation at a rate of 17,443 ha/year. Thus, current rate will rise to 2.2% under scenario-I. However, scenario-VI will significantly reduce rate of deforestation due to fuel wood consumption from 2.2% to 0.5% by 2050 (Table 12). Comparing to scenario-I, scenario-VI will reduce annual deforestation rate by about 73% (Figure 15).

Table 12: Fuel wood demand, demand growth, deforested land for fuel wood and rate of deforestation under six scenarios by 2050

Scenarios	Fuel wood demand	Demand growth (%)	Deforested land for Fuel wood (ha)	Rate of deforestation by (%)
Current	7.2		1.1	0.6
Scenario I	26.9	273.8	4.0	2.2
Scenario II	17.6	144.3	2.6	1.5
Scenario II	23.6	227.4	3.5	0.8
Scenario IV	15.4	114.0	2.3	1.4
Scenario V	19.5	170.5	2.9	1.0
Scenario VI	12.7	76.8	1.9	0.5

Source: Projected output, 2016

Thus, fuel wood harvesting will significantly cause severe deforestation with no further intervention in FP and energy efficiency and diversification of HH energy sources. Similarly, projected studies indicated that fuel wood demand will grow at roughly the same rate as population with rising demand (Amold *et al*, 2006). Bencel (2008) and FAO, (2009) has also indicated that fuel wood can augment deforestation since most wood fuel demand is met from forest and shrubs degradation. Thus, investing on FP interventions can reduce deforestation rate to allowable cut and there by contribute for better natural resource management.

Thus, in addition to ICPR, combination of other alternative energies and increasing energy efficiency technologies will be very crucial to reduce the dominance of biomass energy sources and thereby rate of deforestation (Damte *et al*, 2012).

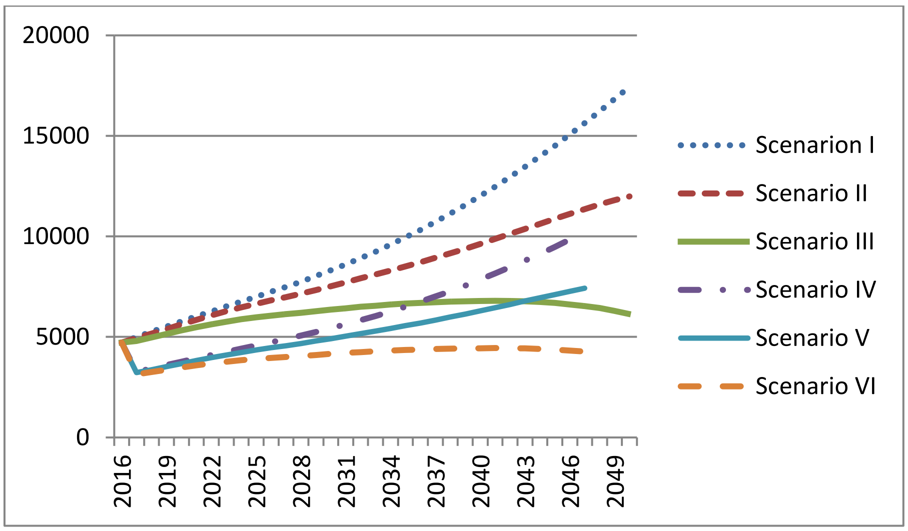

Figure 15: Difference in annual deforestation rate (ha/year) due to fuel wood under the six scenarios. *Source: Projected output, 2016*

4.7.4 Effect of Reduced Total Fertility Rate on Carbon Stock

The average annual loss of 2.51, 1.61 and 1.19 million t/ha of carbon stock due to conversion of forestland into farmland were projected until 2050 in Scenario A, B, and C in BER respectively (Table 13). Similarly, USEPA (2016) and Gibbs (2007) reported that agriculture and associated land use changes have been the principal drivers of deforestation and were responsible for 24% of global greenhouse gas (GHG) emissions in 2010. FAO (2015) reported that humans struggle to increase food required by 70% in 2050 can highly increase the GHG emission by agriculture.

