EJED 2022 4(2):1–24
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj
E J E D

SITUATION ANALYSIS OF IRREGULAR STEPWISE CROSS-BORDER ETHIOPIAN MIGRANTS IN THE SUDAN IN VIEW OF SOCIOECONOMIC STATUS AND HUMAN RIGHTS

Messay Mulugeta*[1], Teferee Makonnen[2], and Meskerem Abi[1]

[1] *Center for Food Security Studies, College of Development Studies, Addis Ababa University, Ethiopia*
[2] *Geography and Environmental Studies, College of Social Sciences, Addis Ababa University, Ethiopia*
Corresponding author: email mesay.mulugeta1@aau.edu.et; Po.Box. 1176 Addis Ababa, Ethiopia

Received: 20th July 2021 *Accepted: 12th January 2022*

DOI: **10.20372/ejed.v04i2.01**

Abstract

The main objective of this research was to investigate the socioeconomic and human rights status of the irregular cross-border Ethiopian migrants in Sudan. The research targeted identifying key policy lessons that could contribute to the existing endeavors of managing migration and preventing human trafficking and smuggling of migrants. Data were collected through desk reviews, informant interviews, group discussions, and observations. The results show that Ethiopian emigrants in Khartoum have been suffering beginning from their origin, en route, and destination. The most common drivers of the emigrants are found to be an amalgam of socioeconomic, political, and environmental factors as well as pseudo-success-stories of the pioneer migrants. The en route was perilous for the migrants in which they faced physical assault, confinement, mistreatment, sexual abuse, and robbery. At the destination, the emigrants had been suffering from religion-based disparagement, nationality-based stigmatization, restricted mobility, exploitative working conditions, confiscation of resources, sexual abuse, vulnerability to drug dependence, and maltreatment. The mechanism to alleviate the problem is triple: one is expected from Ethiopia, the other from Sudan, and the third is a combined effort. In Ethiopia, enhanced democratic culture, political tolerance, good governance, improved access to legal travel authorization (visa) for safe migration, awareness creation campaigns, enhanced monitoring of the private employment agencies, and increased cooperation among stakeholders are found to be vital solutions to prevent illicit cross-border human trafficking and smuggling of migrants. Sudan is recommended to comply with the international conventions it ratified and the national legal frameworks it enforced regarding human trafficking, smuggling of migrants, and refugee protection. Ethiopia and Sudan have also something great to do together to combat the quandary of illicit migration: abolition of visa obligation for the citizens of one another and establishing robust co-managed border supervision command post mandated to address conflicts, irregular migration, and displacement at border areas.

Keywords: Cross-border migration, Ethiopia, Human rights, Human trafficking, Migrant smuggling, Sudan

1 Introduction

1.1 Background and the Rationale

The issue of cross-border human trafficking and smuggling of migrants appeared on the global agenda since 1815 at the Congress of Vienna (Austria), where an international commitment to end forced labor was made in the form of a pledge to eliminate the slave trade (UNHCR, 2006). This was

the first human rights subject dealt with at the international level. Human trafficking involves the recruitment, transportation, transfer, harboring, or receipt of persons usually by force, coercion, or deception for the purpose of exploitation (Gezie *et al.*, 2019). Cross-border migration is related to the broader global socio-economic, political, and technological transformations that are affecting a wide range of high-priority policy issues and our individual lives (IOM, 2019). Modern transportation and communication technologies have made it easier, cheaper, and faster for people to move from one place to another so easily and rapidly. At the same time, conflicts, poverty, income inequality, political intolerance and unemployment and/or underemployment are among the reasons that compel people to leave their homes in search of better livelihoods for themselves and their families (OECD, 2016; Deotti and Elisenda, 2016; Messay and Teferi, 2017; IOM, 2019). Other than conflicts and persecutions, as noted in UNHCR (2015) and OECD (2016), migration and human trafficking from developing countries, particularly Africa, are expected to continue rising because of persisting economic and well-being gaps with developed countries. As a result, the number of international migrants (persons living outside their country of birth) worldwide has continued to grow rapidly over the past 20 years reaching 272 million in 2019, up from 173 million in 2000 (IOM, 2019). The number of refugees and illicit migrants is also increasing. By the end of 2018, for example, refugee numbers mounted up to 25.9 million (IOM, 2019).

Moreover, cross-border migration has multifaceted implications on the status of migrants at a place of destination, which could be taken as both positive and negative outcomes on the demographic, cultural, and socio-economic circumstances of countries (Messay and Teferi, 2017). Similarly, OECD (2016) states that officially authorized cross-border migration holds the potential to improve the lives of migrants and advance welfare in countries of origin provided that appropriate public policies are put in place. There is also empirical evidence that shows the positive microeconomic impacts of migration through remittance flows (e.g. Gallina, 2006; Deotti and Elisenda, 2016). It contributes to the balance of payments in the sending countries and its importance for individuals in covering expenses for food, education, transportation, clothing, and health care as well as housing construction, buying fixed assets such as plots of land. Betz and Simpson (2013) also argue that legal international migration has no negative impacts on native populations if properly harnessed. The IOM (2019) report corroborates the accounts above in that it accounts for the international remittance of 689 billion USD in 2018. The top three remittance recipients were India, China and Mexico. Similarly, USA was the top remittance-sending country followed by the UAE and Saudi Arabia (IOM, 2019). The contribution of remittance to the Ethiopian economy and the livelihood of low-income households is also enormous (Redehegn *et al*., 2019; World Bank, 2020).

The problem comes when migration, particularly cross-border migration, is carried out illegally causing great adverse impacts on the migrants, sending households, and the population at the destination. The most critical consequences of illegal cross-border migration, in the current global milieu are related to insecurity, abuse, unsafe working conditions, humiliation and labor abuse (Mohammed, 2016; Messay and Teferi, 2017). Organized crimes in many destination countries seem to confirm this trend (OECD, 2016). Likewise, illegal migration causes an increased unemployment rate to destination countries, especially in the economic stagnation period (Garson and Loizillon, 2013). Moreover, migration of labour from sending households leads to a reduction in agricultural production, potentially threatening the national food security (Redehegn *et al*., 2019). Other adverse impacts pinpoint to the fact that there is a growing occurrence of flashpoints attributed to anti-immigrants' feelings, which menace the stability, solidarity and integration in the host country. It can also be a cause and consequence of inequality and unequal development as the immigrants sometimes are unable to access, at least temporally, the existing services such as housing in their destinations (Amin, 1995; van Liemt, 2004).

Immigrants are those who enter with the intention to stay, work and live in the host country assuming that the majority of their earnings are obtained in the destination county (UN, 1998; Schaeffer and Mulugeta, 2011). Ethiopia is one of the largest origins, transit, and destination of illicit cross-border migrants in Africa (Messay and Teferi, 2017; Girmachew, 2019; Messay, 2019). International Organization for Migration (IOM) and the International Labor Organization (ILO) in their series of reports estimate that hundreds of thousands of Ethiopians arrive in the Middle East every year. According to ILO (2013), the number of trafficked Ethiopian women and children in the Middle East was as large as 130,000. In 2014, about 91,000 migrants arrived Yemen from the Horn of Africa, of which 80 percent were Ethiopians transited through Djibouti. Likewise, it is estimated that the number of Ethiopians traveling to Sudan each year is as large as 100,000, of which most are stepwise migrants and daily laborers (IOM, 2017a). Stepwise migrants are low-capital migrants that can intentionally follow a stepwise trajectory, working their way up a hierarchy of destination countries and accumulating sufficient capital in the process to eventually gain legal entry into their preferred destinations (Paul, 2011). It helps the migrants to mitigate cost barriers and immigration policy restrictions to realize their destination preferences.

Several factors have been instigating Ethiopians to leave their birthplaces and cross international borders illicitly. The factors include, but are not limited to, fast population growth (about 2.6%/year) and the resultant high competition for resources such as farmland, prevalence of poverty, high population fertility rate (total fertility rate of about 4.6), high inflation rate (greater than 10% for most of the recent (Messay and Teferi, 2017). Once recruited by the traffickers, the Ethiopian migrants are subjected to move in one of the major routes to destination areas such as the Gulf Cooperation Council states, Europe, and South Africa. The three main irregular routes are the Eastern Route (through Djibouti or Somaliland to Yemen and then to the Gulf Cooperation Council (GCC) countries), the Western Route (through Sudan, Libya then Italy); and the Southern Route (takes them to South Africa after crossing many African countries) south and southeast of Ethiopia (Marchand, *et al.*, 2016). The focus of this research is the migrants of the Western Route. The common characteristic of every irregular route is that the migrants usually face perilous, sometimes lethal, challenges on their way to the destination areas right from their start. The overall objective of the research is to investigate the socioeconomic and human rights status of the stepwise illicit cross-border Ethiopian migrants in Sudan, and to identify key policy frameworks for effective prevention of illegal migration and human trafficking in Ethiopia.

1.2 Theoretical Foundation

The theoretical foundation of this study is the level-based analysis of migration theories. It is believed that level-based analysis of migration theories, i.e. micro-level, macro-level and meso-level, are useful to better understand the movement of people in a wider perspective. Hence, it is the best fit for Ethiopia, as an origin, destination, and transit of migrants. Micro-level theories consider migration decisions from an individual perspective, whereas the macro-level theories consider migration decisions from the country's economic perspective. In meso-level theories, migration decisions lie in between the two former theories. Family bonds, social networks, per groups and isolated minority communities determine migration decisions (Wickramasinghe & Wimalaratana, 2016). Micro theories often draw on rational choice theory, which makes several controversial assumptions about how and why individuals make decisions to migrate (Bosewell, 2002; Wickramasinghe & Wimalaratana, 2016). It argues how potential migrants weigh up the various costs and benefits of migrating (Boswell, 2002; Jennissen, 2007). Costs could include the financial and psychological resources invested in moving and integrating with the country of destination, while benefits could include a higher salary or physical safety. Micro-level theories encompass the neoclassical migration theory, the push-pull factors, the behavioral models, and the theory of social systems (Wickramasinghe & Wimalaratana, 2016). It emphasizes structural and objective conditions that act as push-pull fac-

tors for migration. Some of these factors include non-inclusive development, environmental predicaments, socioeconomic-induced underdevelopment, un/underemployment, low wages, or low per capita income relative to the country of destinations in the Middle East & western countries for Ethiopian migrants (de Haas, 2010; Mohammed, 2016). The government's mismanagement-induced push factors may include, but not limited to, deprivation of basic needs (such as lack of access to education, healthcare institutions and credit facilities) nepotism and inequitable distribution of resources/rights. Pull factors would include conducive migration legislation and the labor market situation in receiving countries, such as the Gulf States (Mohammed, 2016). Involuntary displacement would be explained through political factors like civil war and state repression (as the case in Ethiopia between the 1960s to late 2010s) or fear of violence and conflict (Marchand, *et al*., 2016).

Bosewell (2002) argued that meso-level theories such as Social Capital Theory, Institutional Theory and Network Theory could help explain the fact that migration is assumed to occur within a migration system. The core assumption behind the migration system theory is that migration contributes to change the economic, political, social, institutional, and cultural ties as well as migration flows in both the receiving and sending country (Wickramasinghe & Wimalaratana, 2016). Good examples are such ties between Ethiopia and Sudan as well as Ethiopia and the Middle East. Geographical proximity, cultural ties, and most recently the presence of road transportation directly from Addis Ababa to Khartoum have made it easier, cheaper, and faster for Ethiopians to easily access superficial information about Khartoum and beyond. According to meso-theories (Bosewell, 2002; Wickramasinghe & Wimalaratana, 2016), the conditions generating movement are understood as the dynamics of relations between two areas, rather than a set of objective indicators. Networks refer to a set of individual and collective actors (actual and potential migrants, their families, overseas employment agents/firms, religious/social groups, traffickers, etc.), and the multiple social and symbolic ties that link them together (Mohammed, 2016). Once formed, networks can substantially influence the direction and volume of migration flows, providing resources that help people to move, such as information, contacts, economic and social support. The resources that flow through networks make migration more attractive and feasible option for other members of a network and can generate what has been termed chain migration: the phenomenon of serial, large-scale migration from one particular area to another defined area (Deotti and Elisenda, 2016). A case in point is youth migration from Ethiopia to the West or to the Middle East or to South Africa. Systems and networks may make places easier to reach or obtain protection or more attractive as destinations than others (Jennissen, 2007; Mohammed, 2016).

Summarizing the relative strengths of these three approaches, one could conclude that macro-theories offer the most insight into the factors initially triggering 'pioneer voluntary migration' and provide the best explanation for forced displacement. Meso-theories are best at explaining the persistence of voluntary migration, and why it occurs from some areas and not others of similar biophysical scenario. They can also help explain the choice of destination for both voluntary migration and forced displacement victims. Finally, micro-theories can help show how the macro and meso factors are translated into individual decisions to move. This typology of theories provides a useful background for explaining international migration and is a good starting point for constructing a general theory of the causes of migration. However, the task here is to examine policy responses that can help mitigate these causes. This requires a rather different sort of typology, based on the possible different levels of intervention. Here it is useful to distinguish between four different types of causal factors: root causes, proximate causes, enabling conditions, and sustaining factors. Looking at the situation of Ethiopian cross-border illicit migration and the challenges therein through these three lenses (macro, meso and micro theories), it seems the interplay of the three theoretical foundations are prevailing. No single theory can adequately describe the Ethiopian situation. It is a bit complex; causes are many and the consequences are harsh (Figure 1).

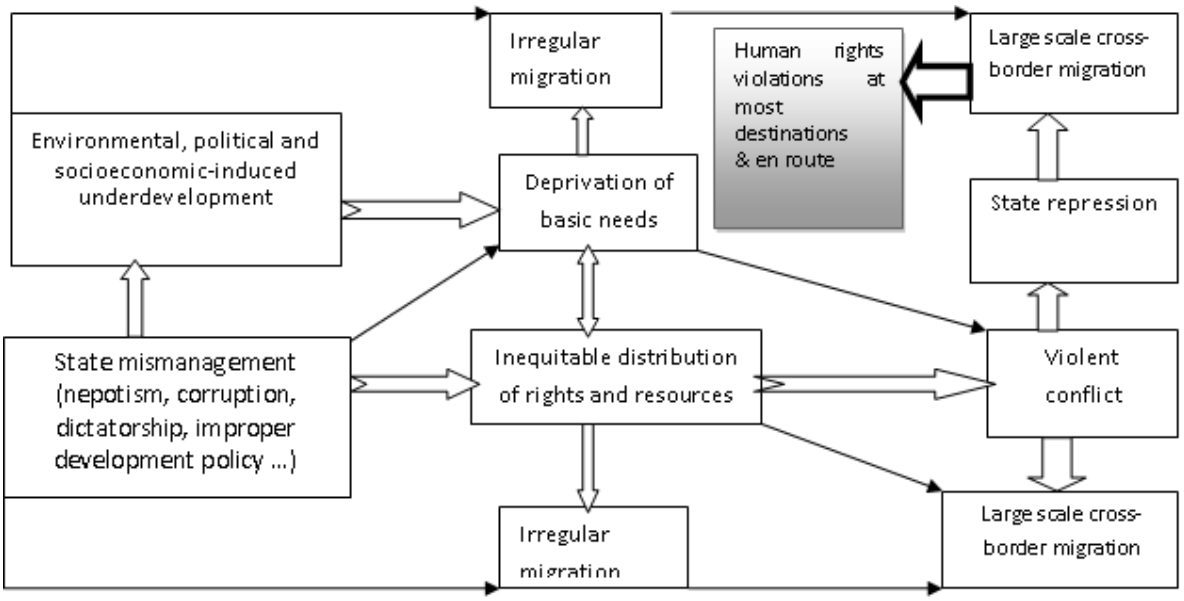


Figure 1. Conceptual framework explaining the Ethiopian illicit cross-border migration and the challenges therein. (Source: Adopted from Boswell (2002))

The conceptual framework presented in Figure 1 shows that migration root causes are the underlying structural or systemic conditions, which provide pre-conditions for migration or forced displacement. In terms of the theories discussed above, they are combinations of macro, meso and micro factors such as economic underdevelopment, weak state performances, social fragmentations and intolerable inequalities shaping the interaction between sending and receiving countries. Proximate causes refer to the immediate conditions that trigger movement, which again can be macro, meso or micro: the escalation of violent conflict, individual persecution, the collapse of local livelihoods or 'new opportunities' at assumed destination areas. Enabling conditions (such as national migrant-related legislations, border controls, travel possibilities, job opportunities, and existence of relative/s and remittance facilities) render the actual journey, entry and stay in countries of destination. Finally, sustaining factors encourage persistent or chain migration from particular places or countries of origin. These are almost exclusively a function of migration networks. All categories of causes of migration point towards the situation of cross-border Ethiopian migration and imply different types of policy response.

1.3 Population movements and illicit out-migration in Ethiopia: A brief literature review in view of the experiences of emigrants in Khartoum

Ethiopia is the cradle of humankind as confirmed by the ancient fossil pieces of evidence at the archeological sites in the Great Rift Valley areas such as Hadar Paleontological Site in Mille district (Yonas, 2012). It is an ancient original abode of human migration before various parts of the world were occupied. Both short and long migratory movements have been going on for millennia in Ethiopia. The Great Ethnic Migrations occurred starting from the first half of the 16th century to the mid-17th century that involved diverse tribal and ethnic groups of Hadya-Sidama, Oromo, Somali and Afar (Messay and Teferi, 2017; Girmachew, 2019). The Oromo expansive movement somewhere from the southern part of Ethiopia (most probably from the Medda Walabu area in Bale) and its settlement as far as the northern part of Ethiopia was remarkable in Ethiopian history (Bahru, 2002; Shivered, 1986 in Kassahun, 1998). In fact, in this most recent decade, pronounced population movement has been taking place owing to the current political instability, social conflicts and natural disasters in Ethiopia.

Internal population movement accelerated in the early 20th century with the rise of urban centers, expansion of industrial establishments and social services as well as the temporary occupation of the Italian colonial powers (1936 – 1941). Migration during the Imperial Era (1930-1974) was spontaneous; whereas the post-1974 (the time when the military junta /commonly known as Derg Government/ came to power in Ethiopia) was more predominantly controlled by the state. After the fall of Derg in May 1991, Ethiopia witnessed growth in GDP, fast urban expansion and infrastructure development, which in turn, resulted in huge rural-urban and intra-rural migration of citizens (Weaver, 1988; Messay and Teferi, 2017; Girmachew 2019). On contrary, the appalling regional and individual economic inequality, the harsh political and governance situations, and the grand corruption (mainly between May 1991 and April 2018) in the country pushed millions into poverty, unemployment, conflict and other severe social ills. These, in turn, have caused suffering to the majority of the Ethiopian youth who were forced to escape the overall perils. The only choice for the majority was therefore emigration, whether illicit or authorized. The incident was accelerating until the outbreak of COVID-19, which halted both authorized and illegal outmigration.

The newly emerging rural youth households have been virtually landless owing to almost nonexistence of land distribution in Ethiopia since 1991, which appears to be a big motivation to leave their home (Dessalegn, 2004; Messay, 2012; Redehegnm 2019). Moreover, the present high rural population pressure (greater than 360 persons per square kilometers in some southern areas), land degradation and diminished carrying capacity of the land, together with erratic rainfall conditions (Messay *et al*., 2017) are vital push factors. The experiences of many of the male Ethiopian emigrant respondents in Khartoum corroborate this fact. ILO (2019) in its World Migration Report 2020 indicates that the great majority of the cross-border migrants are youth owing to lack of adequate job opportunity and placement for graduates. While access to education has increased (from only two state-owned universities in 1991 to about 50 universities at present, for example) over the past two and half decades, ironically the number of unemployed educated youth has also increased. Evidence shows that many young people rarely have a decent job and often none or limited social protection along with being subjected to poor working conditions (Deotti and Elisenda, 2016). The situation is even worse for women, who cannot find decent work opportunities and are most often concentrated in the insecure informal sectors, because of which they prefer to move abroad in any way possible.

Ethiopia and Sudan share one of the longest non-demarcated borderlines in the world (about 750*kms*). As a result, there has been a sustained relationship between the peoples of the two countries. Several research findings and reports (such as Weaver, 1988; IOM, 2019) show that a large number of Ethiopians travel to Sudan owing to geographic proximity, historical ties, agricultural activities, daily labor and conflicts. Some also travel to Sudan fleeing government arrests, and environmental disaster risks. For example, during the great African drought/famine of 1984/5 about 300,000 starved farmers and herders moved to Sudan (Weaver, 1988). These facts justify the two concepts discussed in meso theories of migration (i.e. systems and networks) (de Haas, 2010). The two countries are linked by economic, political, and cultural ties as well as long-established migration networks.

2 Research Methods

To meet the intended objectives of this research, data was collected from primary and secondary sources. Primary data was collected through interviews with illegal stepwise Ethiopian migrants in the Sudan who have been experiencing the perils of trafficking and/or smuggling. Discussions were also made with potential migrants gathering at the gate of the Embassy of the Republic of Sudan (in Adds Ababa) seeking for information, traffickers, and visa. Primary data were also generated from several informants (other than the migrants), who shed light on different facets of the migration process related to illicit cross-border migration and its pitfalls. These

include experts working at the Ministry of Labour and Social Affairs (MoLSA) and the Ethiopian Embassy in Khartoum. Ethiopian migrant association management team in Khartoum (especially Souq-al-Diem area, the Ethiopian corner in Khartoum), and some relevant NGOs (operating in Addis Ababa) were accessed for data. Other vital data sources were a few domestic worker employers in Khartoum, relevant researchers (working in Addis Ababa University (AAU), University of Khartoum (UoK) and Ahfand University for Women (AUW)), a few returnees from Sudan and other Middle East countries, potential migrants at Metema (Ethiopian border city) who were looking forward to crossing into the Sudan territory, some community members living in Metema, a few Ethiopian employment agents in Addis Ababa, some family members left behind the migrant, Ethiopian public transport bus drivers from Addis Ababa to Khartoum (a distance of over 1,400km) and relevant consultants. Document review was found to be an important source of data for the research to capture the extent, progresses, and challenges related to cross-border migration, human trafficking/smuggling, and the consequences of such movement on the migrants. Several reputable publications and reports were reviewed intensively.

Data analysis and reporting have taken the form of descriptive and narrative analysis techniques. The descriptive technique involved describing key numerical circumstances uncovered from the data focusing on total numbers and averages. The narrative analysis focused on the reformulation of stories presented by each respondent considering the context of each case and the different experiences of each respondent. The narrative analysis goes along with the thoughts of micro migration theories (such as push/pull factors, behavioral models & theory of social system). As noted in Bosewell (2002), the micro perspective of migration is an important level of analysis in terms of showing individuals view of the various conditions in migration and how individuals make decisions based on objective factors. The Institutional Review Board (IRB) or Ethics Committee Approval (ECA) of the Center confirmed the overall ethical matter of the research process for Population Studies of the College of Development Studies, Addis Ababa University.

3 Results and Discussion

3.1 Major sources of cross-border migrants, recruitment processes and the en routes in view of the experiences of stepwise Ethiopian emigrants in Khartoum

The origin of cross-border illicit migrants in Ethiopia are various, mostly urban areas and their environs, including (but not limited to) Addis Ababa, Adama, Assela, Bahir Dar, Dire Dawa, Dessie, Gonder, Hawassa, Hosana, Jimma, Robe, and Shashemene (Figure 2). The majority of the observed and interviewed emigrants in Khartoum are from Addis Ababa, Gonder, Jimma, and Shashamane areas. The reason may be geographic proximity (for Gonder and the environs), religious and cultural ties (for Jimma and Shashamane areas), and access to information and chain migration (for those from the Addis Ababa and surrounding areas).

According to the interviews and discussions held with key informants, major rural migrant source areas in Ethiopia are those characterized by high unemployment and precarious jobs, erratic weather conditions (mainly lowland areas), high population pressure, scarce water resources, and low agricultural productivity. These characteristics can be considered as push factors. The results validate the thoughts indicated in macro migration theories (Boswell, 2002), which emphasize the interplay of push-pull and pull factors for a massive migration to happen. It is hard to mention any non-migrant-sending area in Ethiopia as most areas and quite several rural households are assumed to have sent their members abroad in one way or another. It also concurs with the ideas elucidated in micro theories in that individual decision to migrate and weigh up the various costs and benefits of migration would be vital for Ethiopians to move (Boswell, 2002). Correspondingly, the Ethiopian migrants in Khartoum, have invested quite a lot of financial and emotional resources to move to Khartoum; and in Khartoum, too, in search of higher income and physical safety corresponding to the thoughts of micro migration theories.

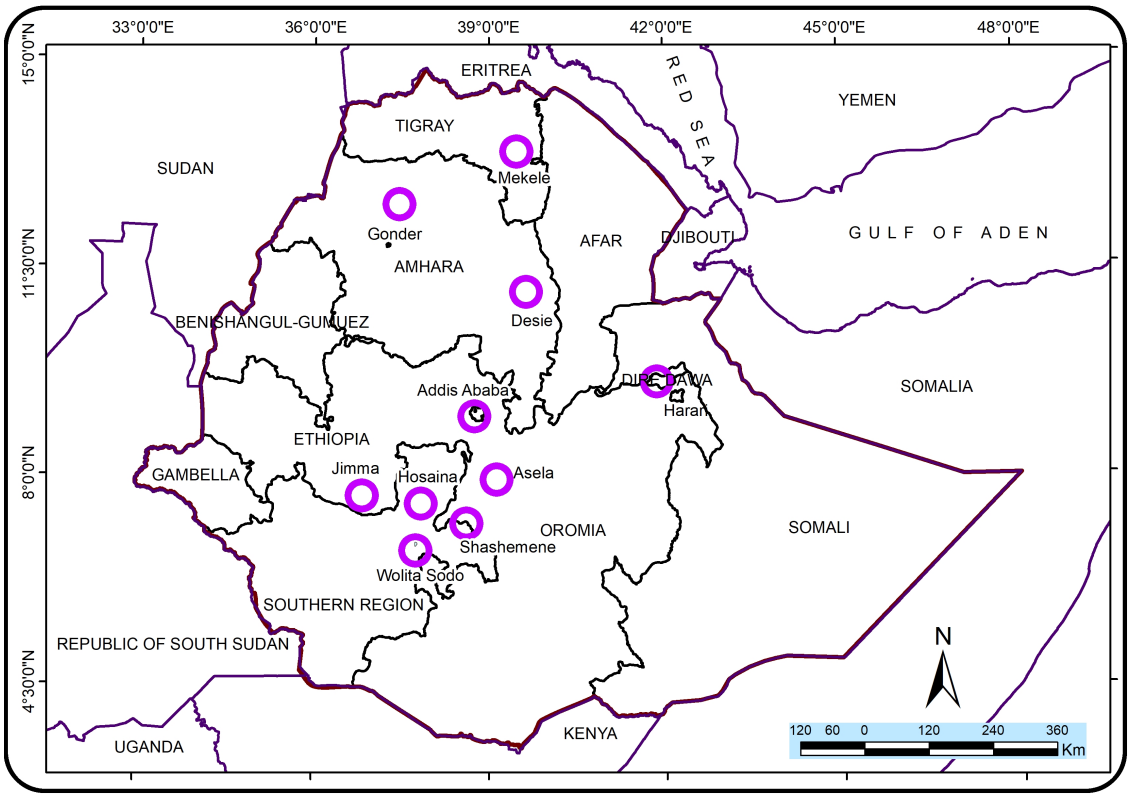


Figure 2. Major cross-border migrant source areas in Ethiopia

It is observed at the gate of the Embassy of the Republic of Sudan (in Adds Ababa) that quite numerous young Ethiopians from different parts of the country (both urban and rural areas) come to the Embassy either for a visa or to find traffickers for their plan to move to Khartoum as a temporary destination area. Most of them are either teenagers and in their early adulthoods school dropouts or certificate level graduates from junior technical colleges. About six informal discussants for this research, for example, had come to Addis Ababa from Hasandabo (a small town near Jimma city) to assess traffickers who would assist them either in getting passport/visa or who would facilitate their move to Sudan even without passport/visa. Various studies and research reports (For instance, Messay, 2019: Redehegn *et al*., 2019) indicate that the role of brokers in human trafficking is vital in Addis Ababa. This is not only in facilitating passport/visa based on the informal networking they have established with the officers in some embassies and the Federal Democratic Republic of Ethiopia (FDRE) Main Department for Immigration and Nationality Affairs, but also for arranging temporary shelters in Addis Ababa city for the migrants as they are new to the city. In the same way, the informal discussants around the gate of the embassy confirmed that brokers are just approaching them to facilitate everything related to their travel, starting from sheltering in Addis Ababa, passport/visa facilitation, en route to and temporary shelter in Khartoum.

Mistreatment, deception, and abuse are realities at the gate of the embassy itself. It is common to see every morning a large crowd of young people gathered around the gate of the embassy disputing with the security people around. The security persons always command them offensively to go away from the embassy and wait for the working hours. Also, some personnel at the front desk for visa service were not treating them to the standard of customer service. Teasing, annoying, and frustrating the visa seekers (potential migrants) were common, though the staff treat other visa applicants very nicely in a

particular way. Again, there were quite a lot of intermediaries informally orienting the crowd of migrant visa seekers around the gate about visa application processes, fees, and informal alternatives towards Khartoum. Informal discussants of about 10 young people waiting for the opening of the gate to collect their visa confirmed that the embassy staffs at the front desk for visa service are double standard. They easily identify migrants for their lack of experience and accents/dialects and impolitely condemn them for the slightest offense while they treat others far more leniently.

The interviews held with Ethiopian informants in Khartoum and the visa seekers at the Embassy of Sudan in Addis Ababa indicate that there are different agitators and actors in the recruitment and trafficking of illicit cross-border migrants. These include local brokers, returnees, visitors, relatives, friends, and licensed employment agencies. Local brokers are individuals going around at the community level lobbying potential young migrants from communities. These people are vital for the reason that they have key networks with the traffickers (both inside and out of Ethiopia) and entice potential migrants with important information about 'the opportunities' abroad and the processes required for passport/visa application and the en route. They promote their services by using the success stories of a few people they have already sent abroad. They also actively disseminate information about 'employment opportunities' in destination countries. The result is consistent with several related studies conducted in Ethiopia (For instance, ILO, 2011; Messay, 2019; Redehegn, *et al*., 2019).