Table 13. Effect of investing on total fertility rate in reducing carbon loss from forest

Scenarios	Carbon Stock (mill t/ha)			CO_2 e (mill t/ha)	
	2015	**2050**	**Mean**	**2015**	**2050**
A	0.89	3.51	2.05	3.36	12.83
B	0.89	2.23	1.61	3.25	8.16
C	0.89	1.13	1.19	3.13	4.13

Source: Projected Outputs, 2016

Table13 indicates that scenario C will potentially conserve more carbon stock and save more money that would be lost due to conversion of forestland into farmland as compared to the other scenarios via reducing rate of deforestation through reducing population pressure on natural forest. This would result in decrease for carbon emitted into the atmosphere and conservation of the landscape. Moreover, conservation of land such land also intern contributed for development and sustainable use of water resources in the Ecoregion. Similarly, FAO (2015) indicated that slowing population growth has the potential to significantly reduce future greenhouse gas emissions and optimize its benefit. Potts and Marsh (2010) also reported investment that could reduce 'unmet need' for family planning by 72% would considerably lower global population in 2050 and reduce carbon emission between 2009 and 2050 by 34 Giga tones.

4.7.5 Effect of Reduced Total Fertility Rate on Water Resource

As the population pressure let local community annually to degrade additional land for production of major crops, most of the lands used for expansion of cropland are found in the upper catchment part of the water resources. These have resulted in loss of significant number of streams and fluctuation of water flow rate in BER. For example, FGD discussant revealed that during Empirial and Derg regimes we used streams nearby our settlements for domestic and animal use. However, we have currently traveled more than two hours in search of water especially for animal use. The FGD discussant in Harena Bulk also mentioned that the scarcity of water was mainly because of the ever-increasing population growth, which has converted forestland in to farmland for crop production.

Projection of water demand in BER up to 2050 also depicted the water demand for household consumption in BER would be 56.26, 49.28 and 40.71 million M3 in Scenario A. B and C respectively (Table 14). Scenario B and C could reduce the water demand for house hold consumption by 12.4% and 27.6% in 2050 with annual average decrement of 5.53% and 13.17% respectively. Scenario C would save significantly higher amount (15.6 million M^3) of water as compared to Scenario A which can be a burden on water resources and government to supply the water for population projected in Scenario A.

Table 14. The effect of reduction in TFR in reducing water demand up to 2050

Year	**Population in million**			**Water demand million (M^3)**			**Water saved by Scenario B (%)**	**Water saved by Scenario C (%)**
	A	B	C	A	B	C		
2015	2.06	2.06	2.06	15.05	15.05	15.05	0.00	0.00
2025	3.02	2.99	2.93	22.01	21.83	21.38	0.82	2.86
2035	4.39	4.23	3.96	32.08	30.87	28.93	3.77	9.82
2045	6.39	5.81	5.06	46.65	42.43	36.92	9.05	20.86
2050	7.71	6.75	5.58	56.26	49.28	40.71	12.41	27.64
Mean	4.31	4.07	3.74	31.44	29.7	27.3	5.53	13.17

Source: Projected output, 2016

Similarly, PAI (2011) reported that population growth is a major contributor to water scarcity in the world as global food demand will be expected to double by 2050. FAO (2008) also revealed that such increment put increased pressure on water resources. PAI (2011) also indicated that the most water scarce areas would be typically those with high population densities and high population growth rates (UN, 2007). Therefore, implementing Scenario C which will slowing population growth rates can also be an effective strategy for achieving universal access to clean and safe water resources and can significantly reduce human population pressure on water resource and catchments.

4.8. Economic benefit of investing in NRM with and without reduced TFR

4.8.1 Land management

Investing on TFR reduction has shown significant economic return by saving investment cost of compost as organic treatment required for increased productivity (Table 15). In order to attain consumption of major crop demand by 2050, on average about 7.7 million metric tons of compost is required on farmlands of BER but scenario C can reduce this figure to 5.4 million metric tons for sustainable productivity.

Table 15: Economic benefit of reducing TFR on Compost required by 2050 in BER.

		NPV		
Scenarios	MT (compost and manure)	Produced crops (MUSD)	Cost of compost &manure USD	Net present cost saved (%)
A	7.7	6457	2,970	
B	6.5	5447	2,506	15.63
C	5.4	4,504	2,072	30.25

Source: Projected Output, 2016

Converted NPV of compost requirement revealed that, Scenario C can significantly reduce cost of organic fertilizer requirement by about 30% required to rehabilitate further degraded natural resource by slowing down population growth. Similarly, Klasen, (2004) confirmed that in a low population growth environment, it is easier to extend sustainability services. Cincotta and Engelman (1997) also agreed that such kinds of domestic savings generated largely from reduced TFR will contribute to natural resource management and economic growth.