The brief story of an interviewee (hairdresser in a Sudanese barbershop) in Khartoum is worth mentioning at this juncture. In the interview, she has given a brief account of her migration starting from the time she met her former teacher (a retiree) in Asella (a zonal city in Central Ethiopia) while she was trying to apply for a vacancy in secretarial service in a government office. Listening to her joblessness challenges for a while, the retired teacher (that time serving as a local broker) instructed her in detail as to how she would manage to go abroad and get a well-paying job at the destination. In the conclusion of their discussion, she agreed to meet another key person in Addis Ababa, who at the end of the day facilitated her journey by bus to Khartoum through Metema, a border town between Ethiopia and the Sudan. At the time of the interview, she had already lived in Khartoum for about six years without any significant savings in financial terms. She was almost hopeless and prone to low payment, ill-treatment, forced overtime work, and sexual abuse by her employer. Next to the local brokers, come other brokers in Addis Ababa for harboring and transportation. These were what most of the interviewees in Khartoum have experienced. The traffickers in Addis Ababa receive the victims from local brokers and transfer them to other traffickers at the Ethiopia-Sudan border (most likely in Metema town) within their network. On their way, the migrants are prone to ill-treatment, sexual abuse, and assault. From Metama, they are forced to join a group of human traffickers located in Sudan territory. The informal discussions held with the community at Metema indicate that these are contrabandists who know the desert routes very well and have contacts with informal labour brokers and/or other group traffickers in Khartoum. Some research findings and reports also confirm the involvement of local authorities and armies patrolling the desert routes in the trafficking process. Consistently, Wickramasinghe & Wimalaratana (2016) indicate that brokers, recruitment agencies, rural agents, smuggling networks, and unstructured institutions heavily influence cross-border migration. For instance, migrants who travel without smugglers are more vulnerable and often face many more problems on their way (Marchand *et al*., 2016)

The role of returnees in agitating potential migrants and facilitating illicit cross-border migration can't be underestimated. Returnees involve in the situation at various stages of trafficking processes with different capacities (IOM, 2015; Ati, 2017; Redehegn *et al*., 2019). While some might just facilitate migration for a fee through their contacts in Addis Ababa or the country of destination, others establish

a trafficking network for handling the whole process. Often, these returnees start brokering by helping a sibling, relative, friend or neighbor to migrate and thereby continue the practice as local brokers thereafter. These kinds of traffickers are very common in communities where a 'culture of migration' has emerged. Returnees are also reported to be active and successful recruiters as they are members of the same community and can tell success stories of their own more persuasively. The results support the migration network theories discussed above (Jennissen, 2007; Mohammed, 2016).

The process of trafficking Ethiopians usually ends in the hands of the destination area traffickers. In the case of Khartoum and the surrounding areas, the Ethiopian emigrant informants have given a brief account of the traffickers. The emigrants pointed out that the traffickers make use of the vulnerability, solitariness, and helplessness of the migrants as opportunities for abuse and smuggling. The traffickers purposively put the migrants in a situation of defenselessness through deception, control and intimidation. The discussants indicate that the traffickers have good information about everything around since most of them are either Sudanese or foreigners (mostly Ethiopians, South Sudanese or Somalis) who lived in Sudan quite for a long period. They have strong links with other co-workers in Ethiopia, Libya, and the Middle East. For those migrants who want to continue their journey, the traffickers around Khartoum often transfer them to other groups who are more clued-up about the long journey to Libya through the deserts.

According to a discussion made with experts in the Ethiopian Embassy in Khartoum, there are also Ethiopian emigrants in Khartoum who have become traffickers themselves through time. Sometimes, they fund the migrants to travel to Khartoum illicitly or legally. They also have strong links with the chains of brokers and smugglers in Ethiopia and the destination areas. In Khartoum, what they do is, receive new arrival migrants from Ethiopia, supply them with temporary shelter in a large group, place them as domestic workers and/or laborers, and collect their wages directly from the employer. The new arrivals are requested to sign an agreement of at least two years to receive their wages from the hands of the broker, not directly from her employer. In case they have a passport or other official documents, they are required to keep it in the hands of the broker as a security against the agreement. Based on the interest of the migrants, the Ethiopian brokers also transfer the new arrivals to other more experienced traffickers for more journeys abroad. As noted in Ati (2017) and other several pieces of research and reports, the brokers make huge money out of the transfer.

3.2 The status of Ethiopian illicit migrants in Sudan

Data related to the number of Ethiopians living in Khartoum is deficient and inconsistent. It is scarcer when it comes to illicit step-wise cross-border migrants due to its inconvenience for a centralized registration system. However, some interviewees at Ethiopian Embassy in Khartoum estimate that tens of thousands of Ethiopians live in Khartoum, temporarily or permanently. Quite several Ethiopians migrate to Sudan every day although the exact number is not known. The rate of migration seems to accelerate every year, according to the informant. The IOM (2019) World Migration Report corroborates the verbal account of the interviewee in that the number of Africans living in different regions is accelerating over the last decades.

The interview result shows that most of the Ethiopian emigrants in Khartoum are young, less educated females. They are stepwise migrants planning to move ahead to other countries in Europe or Gulf states. In Khartoum, they are mostly working in low-paying economic activities like housekeeping, babysitting, cleaning, waitress/waiter, factory daily laboring, guards, messengers, *irreksha* driving, shop keeping, beauty salon, bakery, daily laborers in mining industries, cooking in hotels, painting, carpenters. A few of them are low-level professionals in health care & IT sectors. A few of them are also found engaged in their own promising businesses like cafeterias, restaurants, coffee/tea houses, beauty salons, metalwork, and woodwork. An expert at the em-

bassy narrates that human trafficking from Ethiopia to Sudan is increasing over time though the journey is full of challenges including rape, harassment, mass arrest, imprisonment, beating, and sometimes deaths. The living condition of most of them in Khartoum is very harsh. In most cases, they rent a small room and live in very congested and inhuman situations (as large as 18 persons per room). One can imagine how risky their life is during the COVID-19 pandemic period. In this regard, almost all the respondent Ethiopian emigrants in Khartoum shared the same view that it is a lack of decent livelihoods and employment opportunities that pushed them out; not because they preferred the existing harsh conditions, mistreatment and nostalgia they are facing throughout the trajectory of illicit migration. These results further support the ideas of push-pull factors for migration (Bosewell, 2002; Mohammed, 2016; Wickramasinghe & Wimalaratana, 2016).

Researchers at the University of Khartoum, Ahfand University for Women, and the experts in the Ethiopian Embassy in Khartoum observed Ethiopians living in Khartoum for more than 40 years without work/residence permit. Particularly these days, it is hard for foreigners to access decent jobs in Sudan as the economy is getting worse owing to the conflicts, the economic sanction by the USA, and the cessation of South Sudan with its oil. The impact of the COVID-19 pandemic is also complicating the situation. Even for a Sudanese employment opportunity is very rare. Therefore, the coming to Ethiopian undocumented migrants to Sudan is just like adding fuel to the fire. This may be why the Government of Sudan tries to control illicit emigrants, because of which several Ethiopians are confined in Sudanese prisons (though the numerical data is blurred) for the illegal entrance to the country. Even in January 2020, about 100 Ethiopians have been arrested from Khartoum streets according to many interviewees and informal discussants.

Life in Souq al-Deim Ethiopian Corner

Quite many Ethiopian stepwise illicit migrants were interviewed and informally talked to in Khartoum. Most of the interviewees are found in a city corner known as Souq al-Deim, an unclean and dusty corner where daily laboring and small-scale businesses are carried out. Most of the residents of Souq al-Deim are young females. They came from several areas (both rural and urban) of Ethiopia, the majority being from Gonder, Wollo, Gojjam, Jimma, and Shashamane areas. They identify themselves as coming from poor and uneducated families. The majority had completed the second cycle of primary school, i.e. Grade 8 according to Ethiopian Curriculum. Some of those interviewed had worked in the urban areas previously, while others had migrated from rural areas for the first time. At the time of the interviews, which were held in Souq al-Deim and the cafeteria of the Ethiopian Embassy in Khartoum, most of the young females were engaged in temporary works waiting for traffickers to travel further ahead to the Middle East, Europe or any other better countries such as Egypt. Some are engaged in an arranged fake marriage with Sudanese men who could drop them somewhere in better countries through a tourist visa.

Most Ethiopian migrants in Souq al-Diem are found engaged in small-scale businesses like a barbershop, retailing utilities, street coffee/tea sell, cobblestone carving, metalwork, woodwork, bakery, daily laboring, and many other small informal businesses. A few are found engaged in driving *irreksha* (as locally named, a three-wheeled vehicle mostly used as taxi service). Quite a lot of them are street vendors offering coffee/tea and fast-food services without having a permanently built structure but with a temporary static structure or mobile stall (or head-load). The street vendors are very much complaining about mistreatment and exploitation by the police officers in the area. The fact that most of them have only temporary work and residence permit (known as *e-qaamaa* or *butaaqaa* /Temporary Central Registration Card/) has exposed most of them to mistreatments and exploitations by the local police.

The migrants are required to have *e-qaamaa* to engage in the mentioned small informal businesses. To get *e-qaamaa* is not simple. First, one should pay for *e-qaamaa* about 15,000SDP (about 330 USD) for

medical scrutiny, fingerprinting and other services. *E-qaamaa* service must be renewed every 3 months. It is found to be a great challenge to pay the said money and get/renew the registration card. One of the migrant interviewees said that it was almost impossible for her to pay this amount of cash because of which she was forced to engage shortly in 'idiot jobs' to collect money. The 'idiot jobs' she said include sex work. This shows that some migrants engage in businesses that they don't want to do just to get relieved from temporary financial challenges until the traffickers find them ways to move further ahead to their preferable destination areas such as the Gulf countries or Europe.

Mistreatment, exploitation and discrimination

The migrant community complains that mistreatment/harassment and exploitation exist even in the presence of *e-qaamaa*. Some police officers frequently come to their working places for bribery and fraud. They influence particularly the female migrants to give them money or some other unethical and illegal incentives (such as forced sexual intercourse) for any ordinary unintentional mistakes like misuse of a dustbin, *e-qaamaa* renewal overdue, and false accusation of prostitution. One of the female key informants indicated that she suffered frequent false accusations by police officers in case of unwillingness to pay them a bribe or sexual relations. She remembers a police officer's untrue allegation of wrongdoing and imprisonment 6 times within a few months in 2019 alone. She was required to pay the police station 2,000 SDP (about 40 USD) to be released for each case. In total, she faced 20 times imprisonment cases since she arrived in Khartoum some ten years ago. Moreover, she faced frequent robbery. More dangerously, she escaped many rapes attempts by gangsters and even by a police officer. A study conducted on human trafficking among Ethiopian returnees reported similar findings (Gezie *et al*., 2019).

Mistreatment and exploitation challenges are not only the cases happening to female migrants, but the male interviewees had also reported having faced almost similar challenges as females do. A case in point is a 27-year-old key informant interviewee who has sadly narrated his experiences in this case. He has a small shabby barbershop in Souq al-Diem area. Only because he is a migrant and has no permanent residence and work permit (other than *e-qaamaa*) he faces several exploitations and verbal abuses, if not physical abuse. Bribery and illegal requests by some police staff for free service (haircut, facial massage, etc.) are quite frequent, for which he cannot say no in fear of severer abuses and ill-treatment. His plan to join his brother in Saudi Arabia failed two times because of a lack of money to pay the traffickers at the Sudan-Libya border. In his second attempt in 2016, he was arrested and imprisoned for about 18 months in a single room with a poor sanitation facility, little food/water supply, and no facility to sleep and bath. His attempts to go back to Ethiopia also failed because of many factors: no passport/visa, no adequate startup money to establish his livelihoods in Ethiopia, and fear of criticisms/mocking from his relatives and friends 'for coming back empty-handed'.

The professionals interviewed at Ahfand University for Women (AUW) and the University of Khartoum (UoK) also agree that they have observed harassment of various types happening to Ethiopian migrants in Sudan. They agree that 'the migrants are abused en route and here in temporary destination area'. The maltreatment is even severer in their journeys from Sudan to other destination areas through Libya and Egypt. One of the professional respondents at the Regional Institute of Gender, Diversity, Peace and Rights (RIGDPR) of AUW disappointingly narrated that:

> '*. . . though RIGDPR is working to create a society where women and men are viewed and treated equally and are truly respected regardless of their sex, ethnicity, socioeconomic and political variations, the cruelty that cross-border migrants are facing in Sudan and Libya is heartrending'. The institute planned to create conditions to which all live in peace, dignity and their rights are protected and respected in a society free from all forms of abuse and violations. It is causing more intense distress when the ill-treatment and exploitation are coming from the*

government security staff like what some police officers are applying to the Ethiopian poor emigrants struggling for bare livelihoods in Souq al-Diem area...'.

A professional key informant interview at the Department of Sociology and Social Anthropology (DSSA), Faculty of Economic and Social Studies of the University of Khartoum enlisted the harassment happening to the Ethiopian emigrants at their workplaces. These include verbal harassment, sexual harassment by some policers, bribes to the policy officers only because they have no documents to stay in Khartoum or for their informal street business, false accusations of Ethiopians and Eritreans for sex works. The informant at DSSA said, 'sometimes a few women are truly found engaged in sex works, which is strictly forbidden and considered to be a severe crime case in Sudan. I think this is just to collect money that they may pay to the traffickers on their further en route to other destination areas. This may be due to most governments considering undocumented (illegal) immigrants (those who enter or stay without legal documents and permission) as burdens and sources of crimes as compared to documented (legal) immigrants (Schaeffer and Mulugeta,2011).

It is found that some Ethiopian immigrants in Khartoum are temporarily employed as domestic workers waiting for the traffickers' call for further travel ahead across Libya or Egypt. During the interviews, a Christmas Concert was organized by the Ethiopian Diaspora Community in Khartoum. Fortunately, several domestic workers came to attend the Concert, and they had to pay 200 SDP (about 4 USD) as an entrance fee. The attendees were estimated to be about 500 people. Almost all of them were young Ethiopians, and a few Eritreans and Sudanese. It is so emotional that most of them were busy greeting and chatting more importantly than watching and dancing. They look like suffering from homesickness. The number of middle-aged persons is very small. About 70% were females. Among the concert attendees, six female shared their time for the interview. They emotionally narrated that they suffered a lot both en route and in Khartoum. In their domestic works, they were suffering forced overtime, lack of rest periods, and severe limits on communication and freedom of movement. They indicated that they were prevented from leaving by various forms of penalty and threats, including retention of passports, and withholding of wages. They experienced psychological, physical, and sexual violence. These all are in opposition to the United Nations Convention against Transnational Organized Crime (2002) that declares effective action to prevent and combat trafficking in persons, especially women and children in the countries of origin, transit and destination that includes measures to prevent such trafficking, to punish the traffickers, and to protect the victims of such trafficking, including by protecting their internationally recognized human rights. It is also against the Principles of Human Rights: autonomy, dignity, equality, fairness, and respect.