4.8.2 Economic Benefit of reducing Total fertility via Conserving Forest

The projected forestland conversion would resulted in loss of 295.92, 188.18 and 95.17 million USD because of loss of carbon sink in Scenario A, B and C respectively (Table 16). The result also implies that Scenario B and C would save 107.74 and 200.75 million USD through reducing emission due to conservation of natural forest in BER, which would be 279.83 % and 819.93% of the same in scenario A in 2050.

Table 16: Economic benefit of reducing total fertility rate on carbon stock

Scenario	CO_2 e (mill t/ha)		NPV Cost CO2e (USD mill)		Cost saved (USD mill)			Cost saved in %	
	2015	2050	2015	2050	2015	2050	Mean	2015	2050
A	3.36	12.83	10.07	295.92	-	-		-	-
B	3.25	8.16	9.74	188.18	0.33	107.74	23.76	3.31	279.83
C	3.13	4.13	9.46	95.17	0.67	200.75	45.54	6.86	819.93

Source: projected output, 2016

4.8.3 Economic benefit of reducing TFR through Minimizing Water Demand

Table 17 shows that possible cost incurred to obtain water in BER, i.e. 1.21, 1.06 and 0.88 million USD under Scenario A, B and C respectively. Monetary value of water availability for household consumption indicated that the three Scenarios can potentially reduce cost of water from 0.04 million USD in 2015 to 12.84, 11.87 and 10.6 million USD in 2050. This implies that improving CPR to reduce fertility to 2.5 would optimize the cost and economic benefit of investment in water resources and its utilization.

Table 17. Cost and economic benefit of reducing total fertility rate on minimizing cost of water

Year	Cost of water by Scenario (NPV in million $)			Cost saved by Scenario B & C (thousand $)		Cost saved (%)	
	A	B	C	B	C	B	C
2015	0.04	0.04	0.04	0.00	0.00	0.00	0.00
2025	0.11	0.11	0.11	0.90	3.14	0.82	2.84
2035	0.29	0.28	0.26	10.93	28.30	3.79	9.82
2045	0.75	0.68	0.59	67.93	156.46	9.05	20.85
2050	1.21	1.06	0.88	15.03	334.64	12.42	27.64
Total	12.84	11.87	10.59	965.82	2246.45		
Mean	0.36	0.33	0.29	26.83	62.40	4.04	9.89

Source: Projected output, 2017.

5. Conclusion and Recommendation

5.1. Conclusion

The inhabitants in BER were practiced polygamy (46%), more than six family size (47%) and were not educated (59.7%), had low income (41%) and were predominantly (75%) relayed on mixed farming. Women in the reproductive age have mainly used injectable (48.1%), implants (22.6%) and pills (20.0%) with CPR of 41.5%. The low CPR mainly attributed to husband opposition (38.8%), religious principles (17.7%) and fear of side effects (14.8%). This low CPR of FP have contributed for 38.0% of greater than seven parity and 5.7 total fertility that accrue the need for reducing total fertility rate at least towards world average 2.5.

Population in BER would increase from 1.42 million people in 2007 to 7.71, 6.75 and 5.58 million in 2050 in Scenario A, B, and C, respectively. Scenario B and C would decrease the size of population by 12.4% and 27.6% as compared to Scenario A. Therefore, Scenario C can significantly decreasing the size of population in the Ecoregion. Moreover, Scenario C would increase percent of reproductive age women and decrease child dependency to 30.1% via averting 42, 620 unintended pregnancies and 143,211 unsafe abortions every year until 2050.

Cost and economic benefits analyses of investment on family planning requires annual investment cost of 0.80, 0.89 and 0.96 millions of USD in Scenario A, B and C respectively. The annual cost CYP of sterilization ($1.19), implant ($1.99), Depo Provera ($2.03), pills ($7.04), condoms ($8.20) and IUD ($12.84) were the lowest in Scenario C by 2050. Therefore, the high intention of women to use implant in BER and the lower CYP of sterilization and implant would encourage shifting to long-lasting methods that could be the most appropriate and cost-effective FP methods in BER.

Reducing total fertility of 5.7 to Scenario B and C would save investment costs of both health and education services by 32.02 million USD and 53.42 million USD in 2050 as compared to scenario A. This would result in cost saved per $1 investment in FP of 0.74 and 1.15 USD in health and education with annual average cost of $47.0 and $45.1 per averted unintended pregnancy in Scenario B and C respectively. These indicate that Scenario C can save more investment cost for public services in health and education and would resulted in the highest

GDP per capita as compared to other scenarios that could be used to make other development goals more attainable and more affordable in BER.

The result of historical analysis of land use dynamics in BER indicated that conversion of forestland, grazing land and shrub land in to farmland has direct relationship with population pressure, decrease in size and productivity of farmlands, and effect of climate changes. Annually on average 23.9, 18.9 and 14.2 thousand ha of new land will be required to feed annually increased population until 2050 in scenario A, B and C respectively. Scenario B and C will reduce annually required new land under scenario A by 21% and 52% respectively. Hence, 35% of forestland, 28% of shrub land and 24 % of grazing land will be converted in Scenario C as compared to 59%, 47% and 41% of the same in scenario A until 2050. The average annual loss of 2.51, 1.61 and 1.19 million ton of carbon stock due to conversion of forestland into farmland were projected until 2050 in Scenario A, B, and C in BER respectively. Scenario C would reduce loss of carbon sink that can store annually on average 1.32 million ton of carbon as compared to Scenario A, which was higher than that of scenario B. This implies that implementing Scenario C can ensure sustainable utilization of the natural resources and reduce human induced pressure on environmental resources.

It was found that reducing TFR to 2.5 (Scenario C) would also reduce pressure on natural resources through reducing cost of investment in land resource management (e.g. composting and fertilization) and land use conversion by about 30.3% from 2016 to 2050. Scenario C with fuel wood cover only 65% of household energy would also decrease population pressure on forest resource through decreasing annually deforested land by 73% due to fuel wood consumption as compared to Scenario A with fuel wood the only energy source. The above result depicts that combination of implementation of FP with alternative technologies that can boost productivity and reduce loss in natural resource consumption will radically decrease the pressure of population on natural resources.

The projected forestland conversion would resulted in loss of 295.92, 188.18 and 95.17 million USD because of loss of carbon sink in Scenario A, B and C respectively. The result also implies that Scenario B and C would save 107.74 and 200.75 million USD through reducing emission due to conservation of natural forest in BER, which would be 279.83 % and 819.93% of the same in Scenario A in 2050.

Projection of water demand in BER up to 2050 also depicted the water demand for household consumption in BER would be 56.26, 49.28 and 40.71 million M3 in Scenario A. B and C respectively. Scenario B and C could reduce the water demand for household consumption by 12.4% and 27.6% in 2050 with annual average decrement of 5.53% and 13.17% respectively. Scenario C would save significantly higher amount (15.6 million M3) of water as compared to the demand in Scenario A which can be a burden on water resources and government to supply the water for population projected in Scenario A.

Generally, implementation of Scenario C in BER would reduce human population, ensures economic benefits of future generation through selling carbon sequestered in preserved forest, reduction of cost of production of farmland and water resources development cost, and reducing population burden on natural resources with higher return on investment and socioeconomic and environmental benefits.

5.2. Recommendations

As scenario C has found to significantly reduced population size as compared to other scenarios with relatively higher cost but with the highest benefit in saving investment costs in health, education and natural resource management, it is recommended to implement it to bring sustainable development in BER.

The current contraceptive utilization (41.5%) was relatively higher than the national contraceptive prevalence rate. However, there were reasons for not using modern contraceptive methods including; religious principles, partner /husband opposition, distance of FP service centers from home, fear of side effects, health related problem, do not know which methods are available and do not know where to obtain a contraceptive method. Hence, family planning programs should be tailored to actively involve husbands, community and religious leaders to reduce socio-cultural misconceptions of FP use. In addition, providing IEC and house-hold level discussion on the important of family planning service utilization in the eco-region/district is also recommended.

Shifting to long-acting (sterilization and implant) FP methods would also resulted in low cost and improve effectiveness of FP interventions. Hence, the involvement of the stakeholders is crucial especially in improving service delivery capacity of HEW through providing training on provision of long-acting methods, solving FP related maternal health problems and awareness creation techniques; recruiting health officers that provide the services, and supplying utilities and facilities to make implementation of Scenario C more effective until 2050.