The experience of a key informant, currently serving as a waitress at the Ethiopian Embassy in Khartoum, is also striking. She was born to a well-off family in Addis Ababa, specifically around Desalegn Hotel. She is about 35-year-old. She went to Sudan some 5 years ago under the assistance of a smuggler whom she paid 16,000 ETB (about 500 USD at the current exchange rate). She strongly believes and regrets that a trafficker who was lobbying her to go to Khartoum and then to Europe within a few weeks deceived her. She recalls that she crossed the Ethiopia-Sudan border with hundreds of other young migrants with whom she suffered a lot with thirst, hunger, exhaustion, ill-treatment, and the heat in the desert. She was beaten and raped in Metema (a border town in Ethiopia) and Gedarif (a small border town in Sudan) where she was harbored by the traffickers to escape the border surveillance staff. Her many attempts to move to Europe failed because of a lack of money (far more than what they promised in Addis Ababa) that the traffickers were asking. She is very much regretting not being married and giving birth, not saving, and losing her beauty to the 'Sudanese uncomfortable environment', as she put it. She perceives that she wasted half of her life for nothing. Still, she does not want to go back home. Surprisingly, she still wants to go to Europe or any Gulf country by whatsoever means.

Mass arrest

The results of this study further revealed the mass arrest of Ethiopian emigrants in Khartoum. Some of them were arrested because they did not have *E-qaamaa* or *butaaqaa* while some were arrested only because they are foreigners. They were taken to a very chilly place called Hudaa Omdurman Prison (far from the city of Khartoum). Acceding to the informants, the arrestees were tortured and robbed. They were asked to pay 50,000.00 to 100,000.00 SDP (about 990 to 1,980 USD) as a penalty for their 'wrongdoings'. Two major problems emerged here: for one thing, they did not have the money to pay & in case they manage to pay it, there is no guarantee for them not to be arrested repeatedly. However, Ethiopian Embassy in Khartoum is trying to help the migrants to its level best in collaboration with other organizations such as IOM. It encourages the emigrants in many ways to go back home. It facilitates their release from prisons, to get an exit visa, and to be exempted from penalties. As a good example, the embassy sent about 104 victims (by Ethiopian Government budget) to Ethiopia on 04 January 2020). IOM is also trying to support the migrants in any way possible but still, it has no adequate budget for Ethiopians. More interestingly, the Embassy has built a Safe House in its compound where illegally trafficked persons stay for a while and then are deported to Ethiopia via bus or airline, with the support of the Ethiopian Government and IOM.

In general, irrespective of whether they came in legally or illicitly, the majority of the interviewed and observed Ethiopian emigrants in Khartoum found themselves in degrading working and living situations to survive. They faced various forms of ill-treatment and exploitation revealed in the interviews and observation. To mitigate such harm and cruelty among neighboring people (though not the stand of the government and the majority of the people), the key informant interview at the Department of Sociology and Social Anthropology of the University of Khartoum recommends a series of dialogue among the IGAD Countries as to how they can introduce common favorable policies to manage illicit cross-border migration. There shall be a common conduce ground legal framework on how to deal with emigrants, whether they are legal or illegal. Moreover, the governments of IGAD are recommended to be aware of their respective people as to how they understand each other, respect diversity, and avoid stereotypes.

3.3 The danger of further moving ahead to other destinations from Khartoum

Options to travel further ahead and the dangers therein

The stepwise Ethiopia emigrants try to apply different techniques to further travel to Libya, Egypt, Europe, the Gulf States USA, and Canada. The safest way out for women is to arrange a false marriage to a Sudanese or any well-off man who can arrange a tourist visa for them and himself. This is a marriage of convenience entered into without intending to create a real marital relationship. Pieces of literature show that this marriage type is common in other countries usually gaining an immigration advantage from the marriage. With this marriage arrangement, an emigrant Ethiopian woman in Khartoum is required to pay her 'fake husband' 20,000 SDP (about 400 USD). She is also expected to cover all official expenses to get a marriage certificate, transportation cost, short-time accommodation expenses in a destination country, and all other unforeseen expenses. The 'fake husband' is responsible to apply for a tourist visa and move his 'fake wife' to accompany and drop her in any preferable country in Europe or the Middle East. Regarding the 'false marriage', one of the interviewees, a street tea/coffee vendor in Omdurman Sub-city around the main campus of the Ahfand University for Women, narrated that she entered into a 'false marriage' to a Sudanese man in December 2019. She paid him 20,000 SDP (about 400 USD) for the favor. Her target was to join any refugee camp in Europe after she would move to Spain through a tourist visa accompanying her 'fake husband'. She indicated that she had to pay lots of money to the negotiator between her and the man in addition to the cots she was expected to pay for visa, transportation, and accommodation at the destination city in Europe.

Another option to further move ahead for Ethiopian emigrants in Khartoum is by using international smuggling networks, with full of tremendous risks. Hundreds and possibly thousands of refugees have been kidnapped and sold to traffickers in the deserts such as Egypt's Sinai Peninsula in this option. As noted by Ati (2017), usually, the migrants have been held and tortured until their relatives can raise thousands of dollars in ransom money. International organizations, such as the Human Rights Watch, usually accuse security authorities in Sudan and Egypt of ignoring this violent trade in human beings and, in some cases, even colluding with traffickers. They smuggle their captives to the Suez Canal, where they sell them to Sinai Bedouins, who then transport them across the Sinai Peninsula to 'torture camps where their final 'owners' collect enormous ransoms' (Connell, 2013 cited in Ati, 2017). Surprisingly, the ransoms demanded are over 40,000 USD (a sky-high amount for poor Ethiopian families). What is very astonishing here is the fact that most interviewed women were ready to use the international smuggling networks to travel to their planned destination though they have quite adequate information about the severe challenges en route.

Similarly, the Ethiopia Country Statement by Expertise France, AMMI & RMMS (2017: 1) indicates that human trafficking in East Africa (including Sudan and Ethiopia) takes place within the context of migrant smuggling networks and also independently of the network:

> '*Ethiopian migrants transiting through Sudan, Libya and Yemen, usually find themselves vulnerable to groups that specialized in kidnap for ransom, extortion, debt bondage, sex-trafficking and forced labour. Similarly, some Ethiopians, who seek the services of overseas employment agencies to facilitate labour migration to Saudi Arabia and other Gulf states, become victims of human trafficking when they reach their destination*'.

The experience of an interviewee working as a waiter in a hotel in Khartoum is worth mentioning regarding the international smuggling networks as a means to travel abroad, and the perils therein. Since childhood, this specific interviewee had dreamed of becoming a captain. As a result, he joined the former Ethiopian Naval Training Center (NTC) in Asmara and graduated in 1983/4. He served the naval force for about 7 years until he 'betrayed' the naval force and escaped to Sudan in 1990. He planned to travel to Europe or the USA through Libya. After staying for a while in Sudan, he attempted to enter Europe through Libya. However, his plan was aborted when the lorry, in which he was being smuggled, along with many others, attracted the attention of the Libyan police force near Tripoli. He was imprisoned for about 18 months starting from the time the lorry he was smuggled in was intercepted. He recalls that he traveled thousands of kilometers by truck for about 12 days through a horrible desert. A bottle cap of water with small bread was served only in the morning and evening. After 18 months of ruthless and horrible imprisonment in Libya, he was deported to Ethiopia with the help of IOM. Surprisingly, he again moved to Khartoum by bus after a brief stay with his mother in Addis Ababa. He is 58-year-old, not married, no child. He very much regretted his earlier decisions.

Another option to leave Khartoum is to be registered at the UN Refugee Agency (UNRA) and/or International Federation of Red Cross and Red Crescent Societies (IFRCS) as a stateless person. 'This is very procedural, a rare occurrence, the most preferred and safest,' said most interviewees. They either hide/avoid their Ethiopian citizenship or submit fake documents (sometimes may be true) as if they are fleeing the 'harsh political situations' in Ethiopia while the real factors may be different. The major target here is to move to a developed country under the assistance of IFRCS or UNRA. A challenge here is that after they registered as stateless, some may face difficulties in accessing basic rights such as education, healthcare, employment and freedom of movement in the city. Often, they are not allowed to go to school, see a doctor, get a job, open a bank account, buy a house or even get married officially. Without these things, no doubt, they can face lifetime obstacles and disappointment. This is against Article 6 of the UNODC (2004)'s 'Protocol to Pre-

vent, Suppress and Punish Trafficking in Persons, Especially Women and Children, supplementing the United Nations Convention against Transnational Organized Crime' which urges Each State Party the 'the provision of medical, psychological and material assistance; and employment, educational and training opportunities'.

Like the two other cases, the experience of an interview working as a driver... of what important for this research. He was born around Shashamane town (a potential for good agricultural and business area in central Ethiopia) and went to Sudan 8 years before. He recalled his life in Ethiopia was just hand to mouth because of which he left his wife and three children behind and left to Sudan for a better job opportunity. As soon as he arrived, he joined a refugee camp seeking political asylum. After working as a daily laborer and a waiter for a few years, he managed to buy *irreksha* (in his Sudanese friend's name) and started a short-distance transportation service business in Khartoum. His daily income was about 1,000 SDP (about 20 USD). Again, he very proudly and happily expressed that he heard the good news that his application to move to Australia as a stateless refugee was accepted. Then, he would be moving to Australia within six months from January 2020. He was dreaming that he would soon start a new life with his wife and children in Australia. He wished to see his children attending better school, and support his brothers, too. Similar findings were reported by Paul (2011) in his conducted on Filipino migrants.

***Immigrants and a crossroad*?**

The results show that the life of most illicit emigrants is encircled in harsh challenges. It is challenging them to continue living in Khartoum because of their illicit entrance and the resultant vulnerability to abuse, ill-treatment, bribery, and lack of access to necessary services such as education, healthcare, and banking. It is also clear that proceeding to their targeted final destinations by using international smuggling networks may also result in tremendous risks. Consistently, reports of several organizations and research findings indicate that countless cross-border migrants who attempted the international smuggling networks were endangered. It is also briefly discussed that the 'false marriage' arrangement to proceed to the dreamed destination area is costly, immoral, unreliable and insecure. Another option for many emigrants who are in a vulnerable situation may be coming back home by the support of the Ethiopian Government and/or any concerned organizations and think of livelihoods strategies at home or trying more secure and legal way of looking for job opportunities abroad if migration is inevitable and of great interest. A few of the interviewed Ethiopian immigrants in Khartoum wish to go back home. These are only those who had saved some amount of money, who have relatively well-off close family in Ethiopia, and those who did not own relatively secure businesses and not earning better income in Khartoum.

> Saving (if there is any) is almost impossible as most of them were not entitled to access bank services in Khartoum, either to save money or remit through bank system, owing to lack of official Identification Card or residence permit in Sudan. Sometimes, they remit the money through an informal value/money transfer system (IVTS), usually in the hands of individuals who legally move from Khartoum to Ethiopia, paying higher commissions to the carrier than formal banking systems do. Informal money transit is risky in that sometimes the carrier may deny/cheat or ask quite a lot of commission for the service they rendered. Another key challenge related to saving money at home is the misuse/cheating of the money by their close families at home. A case in point is the story of an interviewee who left Ethiopia 12-years ago and engaged in a street coffee/tea business in Omdurman sub-city (lying on the western banks of the River Nile opposite to the city center of the capital). She indicated that she paid a 10,000 SDP (about 200 USD) commission for the informal money carrier to remit 50,000 SDP (about 1,000 USD) for the expenses of her father's 40th Day Memorial Service Ceremony for the dead (traditionally known as tiskar in her birthplace, Maksegnit in Gonder). Her attempt to remit 350,000 ETB (about 11,000 USD) to

her uncle living in Addis Ababa for her saving is unsuccessful as the person misused/consumed the money disloyally. Disloyalty and misuse of their close family for the money they are remitting for their saving is one of the severe challenges for quite a number of the interviewed Ethiopian immigrants in Khartoum.

3.4 The shared responsibilities and attempts of addressing illicit cross-border migration by Ethiopia and Sudan

According to the United Nations Office on Drugs and Crime (UNODC), every country in the world is affected by the crimes of trafficking in persons and the smuggling of migrants. As a result, UNODC put in place the United Nations Convention against Transnational Organized Crime and the Protocols Thereto (UNODC, 2004) urging 'Each State Party shall adopt such legislative and other measures as may be necessary to establish as criminal offenses, when [trafficking in Persons and Smuggling of migrants] committed intentionally'. However, the major challenges for most countries are the capacity to identify the criminals and assist the victims, many of whom endure unimaginable hardships in their bid for a better life. The UNODC (2004)'s Protocol further urges Each State Parties to take actions and cooperate in areas of protection of victims of trafficking in persons, keeping up the status of victims of trafficking in persons in receiving States, prevention of trafficking in persons, exchanging information exchange, training and border measures. In the same way, in addition to what has been mentioned, UNODC (2004)'s Protocol recommends each state party to cooperate in criminalization and liability of cross-border migrant smugglers, prevention of smuggling of migrants, and returning of smuggled migrants.

Ethiopia and Sudan are expected to work together and/or indecently in common to combat the existing risks related to trafficking in persons and the smuggling of migrants. Though the reality on the ground is still frustrating, as indicated in Ati (2017:3) and IOM (2015), the Sudan government has already started positive steps to fight human smuggling and trafficking. Some of the measures in this regard include signing the UN Convention against Transnational Organized Crime; hosting the UN Conference for Transitional Organized Crimes that covered human trafficking in 2005; issuing the first anti-trafficking law in the country in 2010 at Kassala State; and enacting a law against illegal immigration and human trafficking in 2013 in Gedarif State. The Sudan government decided in September 2013 to issue work permits to approximately 30,000 refugees in Kassala State, which reduces the refugees' vulnerability to exploitation, forced labor, and trafficking. It also signed the Joint Strategy with UNHCR and IOM to address human trafficking, kidnapping, and the smuggling of persons in Sudan in December 2013. Sudan initiated prosecutions in over 25 suspected human trafficking crimes in Khartoum and Kassala states; and established in 2013 the 'Rapid Emergency Taskforce and Response Unit' to deal with trafficking crimes in eastern Sudan; Likewise, Sudan established a national committee to combat child trafficking and illegal immigration and initiated an anti-trafficking section within the Sudanese Working Abroad Secretariat (SWAS) (Ministry of Labor) to repatriate abused workers from the Middle East, mainly female domestic workers and boys who were used as hajan camel racing riders. The country ceased its public denial of the existence of human trafficking in Sudan and acknowledged the scope and extent of the country's human trafficking problem. In addition, the Sudanese Government endorsed a Joint Partners Strategy with the UN and IOM to address trafficking and smuggling (2015-2017) that increased its capacity resulting in greater numbers of trafficking victims rescued and assisted. Sudan is engaging in greater levels of engagement on training and workshops with partners to strengthen and build capacity to fight against human trafficking and smuggling.