Effective family planning has shown significant improvement of natural resource management and socioeconomic condition of the BER. Thus, family planning must not be considered as a narrow sectorial issue. Instead a cross sectorial response is need. In general, different sectors of government, NGOs and the community in BER should contribute resources for development of FP infrastructures and equip health centers and health posts with necessary facilities and capable experts in order to increase accessibility, quality and service delivery potential of the health centers.

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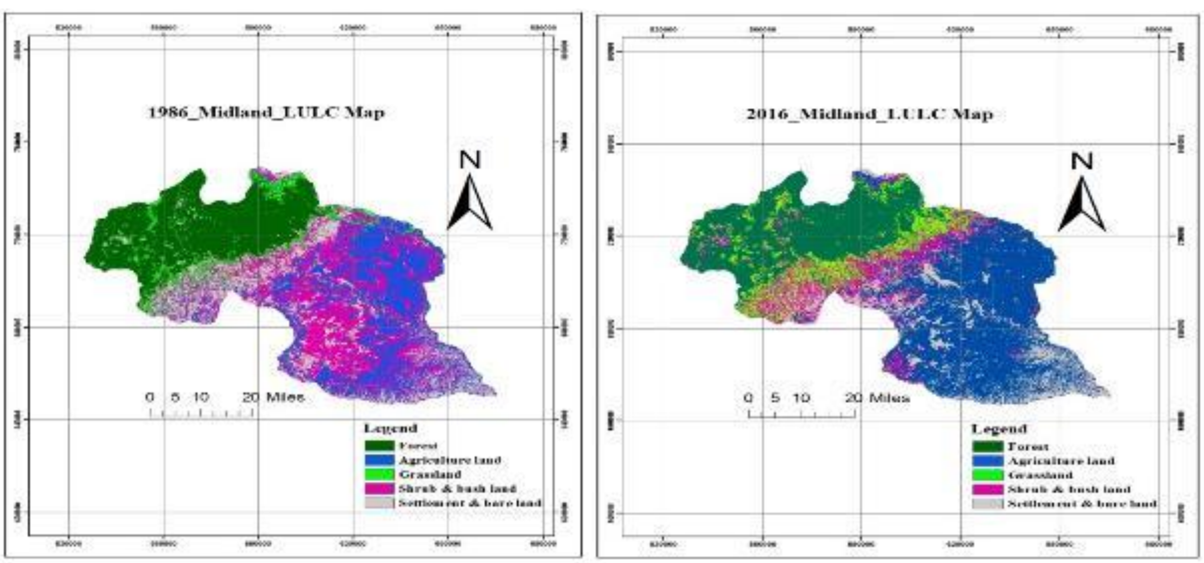
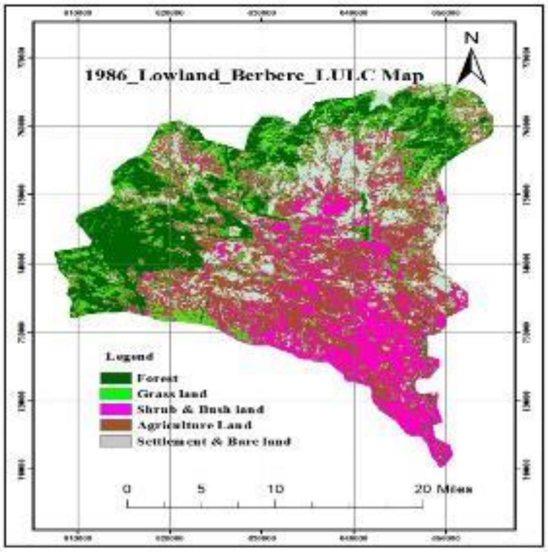
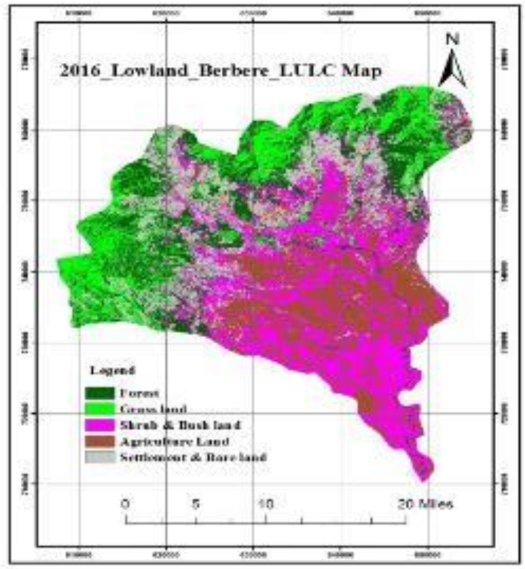
7. Annexes

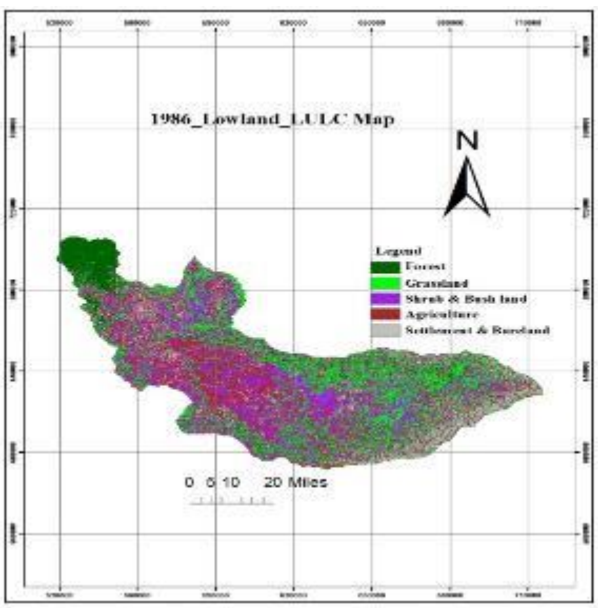
Annex1: FDGS and Key Informant pictures

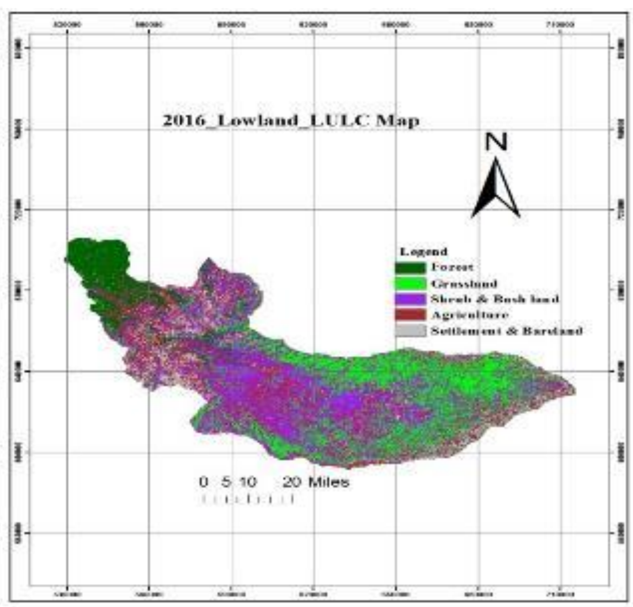
Annex 2: LULC change of Highland part of BER(1986 and 2016)











Annex 3: LULC change in BER eco region in percent

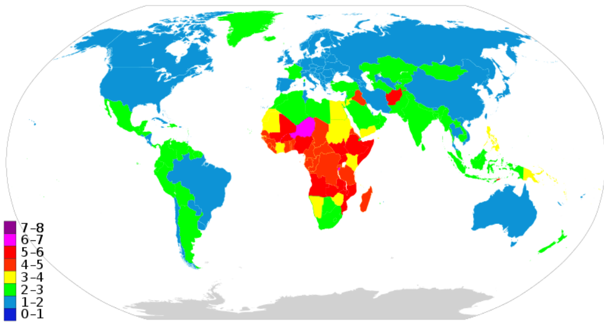
LULC	Highland		Mid Land		Lowland		BER			
	1986	2016	1986	2016	1986	2016	1986		2016	
	Ha	Ha	Ha	Ha	Total	Total				
Forest	65858	35300	194833	121957	12000.1	10238.6	272691.1	27.4	167496	16.8
Agriculture	38795	78878	40716	91718	27135.9	29013.3	106646.9	10.7	199609	20.0
Grass land	42478	2094	1039	40391	22743.3	20863.4	16912	17.0	82197	8.3

		3	06				7.3			
Shrub and Bush land	48820	52055	206577	249966	31056.3	32061.5	286453.3	28.8	334083	33.5
Settlement and bare land	40386	49161	109443	151443	11384.1	12142.9	161213.1	16.2	212747	21.4