Similarly, the role of Ethiopia is immense in combating irregular migration and the human suffering herein. This is because Ethiopia is a source, transit, and destination country for irregular migration within Africa, as well as to the Middle East and Europe (Marchand *et al*., 2016; Expertise France, AMMi and RMMS, 2017). The government of

Ethiopia has undertaken several measures to combat migrant smuggling and human trafficking in East Africa in general and in its territory in particular. First, Ethiopia enacted Refugees Proclamation No 1110/2019 to be applied without discrimination based on race, religion, nationality, membership of a particular social group, political opinion, or other similar grounds. Second, in 2018, the Ethiopian government lifted the ban on overseas migration. The new legislation aimed at protecting its citizens from ill-treatment by establishing regulations for recruitment agencies, minimum age requirements, a minimum level of education, and training for migrant workers before departure. Third, Ethiopia has ratified International Treaties relating to refugees and made an integral part of the law of the land. These include The Geneva Refugee Convention (1951), the New York Protocol Relating to the Status of Refugees (1967), The Organization of African Unity Convention Governing the Specific Aspects of the Refugee Problems in Africa (1969), United Nations Convention against Transnational Organized Crime. This has helped Ethiopia to control, hunt, and bring to justice human traffickers and smugglers. Fourth, Ethiopia is assisting in the interception of individuals vulnerable to trafficking and convicting an increased number of traffickers; overseas recruitment agencies, and amplified awareness across the country on trafficking and trafficking-related crimes through its community dialogue program. There are also some efforts by the government and partners to strengthen the capacity to collect, share and manage information better, but the gap remains big. Fifth, Ethiopia enacted Proclamation No. 909/2015 to 'Provide for the Prevention and Suppression of Trafficking in Persons and Smuggling of Migrants; and National Coordination Mechanism has been re-established by Proclamation No 909/2015.

According to the data obtained from OEWD of MoLSA, Ethiopia has also signed bilateral labour agreements with four Middle East destinations for Ethiopian workers, namely Saudi Arabia, UAE, Qatar, and Jordan. The issue of labour agreement is under discussion with many other courtiers in Africa, Middle East, Europe, and East Asia. Specific to Sudan, the target is to protect seasonal labourers who travel to Sudan as daily laborers in the agriculture and construction sectors. This creates a viable legal framework for the protection and safety of workers. The country established National Anti-Trafficking Council and Taskforce to address trafficking at national, regional, zonal, and district levels with a focus on prevention, prosecution, and protection. Similarly, foreign policy reform is one of the most acclaimed improvements in current Ethiopia under the leadership of HE PM Dr. Abiy Ahmed. The official visits, discussions, and agreements with all neighboring East African and Arabian countries as well as an end to the Ethiopia-Eritrea conflict have great contributions to peacebuilding and stability of the region, which in turn, helps greatly in combating the existing human trafficking and smuggling in the area. Ethiopia is always keen to withdraw its stranded illicit migrants in other countries such as Djibouti, Libya, Mozambique, Saudi Arabia, Sudan, UAE, and Yemen with the support of IOM, the governments, and other organizations. One excellent example is the repatriation of hundreds of Ethiopian citizens working in Lebanon who are stranded because of the COVID-19 pandemic. Above all, Ethiopia is currently working hard to transform its economy and democratic leadership to create a conducive socio-economic and political environment where every citizen works freely, develops/grows, avoids illicit cross-border migration and transforms his/her life within the territory. With this, citizens will travel abroad only legally in case of inevitable situations like the availability of more paying job opportunities and training.

Ethiopia and Sudan have still, even more, to do to adequately combat the perils of human trafficking and smuggling in persons in their territory. Hitherto, the lack of proper border demarcation between the two countries is a cause for frequent disputes among local people resulting in population displacement, injuries, and weak border surveillance in the area. As noted in Ati (2017), Sudan's reporting of investigations, prosecutions, or convictions related to human trafficking is not adequate. There is also a lack of adoption of proper/practical measures to combat traf-

ficking, which has resulted in new forms of trafficking arising within the country. Similarly, there is a gap in proactively identifying victims among vulnerable populations and in the process of transferring victims to organizations and institutions providing care. Consistently, the US Department of State in its report on Trafficking in Person (2019) mentioned Ethiopia as not being fully in line with the minimum standards for the elimination of human trafficking and smuggling, but it is making momentous efforts. According to the report, Ethiopia has not sufficiently addressed internal trafficking, including child sex trafficking, and lacked standard procedures for frontline responders to proactively identify trafficking victims among vulnerable migrants. Similarly, the provision of sufficient victim services to male victims has not yet started. Besides, Ethiopia's internal civil unrest in some border areas of the country's regional states has generated millions of internally displaced persons (IDPs), which in turn, may fire up the existing cross-border out-migration leading to further human trafficking and smuggling. Regarding IDPs in Ethiopia, IOM (2019) indicated the existence of 2.9 million new conflict-induced displacements in Ethiopia in 2018, the largest number globally. Moreover, there were more than 290,000 new disaster-induced displacements in Ethiopia. The gaps shown under this sub-title strongly justify the fact that Ethiopia and Sudan have something great to do in common to combat the existing severe trafficking in persons and smuggling of migrants in their territory.

Given the UNODC (2008)'s framework for action, the major motivation for illicit out-migration from Ethiopia is inadequate enforcement of Labour standards, absence of bilateral labour agreement with major employing Middle East countries, and the assumed 'better income in some destination countries than the case in Ethiopia'. The fact that Ethiopia and destination countries tolerate restriction of freedom of movement, long working hours, poor, inadequate health and safety measures, substandard wages, and housing provisions is highly contributing to the expansion of human trafficking and smuggling. Another factor that contributes to the proliferation of trafficking in view of the framework is the absence of Labour inspection and monitoring in countries of destination. This situation is especially true in already marginalized sectors such as cattle/camel herding and domestic services. The data obtained from interviews with PEALT and related pieces of literature show that the government of Ethiopia is doing its level best to protect the rights and well-being of Ethiopian migrants in destination areas. The activities include awareness creation on human trafficking, licensing and monitoring foreign employment agents, patrolling borderlines, and transporting Ethiopian victims from risky areas. The government has been organizing a series of repatriation schemes from Sudan, Yemen, Saudi Arabia, Lebanon, and the other Gulf States. The beneficiaries of the programs have been those who were unable to continue to support themselves or fund their travel home, the migrants were left helpless.

There is no comprehensive victim-sensitive compensation mechanism for the victimized migrants in each destination country that could be solved through the ongoing bilateral agreements between Ethiopia and the countries. The statements of the PEALT interviewee indicate that a well-balanced bilateral agreement ensures not only to adequately redress the problem but also to avoid secondary victimization, in which the migrants are treated as criminals not as victims, risk detention and deportation if the employer notifies police that the worker has absconded. The problem is multidimensional that even where justice is about to be served, they cannot explain what happened to them to police and service providers due to the language barrier. There is also an attempt of providing the returnee victims with comprehensive and immediate services for the injuries and trauma they survived. To prevent the exploitation of Ethiopian migrant job seekers, MoLSA has introduced requirements for migrant workers to produce foreign employment contracts by which they verify employers' compliance with national law. Although this measure regulates Labour migration, it does not hinder trafficking and even exploitation. Concerning this, some returnee interviewees stated that they were forced to sign modified contracts other than

what they did in Addis Ababa upon their arrival in destination countries.

Furthermore, Ethiopia entered into a labour agreement with some major destination countries to protect the rights of its migrant workers in the countries. According to an interview made with an expert in PEALT of MoLSA, Ethiopia has concluded a visa abolition agreement with Kenya. Likewise, the FDRE Diaspora Policy was launched in 2013 (MoFA, 2013) to guide the country's diaspora affairs and in particular to maximize the economic potential and skills of the Ethiopian Diaspora for national development. The policy promotes diaspora engagement and participation in investment, trade, and tourism, and thus encourages foreign currency inflow as well as knowledge and technology transfer. Concerning this, the interviewed Ethiopian Diaspora Community leaders in Khartoum are complaining about the remoteness of residence permit (against the convection) and the absence of Ethiopian banking service in Khartoum (unlike the cases in Djibouti and Juba) hindering them to access bank services for saving and remittance. The community leaders recommend the state-owned Commercial Bank of Ethiopia (CBE) to open its branch in Khartoum (like its attempts in Washington, D.C, and Dubai) where hundreds of thousands of Ethiopians live either permanently or temporarily as step-migrants. Mostly, the most interviewed and observed Ethiopian illicit emigrants in Khartoum are suffering abuses against related conventions and the Universal Declaration of Human Rights.

4 Conclusion and Recommendations

This research realized that cross-border human trafficking and smuggling of migrants in Ethiopia and Sudan are pervasive; the causes are varied and multifaceted; the stakeholders are numerous, and the consequences are severe and diverse. In Ethiopia, almost every corner of the country (both urban and rural) has been affected by the perils of illicit cross-border migration and human trafficking. Ethiopian youth are migrating out mainly through three routes where the western route to Sudan was specifically investigated in this research. Most Ethiopian immigrants' situations in Khartoum were found to be unfortunate in every aspect from the time they decided to illicitly travel. The target of most of them is a failure. Their intentions to go ahead with the remaining long journey to 'better destination areas' through the deserts of Sudan and Libya are full of perils; while continuing living in Khartoum is non-paying, wasteful, and unsafe. Similarly, returning home after all the futile difficulties that they faced en route and at the destination is considered as poignant and disgraceful for most of them. However, the only safest option for them seems to go back home with courage and start a new livelihood system integrating the experiences and skills they gained from the perils of migration. The results of the study imply the urgency and importance of addressing the root causes of migration in general and irregular migration in particular in Ethiopia.

Pertinent to the complexities of cross-border human trafficking from Ethiopia to Sudan and beyond, the remedies could be multidimensional. To address the existing embarrassing situations, inclusive development interventions, enhanced agricultural production systems, rule of law, proper job creation strategies, and improved awareness creation approaches are recommended. The provision of loans and revolving funds with strict follow-up on projects that are carried out by the youth has to be given attention by concerned government sectors such as Federal Urban Job Creation and Food Security Agency (FJCFSA). It is exigent and vital for the government to enhance good governance and develop a democratic culture and political tolerance to curb the prevalence of ethnopolitical challenges. It looks like a critical time for the government, CSOs, NGOs, researchers, religious organizations, community leaders, and political parties to indoctrinate Ethiopian youth to look for opportunities at home in place of planning for a risky unlawful migration business. Moreover, Ethiopia should put in place continuous awareness creation campaigns on the risks of illicit outmigration to fight human trafficking and illegal cross-border movement through the media, formal and informal education, religious institutions and teachings, and other means

necessary.

Moreover, cross-border co-operation should be enhanced between Ethiopia and Sudan on issues like harmonization of border control procedures and joint patrols and bilateral exchange of information related to human trafficking and smuggling, including proper demarcation of borderlines. Likewise, although fragmented elements of migration policy do exist in different proclamations and policies, Ethiopia does not have a concerted policy framework on migration. Therefore, a comprehensive national migration policy is recommended to be in place. In the same way, the passport and visa procedures in Ethiopia should also be modernized, decentralized, and accessible at least at all regional towns. This could help reduce the predicaments of securing a passport and of resorting to illegal channels. It is quite clear that reducing human trafficking through the promotion of safe migration may have positive outcomes for both migrant-sending families and the migrants themselves. Similarly, it is essential to work towards supporting the potential migrants to acquire all the necessary skills and knowledge for the success of the intended employment opportunity abroad. Bilateral agreements between Ethiopia and Sudan as regards to enhancing co-operation against human trafficking and constant monitoring of the implementation of the agreement would be a sensible mechanism to ensure the protection of Labour migrants.

Concerning rehabilitating the victimized emigrants in Khartoum, the Government of Sudan should be abided by the Palermo Protocol (UNODC, 2004) so that the Ethiopian immigrants in Khartoum would be protected, respected, supported, and will have access to basic services such as health, education, banking, shelter, and livelihood mechanism. In addition, the Ethiopian Government should establish adequate rehabilitation centers and raise funds that could be used to assist the distressed returnees. Comprehensive and immediate services such as temporary shelter, medical and psychosocial care, legal aid, food, clothing, and reintegration schemes are vital for the victims. Particular attention should be given to the specific needs of women, children, and elderly victims. The government, NGOs, and CSOs can play key roles in establishing rehabilitation centers where victimized returnees could recover from the ill-treatment and trauma they encountered in Khartoum and the en-route. At the centers, they could be re-educated and socialized to better adapt themselves to their previous socioeconomic environment.

As regards prosecution, effective prosecution of human trafficking calls for more works and concerted efforts of the community, the victims, the police, the administrative and legal authorities, and other relevant bodies. In this regard, it seems very highly important to have different institutions mandated to collect, share and manage information about trafficking in persons and smuggling of migrants from Ethiopia to Khartoum and beyond, and a centralized body to manage, analyze and share the data meant for prevention of the perils and investigation and persecution processes of the traffickers and smugglers. In conclusion, we recommend the enhanced dialogue between the governments of Ethiopia and Sudan as to how they would prevent the perils of illicit cross-border migration and avoid 'stereotypes' among the neighboring peoples. Moreover, increased cooperation and exchange of best practices between the two countries on counter-trafficking efforts and strengthening cross-border patrols to end border encroachments is vital. Furthermore, the launching of a branch of Ethiopian bank in Khartoum to serve the immigrants to remit money and/or access other banking services is very essential.

Conflict of Interest

The authors declares that there is no conflict of interest.

References

Amin, S. (1995). Migration in Contemporary Africa. In Jonathan Baker and Tade Akin Aina (eds). *The Migration Experience in Africa*. Sweden: Nordiska Afrika institutet.

Ati, H. A. (2017). *Human Smuggling and Trafficking*

in Eastern Sudan. Report No.2, University of Burgen, Sudan.

Bahru Zewde (2002). A History of Modern Ethiopia, 1855–1991: 2nd Ed., Eastern African Studies.

Betz, W. and Simpson, N. B. (2013). The Effects of International Migration on the Well-Being of Native Populations in Europe, Institute of Labour Studies, IZA DP No 7367.

Boswell, Christina (2002). New Issues in Refugee Research: Addressing the Causes of Migratory and Refugee Movements: The role of the European Union. Working Paper No. 73, Institute for Peace Research and Security Policy University of Hamburg, Germany.

Deotti, Laura and Estruch, Elisenda (2016). Knowledge materials: Addressing rural youth migration at its root causes: A conceptual framework. Social Policies and Rural Institutions Division, Food and Agriculture and Organization of the United Nations, Rome.

de Haas, Hein (2010). The Internal Dynamics of Migration Processes: A Theoretical Inquiry. *Journal of Ethnic and Migration Studies*, 36 (10), 1587-1617, https://www.doi.org.10.1080/1369183X.2010.489361

Federal Democratic Republic of Ethiopia /FDRE/ (1995). Constitution of the Federal Democratic Republic of Ethiopia, Addis Ababa.

FDRE (2004). The Criminal Code of the Federal Democratic Republic of Ethiopia, Proclamation No.414/2004, Addis Ababa.

FDRE (2015). Proclamation for the Prevention and Suppression of Trafficking in Persons and Smuggling of Migrants: Proclamation No. 909/2015, Addis Ababa.

Gallina, A. (2006). Impact of International Migration on the Economic Development of Countries in the Mediterranean Basin, UN/POP/EGM/2006/04.

Garson, J. P. and Loizillon, A. (2013). Changes and Challenges: Europe and Migration from 1950 to Present. In the Economic and Social Aspects of Migration, the Conference Jointly Organized by European Commission and OECd, Brussels, 21-22 January 2013.

Gezie, Lemma D., Yalew, Alemayehu W. and Gete, Yigzaw K. (2019). Human trafficking among Ethiopian returnees: its magnitude and risk factors. *BMC Public Health*, 19(104), https://doi.org/10.1186/s12889-019-6395-z

Girmachewu Adugna (2019). Migration patterns and emigrants' transnational activities: comparative findings from two migrant origin areas in Ethiopia. *Comparative Migration Studies* 7(5), https://doi.org/10.1186/s40878-018-0107-1

Intergovernmental Authority on Development /IGAD/ (2016). Human Trafficking and Smuggling on the Horn of Africa-Central Mediterranean Route, Sahan Foundation and IGAD Security Sector Program (ISSP), February 2016.