Annex 4: Multi stage Sub sampling of respondents

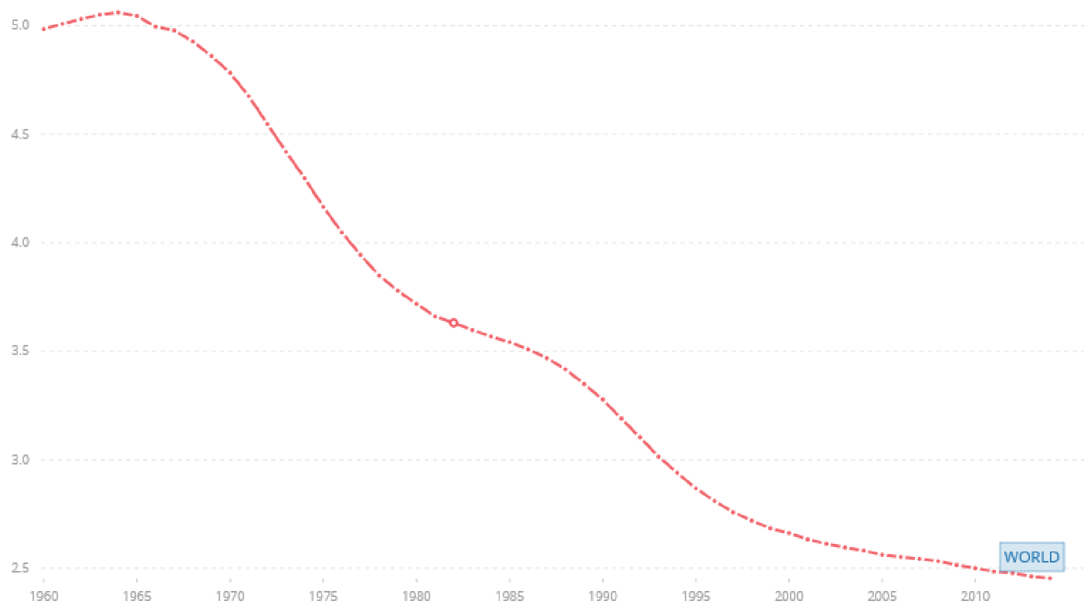
		Both	Male	Female	Number of HH		No. of questionnaire	K
	Harenna_buluk	76,603	38,788	37,815	15,830	0.18429	125.32	0.22
	HAWO	6,730	3,397	3,333	1,319	0.57623	72.21	18.27
	SODU WELMEL	4,651	2,368	2,283	970	0.42376	53.11	18.27
Mid					2,289			
	Dalo Manna	79,010	40,060	38,950	16,726	0.19472	132.41	0.24
	BURKITI	4,831	2,547	2,284	967	0.5882	77.88	12.42
	ODA DIMA	3,184	1,644	1,540	677	0.4118	54.53	12.42
					1644			
	Madd Walabu	94,543	47,539	47,004	19,638	0.22862	145.46	0.28
	BERISA	4,749	2,422	2,327	970	0.395595	61.5	15.77
	WERE	7,123	3,512	3,611	1,482	0.60440	93.96	15.77
Lowland					2,452			
	Barbare	84,992	43,496	41,496	18,330	0.21339	135.11	0.26
	SIRIMA	7,617	3,913	3,704	1,631	0.6649	96.48	16.9
	HARO NANO	3,958	2,005	1,953	822	0.3351	48.63	16.9
					2,453			
	Goba	40,757	20,615	20,142	8,406	0.09786	66.55	0.12
	WELTIE KUBSA	3,346	1,691	1,655	660	0.55649	37.03	17.82
	ETITU/fasil SURA	2,529	1,243	1,286	526	0.4435	29.51	17.82
Highland					1,186			
	Dinsho	36,158	17,754	18,404	6,967	0.08110	55.15	0.1
	HORA SOBA	5,890	2,893	2,997	1,130	0.53301	29.4	38.44
	Mi'oo	4,964	2,369	2,595	990	0.46698	25.76	38.44
Total							**660**	

Annex 5: TFR of the world in 2015. Source: The World FactBook (CIA) - https://www.cia.gov/library/publications/the-world-factbook/fields/2127.htm



Years	TFR
2000–2005	2.62
2005–2010	2.52
2010–2015	2.36

Annex 6: Averaged TFR trend of the world.



Source: World Bank http://data.worldbank.org/indicator/SP.DYN.TFRT.IN