International Centre for Migration Policy Development (ICMPD) (2008). East Africa Migration Route Initiative Gaps & Needs Analysis Project Country Reports: Ethiopia, Kenya, Libya. Vienna.

International Labour Organization /ILO/ (2008). ILO Action Against Trafficking in Human Beings, Geneva.

International Labour Organization /ILO/ (2011). Trafficking in Persons Overseas for Labour Purposes: The Case of Ethiopian Domestic Workers. ILO Country Office Addis Ababa in Collaboration with the Ministry of Labour and Social Affairs (MoLSA) the Ethiopian Employers' Federation and the Confederation of Ethiopian Trade Unions, Addis Ababa.

International Labour Organization /ILO/ (2013). International Labour Organization (2013). Global Employment Trends, International Labour Office, Geneva.

International Labour Organization /ILOb/ (2017). Promote Effective Labour Migration Governance in Ethiopia, Program Achievement, Geneva.

International Labour Organization /ILO/ (2020). Addressing the Root causes of Migration in Ethiopia, ttps://www.ilo.org/africa/technical-cooperation/WCMS_554065/lang--en/index.htm, Accessed on 09 February 2020)

International Organization for Migration /IOM/ (2005). Migration Development Nexus: Evidence and Policy Options, IOM Migration Research Series No. 8, Geneva, Switzerland.

International Organization for Migration /IOM/ (2015). Human Trafficking and Smuggling of Migrants in the Context of Mixed Migration Flows: State of Play in the IGAD Region, Sixth IGAD Regional Consultative Process on Migration (IGAD RCP), International Organization for Migration Special Liaison Office (SLO) in Ethiopia.

International Organization for Migration /IOM/ (2017a). Enabling a Better Understanding of Migration Flows (and Its Root-causes) from Ethiopia Towards Europe Desk-Review Report Displacement Tracking Matrix (DTM), Geneva, Switzerland.

International Organization for Migration /IOM/ (2019). World Migration Report 2020, Geneva Switzerland.

Jennissen, Roel (2007). Causality Chains in the International Migration Systems Approach. *Population Research and Policy Review*, 26: 411–436. https://www.doi.org/10.1007/s11113-007-9039-4

Kassahun Berhanu (1998). Resettlement: A Strategy for Vulnerable Groups?. Paper Presented at the Inaugural Workshop for the Forum for Social Studies (FSS). (September) Addis Ababa: Department of Political Science and International Relations, Addis Ababa University.

van Liemt, Gijsbert (2004). Human Trafficking in Europe: An Economic Perspective. Working Paper, International Labour Organisation, Geneva.

Marchand, Katrin, Roosen, Inez, Reinold, Julia and Siegel, Melissa (2017). Irregular Migration from and in the East and Horn of Africa. Maastricht Graduate School of Governance, Maastricht University.

Ministry of Foreign Affairs /MoFA/ (2013). Federal Democratic Republic of Ethiopia Diaspora Policy, Addis Ababa.

Messay Mulugeta and Teferee Makonnen (2017). Illicit Cross-border Migration in Ethiopia: Causes, Patterns and Policy Responses, *Ethiopian Journal of the Social Sciences and Humanities (EJOSSAH)*, 13(2), https://www.doi.org/10.4314/ejossah.v13i2.3

Messay Mulugeta, Degefa Tolossa and Gezahegn Abebe (2017). Description of Long-term Climate Data in Eastern and Southeastern Ethiopia. *Journal of Data in Brief*, 12: 26–36, published in Elsevier

Messay Mulugeta (2019). Cross-Border Migration and Human Trafficking in Ethiopia: Contributing Factors, Policy Responses and the Way Forward. In Fudan *Journal of the Humanities and Social Sciences*, 12 (1), Fudan University.

Mohammed YA (2016). Cause and Consequence of Cross Border Illegal Migration from South Wollo, Ethiopia. *Arts and Social Sciences Journal*, 7(188), https://www.doi.org/10.4172/2151-6200.1000188

Organization for Economic Co-operation and Development /OECD/ (2016). Perspectives on Global Development 2017, International Migration in Shifting World. OECD Publishing Service, Paris.

Paul, Anju Mary (2011). Stepwise International Migration: A Multistage Migration Pattern for the Aspiring Migrant. *American Journal of Sociology*, 116(6): 1842-86, the University of Chicago, https://www.jstor.org/stable/10.1086/659641

Redehegn MA, Sun D, EsheteAM, Gichuki, C. N (2019). Development Impacts of Migration and Remittances on Migrant-Sending Communities: Evidence from Ethiopia. *PLoS ONE* 14(2).

Schaeffer, Peter V. and Mulugeta S. Kahsai (2011). A Theoretical Note on the Relationship between Documented and Undocumented Migration. International Journal of Population Research, Volume 2011. https://www.doi.org/10.1155/2011/873967

Simpson, Nicole B. (2017). Demographic and economic determinants of migration. *IZA World of Labor*, 373. https://www.doi.org/10.15185/izawol.373

United Nations /UN/ (1998). Recommendations on Statistics of International Migration: Revision 1, Statistical Paper Series M, No 1, Department of Economic and Social Affairs, Statistics Division, New York.

United Nations /UN/ (2016). International Migration Report 2015, Department of Economic and Social Affairs, New York.

United Nations Development Program /UNHCR/ (2006). Refugee Protection and Human Trafficking Selected Legal Reference Materials First Edition - December 2008 Protection Policy and Legal Advice Section (PPLAS) Division of International Protection Services (DIPS), Geneva, Switzerland.

United Nations High Commissioner for Refugee /UNHCR/ (2015). Global Trends: Forced Displacement in 2015, UNHCR Global Refugee Agency, Geneva, Switzerland.

UNHCR (2016). Global Resettlement Needs. 21st Annual Tripartite Consultations on Resettlement, Geneva: June 29-July 1 2015.

United Nations Office on Drug and Crime /UNODC/ (2004). The United Nations Convention against Transnational Organized Crime and the Protocols Thereto (UNODC, 2004).

United Nations Office on Drug and Crime /UNODC/ (2008). International Framework for Action to Implement the Trafficking in Persons Protocol, Vienna

Unites States of America Department of State (2019). Trafficking in Person Report, Washington, D.C

Weaver, J. L. (1988). Searching for Survival: Urban Ethiopian Refugees in Sudan. *Journal of Developing Areas*, 22: 437-476

Wickramasinghe, A. & Wimalaratana, W. (2016). International Migration and Migration Theories, Social Affairs: *A Journal for the Social Sciences*, 1(5): 13-32

World Bank (2020), Remittance Inflows to GDP for Ethiopia [DDOI11ETA156NWDB], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/DDOI11ETA156NWDB

Yonas Beyene (2012). Ethiopia's Paleoanthropological World Heritage sites: Research and conservation. In NuriaSanz (Ed.) *Human origin sites and the World Heritage Convention in Africa*, the United Nations Educational, Scientific and Cultural Organization, Paris.

EJED 2022 4(2):25–38
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj
E J E D

Floristic Composition, Diversity and Management of Home-gardens in Uba-Debretsehay District, Southern Ethiopia: Implication for Biodiversity Conservation

Abreham Assefa*, Kefyalew Belachew and Tamru Demsis

Department of Biology, College of Natural & Computational Sciences, Dilla University, Ethiopia
**Corresponding author, Email: abrehamas@du.edu.et; P.O.Box. 419 Dilla, Ethiopia*

Received: 19th June 2022 *Accepted: 04th November 2022*

DOI: **10.20372/ejed.v04i2.02**

Abstract

Home-gardens contribute a lot to the fulfillment of ecological, socioeconomic, and cultural functions and local community needs. This study was conducted with the main objective of assessing the composition and measuring diversity of plant species grown in home-gardens of Uba-Debretsehay district, southern Ethiopia. Six sampling kebeles were purposively selected. 90 households were considered in this study for data collection. A total of 87 plant species belonging to 40 plant families were documented in the sampled home-gardens. Family-wise distribution showed that Fabaceae and Poaceae were the richest families concerning the number of plant species each represents. The home-garden plants documented in Uba-Debretsehay have a range of use values including food, medicine, cash, ornament, spice, and construction. Regarding altitude, Ensete ventricosum, a staple food, was cultivated in home-gardens situated in highland and midland areas. Coffea arabica, various fruits, and vegetables were cultivated in midland areas of the study area while Mussa paradisca, Mangifera indica, and Saccharum officinarum were cultivated at lower altitude areas. Home-gardens in Uba-Debretsehay district consist of different varieties of plant species and serve as a basic agro-ecosystem required for the cultivation and conservation of various plant species. Home-gardens situated in Kolla agroecology have relatively a higher diversity than home-gardens in Woynadega and Dega agro-ecology; however, the overall diversity is low. Agronomists, researchers as well as other concerned bodies need to contribute to conserving plant species cultivated in the home-gardens of the study area and maintaining their diversity to protect them from getting impacted by various factors (natural/environmental and man-made factors).

Keywords/Phrases: Ethnobotany, Home-garden, Diversity, Management, Uba-Debretsehay

1 Introduction

Home-gardens are integrated systems comprising various things in small areas that produce a variety of foods and agricultural products including staple crops, vegetables, fruits, and medicinal plants (Polegriand Negri, 2010). Home-gardens provide high diversity of resources for local households and significantly contribute to the conservation of native biodiversity (Larios *et al*., 2013). According to Gebreegziabeher *et al*. (2011), about 80% of the Ethiopian population depends on agriculture for their livelihoods contributing to 42-45% of the total gross domestic product of the country. Occurrences of high species diversity in home-garden have a range of socioeconomic and agroecological roles including the production of food and other products such as firewood, fodder, spices, medicinal plants, and ornamentals (Unofia *et al*., 2012).

Traditional home-garden land use is viewed as one of the household strategies for the production of food, fuel-wood and fodder. It also serves as a way to maintain sustainable local agricultural practices. According to Abebe (2005), agroforestry home-gardens of the Southern Ethiopian highlands are dominated

by the native perennial crops, enset and coffee, and additionally include a large variety of staple food crops, vegetables and tree crops. These integrated land use systems are believed to enhance agriculture due to the association between multiple crops and trees on one hand and various crops that have ecological and economic benefits on the other and contributing to the efforts to maintain food security in the region (Negash & Niehof, 2004; Awas *et al*., 2010). Traditional home-gardens cover a wider range of area in the Southern Nations Nationalities and People's Regional State (SNNPRS) and are situated at an altitude between 1500m and 2300m above sea level, where moisture and temperature conditions are favorable for agriculture. These home-gardens are characterized by the two native perennial crops: Enset and Coffee. The "Enset-Coffee-Animal fodder" system of southern Ethiopia represents a typical multistory home-garden (Kippe, 2002; Kebebew & Urgessa, 2011). The cultivation of different crops in home-gardens is regarded as a strategy of farmers to diversify their subsistence and cash needs. Diversification also helps to stabilize yield and income in cases of incidences of disease and pests, and market price fluctuations.

Scientific investigation is deemed necessary to examine the capacity of home-garden for the plant species it harbors as well as its potential to satisfy the ecological and household demands of the local community in Uba-Debretsehay district. This study aimed at examining home-garden species diversity uses of plants grown in home-gardens and documenting the present home-garden management practices in Uba-Debretsehay district that would provide relevant information required for determining the capacity and potential of home-gardens in the district and for the maintenance of sustainable biodiversity in the agroforestry home-gardens in SNNPRS.

2 Research Methods

2.1 Description of the Study Area

Uba-Debretsehay district is located in the Gofa Zone of SNNPR, southern Ethiopia, at a distance of 530km from Addis Ababa and 275km from Hawassa town. The district is situated between $5^0$50' – $6^0$10'N latitude and $36^0$40' – $36^0$70'E longitude (Figure 1).

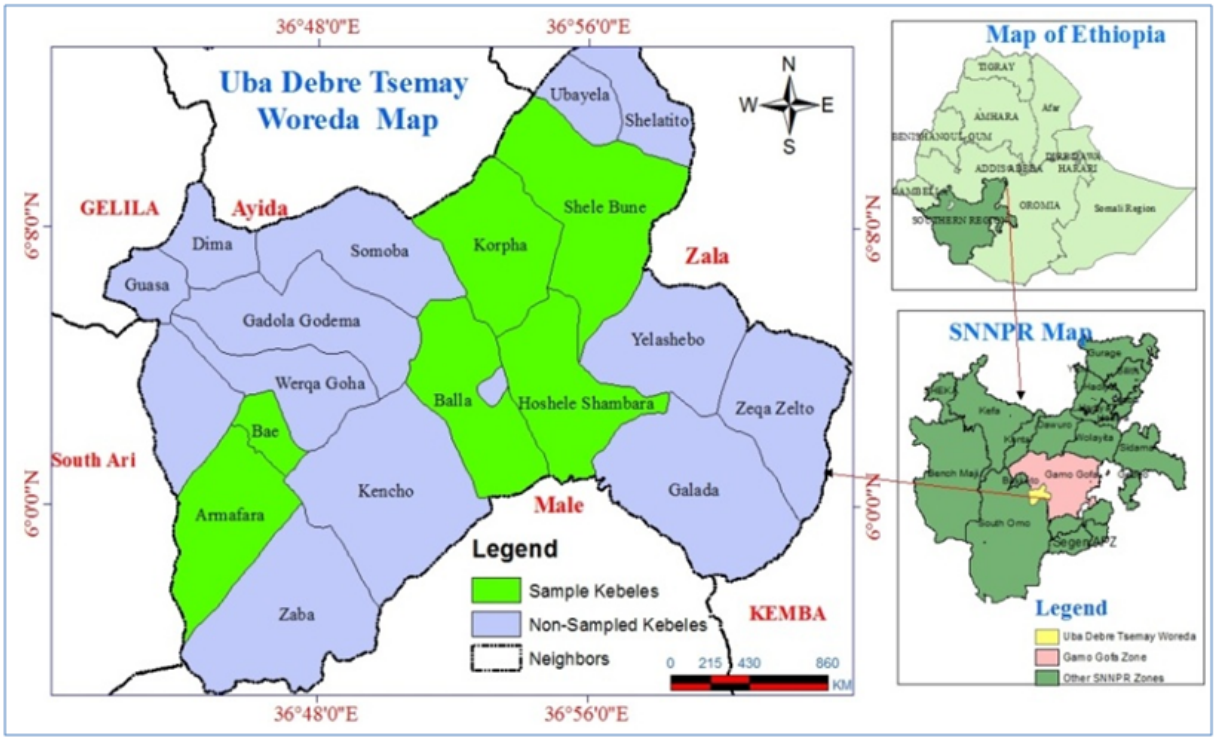


Figure 1. Map of the study area

The topography of the district is characterized by gorges, rugged mountains, plains, and plateaus spread over the elevation range of 950m to 3002m above sea level. The district is characterized by three traditional agroecological zones ('*Kolla*', '*Dega*' and '*Woynadega*') that contributed to variations in the distribution and diversity of plants in various parts of the district. According to the ARDO of Uba-Debretsehay District (2021), the district was characterized by 45% '*Kolla*', 20% '*Woynadega*', and 35% '*Dega*' agroecology.

The annual rainfall that the study area receives varies from year to year with the amount of rainfall ranging from 550mm to 1200mm. The rainy season of the study area extends from March to November. The study area has a mean minimum and maximum annual temperature of 17.5^0C and 28.2^0C, respectively (Habtewold *et al*., 2021). According to CSA (2007), the population of the district was estimated to be 87,132 (49% were males and 51% were females). The number of households existing in the district was 17,426 distributed in 20 '*kebeles*' (a smallest administrative unit in the district).

2.2 Sampling Techniques

Among the total *kebeles* in Uba-Debretsehay district, which were known by home-garden plant cultivation and management, six *kebeles* (two from *kebeles* that have altitudes between 2500-3002m. asl. [highland areas], two from *kebeles* that are characterized by elevation between 1500-2500m.asl. [midland areas], and two from lowland *kebeles* that are situated at altitudes between 950-1500m. asl. [lowland areas]) were considered for selection/sampling of home-gardens where data used in this study were collected. A random sample of 90 households (15 households from each sampled *kebele*) from households that have been practicing home-garden cultivation in the sampled *kebeles* was taken for data collection. In addition, a total of 12 key informants (two from each sampled *kebele*) were purposefully selected based on their history of traditional home-garden practice and cultivation of a wide range of plants.

2.3 Data Collection

Ethnobotanical data relevant to this study were gathered from sampled home-gardens and informants following Martin (1995) and Cotton (1996) using a semi-structured questionnaire, interviews, focus group discussions (FGDs), field/expert inspection and assessment of composition & diversity of plant species cultivated in the home-gardens in the study area. A complete list of plant species cultivated in the home-gardens in the study area along with the information on their uses among the households of Uba-Debretsehay district cultivating the plants was presented in the annex. This information was obtained from each sampled household in the study area and their corresponding home-garden.

2.4 Data Analysis

Home-garden Diversity: Home-garden diversity across each agroecology in the study area was computed using the Shannon Winner diversity index (*H'*) and presented along with their respective species richness value.

Shannon diversity was calculated using the equation:

$$H' = -\sum (P_i \, ln - P_i)$$

Where, *H'* is the Shannon winner diversity index,
$\sum$ is a summation,
P_i is proportion of the i^{th} species and
ln is the natural logarithm.

Jaccard's Coefficient of Similarity: Jaccard's coefficient of similarity was computed following Magurran (1988) and used to measure similarity between the sampled home-gardens in the study area and three other traditional home-gardens situated in other three districts in the country, taking plant species composition of unique and common plant species to the two home-gardens under comparison.

The Jaccard's coefficient of similarity was calculated using the equation:

$$Js = c/(c + a + b);$$

where, Js = Jaccard's coefficient of similarity;
a = the number of species unique to the home-gardens in the current study area;
b = the number of species unique to home-gardens in other districts being compared; and
c = the number of species common to the two districts under comparison.

3 Results and Discussions

3.1 Floristic Composition of the Home-gardens in Uba-Debretsehay District

The local community in the study area cultivates various plant species in their home-gardens. A total of 87 plant species belonging to 69 genera and 40 families were documented in the sampled home-gardens in Uba-Debretsehay district. Among the plant families in the study area, Fabaceae & Poaceae accounted for a 10.34% of plant species each, followed by Solanaceae (6.90%), Rutaceae (5.75%), and Brassicaceae, Euphorbiaceae & Mirtaceae each accounted for 4.60% of the total plant species encountered in the study area (Figure 2). A matrix containing the floristic composition of plants encountered in the sampled home-gardens in the study area along with their respective family names, life form or habits, and plant uses is provided in the annex section.

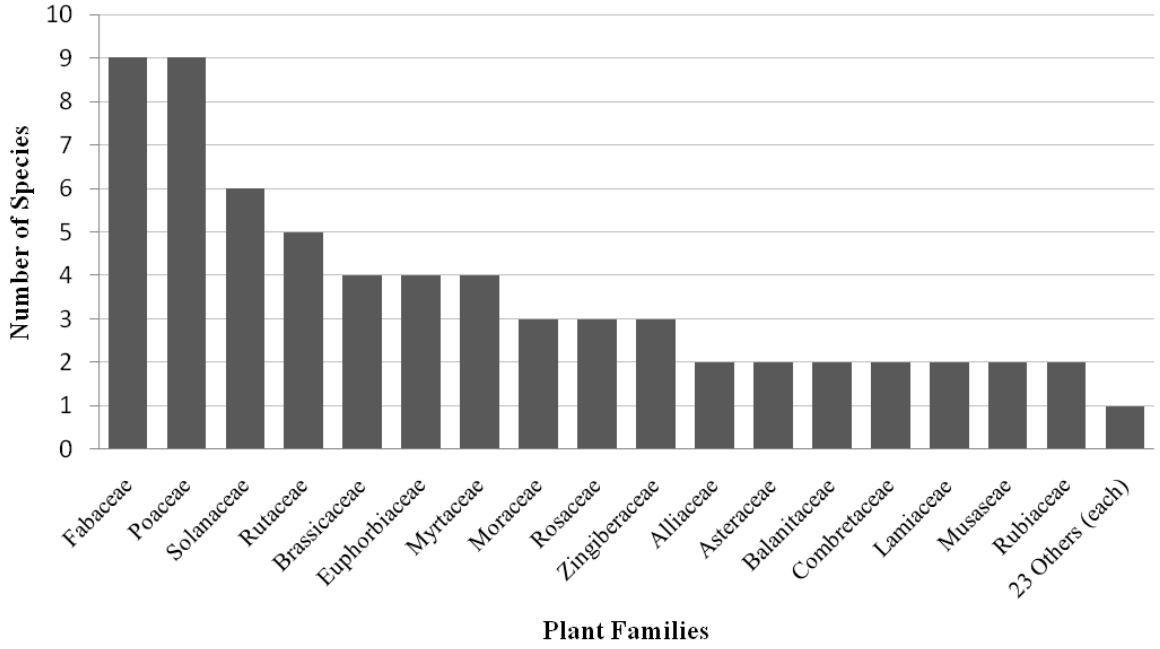


Figure 2. Major plant families and the number of corresponding plant species in the home-gardens in the study area

Fabaceae and Poaceae are found to be the richest plant families regarding the number of plant species they represent. Each of these plant families accounted for 10.7% of the total plant species encountered in the home-gardens in the study area. Family Solanaceae and Rubiaceae are recognized for their higher number of plant species that are cultivated in the home-gardens of the study area next to the family Fabaceae and Poaceae. These families each accounted for 5.88% of the total plant species in the home-gardens in the study area. Rutaceae, Brassicaceae & Euphorbiaceae each accounted for 4.71% of the total plant species encountered in the study area, while the family Rosaceae and Zingebraceae each accounted for 3.53% of the total plant species encountered in the study area. A similar finding was reported by Wassihun *et al*. (2003) and Tamirat (2011), where the family Fabaceae and Poaceae were placed at the top rank in the list of plant families presented together with the number of the respective plant species they were represented by.

Regarding the plant habit or growth form, the plant species encountered in the home-gardens in the study area are characterized by four major plant growth forms. A majority of the plant species encountered in the home-gardens in the study area are characterized as herbs. Herbs documented in the home-gardens in the study area have accounted for 43.68% of the total plant species encountered in the home-gardens in the study area, while trees, shrubs and climbers have accounted for 40.23%, 11.49%, and 4.60% of the total plant species respectively (Figure 3).

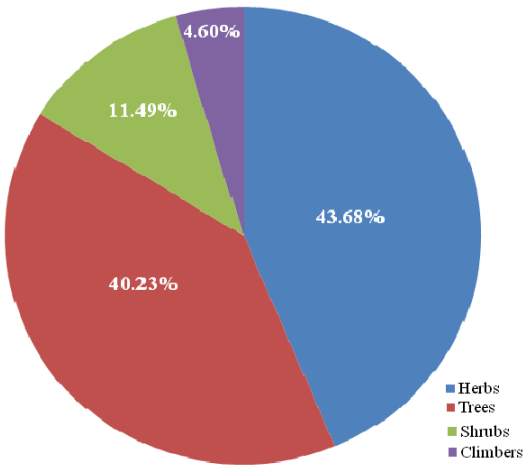


Figure 3. Growth forms and proportion of corresponding plant species encountered in the home-gardens in Uba-Debretsehay district

3.2 Diversity and Richness of Plant Species in the Home-gardens in the Study Area

Depending on the size and purpose which the home-gardens are established, the home-gardens in the study area have showed variations with respect to plant species diversity and richness. Home-gardens situated at '*Woynadega*' agroecology have showed the highest diversity compared to home-gardens located in either '*Dega*', or '*Kolla*' agroecological areas. The least diversity is observed in home-gardens situated at '*Dega*' agroecological areas (Table 1). However, these data on overall species diversity in the home-gardens in the study area concerns empirical data only, and cannot directly be related to the functioning of the home-gardens. As the present analysis focused on crop species only, two major types of diversities were not yet incorporated in this study, i.e. diversity of tree species belonging to either the ecological or conservational functional groups or the genetic diversity in crop species.

Table 1. Diversity and richness of home-gardens situated in different agroecology in Uba-Debretsehay district

Agroecology where the Home-gardens are situated	Species Richness	Diversity (*H'*)
'*Dega*'	46	3.83
'*Woynadega*'	59	4.08
'*Kolla*'	55	4.01

As discussed above, the functioning of the home-gardens are highly related to the presence of the two major crop species namely, enset and coffee. Enset forms a major staple food for households, while coffee is the major cash crop providing income for household expenditures. Ecologically, both species can be grown in integration with each other and with another under-storey and upper-storey crops, providing ecological services such as erosion control, provision of organic matter, and regulation of water and temperature. Home-gardens are often described as generic land-use systems with high species diversity. It was found that taxonomically diverse plant groups are managed in home-gardens in Uba-Debretsehay district, and are used by the local community for various purposes. This shows that traditional knowledge is contributing to the diversity of crops in the home-gardens of the study area. The result agreed with the findings of Asfaw & Nigatu (1995) and Wassihun *et al.* (2003). However, within and between these systems, important variations in crop diversity may occur. This spatial variation is related to temporal variation in species diversity resulting from dynamics in crop composition.

Homegarden composition can be affected by two main processes of change. The development of cash

crops might be influenced by socioeconomic variables like market accessibility as well as ecological factors like crop appropriateness. On the one hand, there is a tendency towards increased incorporation of cash crops as a result of adaptation to the expansion of commercial networks offering options for income generation. The advance of cash cropping depends on both ecological factors such as crop suitability and socioeconomic factors such as access to markets. Varitations in these factors will gradually contribute for the occurence of a wide range of home-garden types. At the other hand the area share of the two main crops, enset and coffee, is being affected by an increased emphasis on annual food crops as a result of rising land fragmentation. When there is a food scarcity, small farmers sometimes lower their enset production area in favor of annual crops like maize or sweet potatoes. A variety of homegarden types will then progressively appear as a result of variations in these aspects.

3.3 Similarity of Home-gardens in Uba-Debretsehay and other Districts

The results of Jaccard's similarity coefficients (Table 2) shows that the highest similarity coefficient of (40%) was obtained for the south and southwestern highlands of Ethiopia (Abebe, 2005), while the least (11%) was for the Ziway area (Giday, 2001). The reason for the lowest similarity might be attributed to the difference in agroecology.

Table 2. Jaccard's coefficient of similarity (*Js*) computed for the home-gardens in the current study area and other home-gardens in three other districts in Ethiopia (districts other than Uba-Debretsehay district)

Place where the home-gardens being compared are situated	Altitudinal Range	Species Richness	*a*	*b*	*a*+*b*	*c*	*Js*
Uba-Debretsehay district, the current study area.	950-3002	87	-	-	-	-	-
Kochere district, Gedeo Zone (Tamrat, 2011).	1700-2500	165	20	100	120	65	0.35
Zeway (Giday, 2001).	1700-1830	33	73	21	94	12	0.11
South and southwestern highlands of Ethiopia (Abebe, 2005).	*na*	80	38	33	71	47	0.40

Key: *a* = number of plant species present unique to the home-gardens in the current study area; *b* = number of species unique to home-gardens in another district under comparison; *c* = number of plant species common to home-gardens in the current study area and the other district being compared; *Js* = Jaccard's coefficient of similarity; and *na* = not available.

3.4 Use Categories of Plants in the Home-gardens

The community in Uba-Debretsehay district has planted various types of woody plant species other than crops in their home-gardens. Woody plants that were managed in and around the home-gardens of the study area include *Eucalyptus camaldulnisis*, *Arundinaria alpine*, *Cordia africana*, *Juniperus procera*, and *Combretum molle*. These woody plant species are planted in home-gardens in the study area for various purposes/values such as food, extraction or preparation of traditional medicine, source of income (from selling crops), farm implements & construction materials, firewood, spices & condiments and ornamental (Figure 4).

The results in this study showed that the majority of the plants grown in the home-gardens of the study area were good sources of food. This suggests that the primary goal of home garden establishment and plant cultivation might be to meet the household's demand for food as reported by Wassihun *et al*. (2003).

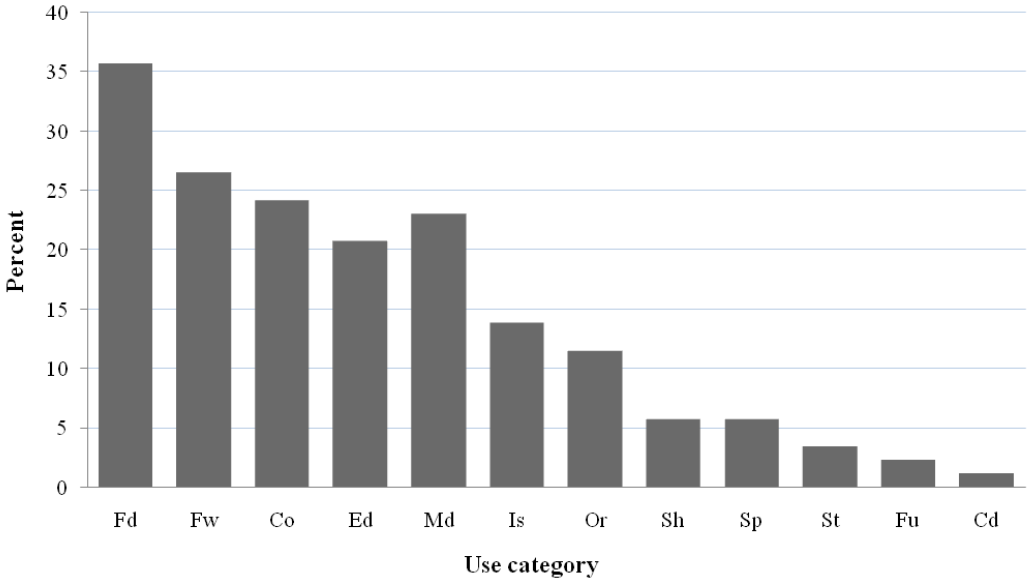


Figure 4. Use category of plants encountered in sampled home-gardens in Uba-Debretsehay district

Key: Ed=Edible, Md=Medicinal, Co=Construction of houses, Fw=Firewood, Or=Ornamental, Lf=Live fence, Fd= Source of Food, Fu= Construction of Furniture, Sh=Shade trees, Bh= Construction of Beehives, Is= Source of Income, St=Stimulants, Sp=Spices, Cd=Condiments.

3.5 Plants used as Food Sources

Among the plant species documented in the home-gardens studied, 31 plant species are cultivated for their food value constituting 35.63% of the total plant species documented in the study area (Figure 4). Regarding the horticultural categories, as indicated in Tamrat (2001), plants whose seeds are consumed are widely cultivated in the current study area indicating that these plant species have been playing a major role in the food system in the study area compared to fruit and root plants (Figure 5).

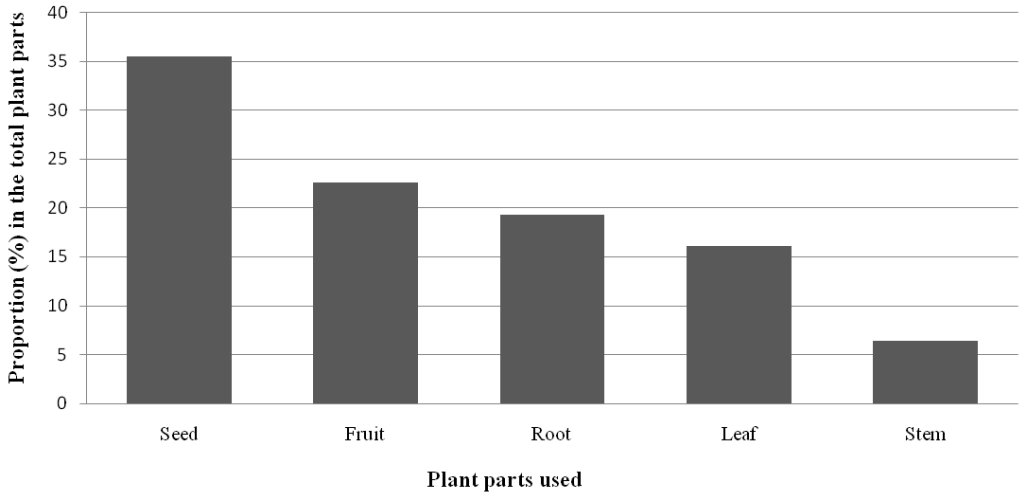


Figure 5. Plant parts used as source of food and their corresponding proportion

Ensete ventricosum was widely cultivated and the most commonly occurring crop in home-gardens in the higher altitudes (both '*Dega*' and '*Woynadega*' agroecologies) in the study area.

The result showed that *Zea mays*, *Ensete ventricosum*, *Moringa stenopetala*, and *Brassica carinata*

are widely cultivated (frequently occurring) in home-gardens in the study area and serve as the main source of food for the local community (Figure 6).

Figure 6. Partial view of a home-garden in Uba-Debretsehay district where *Ensete ventricosum* was widely cultivated. (Photo taken by the author)

This result agrees with the finding of Tamirat (2011) in which *Ensete ventricosum* and *Zea mays* were reported to be among the top frequently occurring crops in traditional home-gardens in the Gedeo Zone.

3.6 Plants used as Spices

Several plant species are cultivated to make spices to enhance the flavor and taste of cooked dishes, butter, coffee, and tea. Five plant species that are used as spices or sources of spices were documented in the home-gardens in the study area. These are *Aframomum corrorima*, *Ocimum basilicum*, *Allium sativum*, *Curcuma longa* and *Zingiber officinale*. These plant species are commonly grown in home-gardens in the study area. Spices were consumed at the home, sold at the local market to pay for other family necessities, and utilized for other household needs.

3.7 Ornamental Plants

The local community at Uba-Debretsehay district cultivates various ornamental plants in their home-gardens. Along with other plant species cultivated in the home-gardens in the district, 10 ornamental plants used for ornamentation (beautification) were recorded from the home-gardens in Uba-Debretsehay district. The names of these ornamental plants are presented in the annex section.

3.8 Cash Crops

From the total of 12 cash crops encountered in the home-gardens in the study area, five plant species are commonly sold in the local market for household income. These cash crop species are *Musa paradisica*, *Catha edulis*, *Coffea arabica*, *Mangifera indica* and *Saccharum officinarum*.

3.9 Medicinal Plants

A total of 20 medicinal plant species that have been cultivated in the home-gardens of the study area and are used by the local community to treat various human ailments were documented. These medicinal plants accounted for 22.99% of the total number of plant species encountered in the home-gardens in Uba-Debretsehay district (Table 3 and Figure 4).

The local healers in Uba-Debretsehay district prepare different potential remedies to cure various human diseases/illnesses using their indigenous knowledge, from medicinal plants cultivated in their home-gardens and/or grown in the wild. These remedies are prepared in various forms including powder & liquid or semi-liquid among others and applied in several ways based on either the type/nature of the disease treated as well as the area (the body part) where the treatment is applied. Based on the area of application, remedies were made either for internal use that was taken orally (either swallowed or chewed) or directly applied in or on specific organs

such as the eye and ear and the external use (applied on the surface of the body part [on the affected part of a skin]). The experience or level of knowledge of the local healers living in Uba-Debretsehay district in remedy preparation from traditional medicinal plants and administration of remedies varies from the healer to healer. According to Awas (2007), such variations might be due to differences in the age and educational level of healers, and their experience/frequencies of preparation of remedies for particular diseases/illnesses in the study area.

Table 3. List of medicinal plants encountered in the home-gardens in the study area and diseases that were treated by remedies extracted from them

SN.	Plant's Botanical Name	Disease/complications treated
1	*Allium sativum*	Liver disease
2	*Carica papaya*	Giardia, Amoeba & Malaria
3	*Catha edulis*	Asthma
4	*Citrus ×aurantiifolia*	Stomach ache & common cold
5	*Croton macrostachys*	Cough
6	*Cucurbita pepo*	Chest pain
7	*Cymbopogon citrates*	Conmen cold
8	*Dodonaea angustifolia*	Rabies
9	*Eucalyptus globules*	Common cold
10	*Ficus lutea*	Wound, sore & boils
11	*Hagenia abyssinica*	Tapeworm
12	*Lepidium sativum*	Stomach ache
13	*Moringa stenopetala*	Stomach ache & hypertension
14	*Ocimum lamiifolium*	Skin irritation & allergy of solar radiation
15	*Ricinus communis*	Expelling placenta
16	*Ruta chalepensis*	Malaria, common cold & stomach ache
17	*Vangueria apiculata*	Tooth ache
18	*Vernonia amygdalina*	Stomach ache & common cold

Source: Survey date

3.10 Plants used for Construction

Among the total plant species cultivated in sampled home-gardens in the study area, 21 are used for construction purposes (Annex) accounting for 24.14% of the total plants recorded in the home-gardens of the study area (Figure 4). Some of the plants cultivated for construction were used for various other purposes by the community. It was indicated that *Eucalyptus camaldulnisi*s, *Arundinaria alpine*, *Cordia africana*, *Juniperus procera*, and *Combretum molle* were among the top five preferred plant species for the construction of houses. *Arundinaria alpine* is used for house construction and furniture and is grown in the district at altitudes between 2500m and 2850m asl. *Eucalyptus camaldulensis* (Figure 7) was managed in the study area either as a large-scale plantation or a small pocket at the periphery of their farmlands or near homestead areas. It grows in highland, midland and lowland agroecologies and is utilized for hose construction, fencing, and firewood.

3.11 Home-garden Management

The community at Uba-Debretsehay district has been managing their home-gardens in various ways. One of the management approaches practiced by the local community at Uba-Debretsehay district is maintaining the diversity of the home-gardens by planting wide ranges of home-garden plant species in their

Figure 7. Woody plants cultivated for the purpose of house construction: (a) *Arundinaria alpine*; and (b) *Eucalyptus camaldulensis*. (Photo taken by the author)

home-gardens. Cultivating varieties of crops have enabled the community to maintain home-garden diversity and better utilize their home-garden resources by earning income from the sale of these crops and/or making use of the resources for their household consumption. Intercropping is another home-garden management activity that is widely practiced by the local community in the study area. Annual plants/crops were cultivated by intercropping with perennial plants.

The local community has been employing crop selection as a means of home-garden management practice. This home-garden management practice requires the selection and cultivation of particular plant/crop species based on each household's choice/preference. Households applying crop selection use one or more criteria or requirements for their preference of the crop types including quality or quantity of yield, the time a crop requires to establish & mature (produce the required yield), resistance to disease and tolerance to stress/shock (drought, salinity, acidity, *etc*.).

Moreover, organic fertilizer that is produced by the local community using animal manure and hey from litter falls and crop residue was widely applied in the home-gardens in Uba-Debretsehay district to maintain soil fertility. Besides the leguminous plants cultivated in the home gardens of the study area for soil fertility by fixing atmospheric nitrogen, plants such as *Cordia africana* and *Ficus sycomorus* are grown in most home-gardens in the district for their contribution to increasing soil fertility and soil moisture retention.

3.12 Gender role in the Home-garden Management

Though agriculture is predominantly men's activity, women in the community in the Uba-Debretsehay district engage in farming activities and makes a great contribution to their households. Planting crops or trees, watering, weeding, and maintaining fences are all parts of managing a home-garden. In Uba-Debretsehay district, men and women both share responsibility for overseeing home-gardens. They employ leaf litter and animal manure to keep their soil fertile. Women in the district engage in the preparation & transportation of manures to the farm, tilling, sowing, weeding and harvesting of yields from their farms or home-gardens (Wassihun *et al*., 2003). Moreover, most elderly people living in the study area spend most of their time in their home-gardens taking care of the crops/plants cultivated in their home-gardens.

4 Conclusion

Communities living in the Uba-Debretsehay district cultivate various plant/crop species in their home-gardens. These home-gardens are diverse and rich in plant species that are used as sources of food, medicine, cash (household income), ornament, *etc*.

Home-gardens in Uba-Debretsehay district consist of different types and/or varieties of plant species and serve as a basic agroecosystem used to cultivate as well as conserve a wide range of plants/crops.

The composition, diversity and richness of home garden plant species vary from one agroecology to another. *Zea mays*, *Eragrostis tef*, and *Moringa stenopetala* are found to be the main source of food in areas characterized by '*kola*' agroecology while *Ensete ventricosum* grows in both '*Dega*' and '*Woynadega*' agroecologies. *Musa paradisica* is the most important cash crop in the study area followed by *Catha edulis*, *Coffea arabica*, *Saccharum officinarum* and fruit crops including *Mangifera indica* and *Persea americana* that helped the local community to earn money desired to satisfy their household needs.

Proper traditional home-garden management practice has a great contribution to biodiversity conservation and will promote food security. Home-gardens management practices utilized by the local community in Uba-Debretsehay district have contributed to maintaining crop diversity in the area. However, the selection of cultivated crops based on their resistance to disease, drought tolerance and high market values may have an impact on the genetic resources of some plant species. Repeated practice of crop selection will contribute to the loss of plant genetic resources in the study area.

Acknowledgments

The authors acknowledge the key informants, focus group discussants & local administrators in the Uba-Debretsehay district and others who directly or indirectly participated in this study by providing relevant information and contributed to the successful completion of the study.

Conflict of Interest

The authors declares that there is no conflict of interest.

References

Abebe T. (2005). Diversity in home-garden agroforestry systems of southern Ethiopia. Dissertation, Wageningen University, The Netherlands.

Asfaw Z. & Nigatu A. (1995). *Home-gardens in Ethiopia: characteristics and plant diversity. SINET: Eth. J. Sc*i. 18:23-266.

Awas T. (2007). Plant diversity in western Ethiopia: Ecology, Ethnobotany and Conservation. PhD dissertation, Oslo University, Norway.

Awas T., Wiersum, K.F. & Bongers, F. (2010). Spatial and temporal variation in crop diversity in agroforestry home-gardens of southern Ethiopia. *Agroforest. Syst*. 78, 309-322.

Cotton, M.J. (1996). *Ethnobotany: principles and Applications*. John Wiley and sons Ltd., west Sussex, England.

CSA (Central Statistical Authority) (2007).Population and Housing Census 2007. Addis Ababa.

Gebreegziabeher Z., Jesper S, Mekonnen A. & Alemu A. (2011). Climate Change and the Ethiopian Economy. A Computable General Equilibrium Analysis. Ethiopia: Environment for Development.

Giday M. (2001). An ethnobotanical study of medicinal plants used by the Zay people in Ethiopia. *CBM: Skirif series* 3:81-99. Uppsala.

Habtewold M., Dane C. & Ayza A. (2021). Participatory Evaluation and Demonstration of Onion Spacing in Irrigated Agriculture at Kencho *kebele* in Uba-Debretsehay Wereda, Southern Ethiopia. *Ethiop. J. Agric. Sci*. 31(2): 105-114.

Kebebew Z. & Urgessa K. (2011). Agroforestry perspective in land use pattern and farmers coping strategy: Experience from southwestern Ethiopia. *World J. Agric. Sci*. 7:73-77.

Kippe T, (2002). *Five thousand years of sustainability: a case study on Gedeo land Use (Southern Ethiopia)*: Tree mail Publisher, Heelsum. (Netherlands).

Larios, C., Casas, A., Vallejo M., Moreno-Calles A.I. & Blancas, J. (2013). Plant management and biodiversity conservation in Náhuatl homegardens of the Tehuacán Valley, Mexico. *J. of Ethnobiology and Ethnomedicine*. 9(1):74

Magurran, A. E. (1988). *Ecological Diversity and its Management*. Croom Helm, London.

Martin, M.J. (1995). *A methods manual*. Chapman and Hall, London. Pp.251.

Negash A. & Niehof, A. (2004). The significance of enset culture and biodiversity for rural household food and livelihood security in southwest Ethiopia. *Agri. & Human Values*, 21, 61-71.

Polegri, L. & Negri, V. (2010). Molecular markers for promoting agro-biodiversity conservation: a case study from Italy. How cowpea landraces were saved from extinction. *Genetic resources and crop evolution*, 57(6):867-880.

Tamirat S. (2011). Study of useful plants in and Around Gate Uduma (Traditional Gedeo Homegardens) in Kochere wereda of Gedeo zone, SNNPRS, Ethiopia.

Uba-Debretsehay District Agricultural and Rural Development Office (2021). Annual Report. Unpublished

Unofia S.I., Owoh P.W., Ukpong E.E. & Ekpo I.E. (2012). Assessment of plant species of socioeconomic importance conserved in home-garden of Nsitubium local government area of AkwaIbom state, Nigeria. *Nig. J. Agric. Food Environ*. 8:99-108.

Wassihun B., Asfaw Z. & Demissew S. (2003). Ethnobotanical study of Useful plants in Daniio Gade (home-gardens) in southern Ethiopia. *Ethiop. J. Biol. Sci*. 2(2): 119-141.

Annex: List of plant species documented in the home-gardens of Uba-Debretsehay district

Botanical Name	Plant Family	Habit	Uses
Acacia bussei Harms	Fabaceae	T	Fw,Co,Sh
Acacia Senegal L.	Fabaceae	T	Fw,Co
Aframomum corrorima (A.Braun) P.C.M.Jansen	Zingiberaceae	H	Is,Sp
Allium cepa L.	Alliaceae	H	E
Allium sativum L.	Alliaceae	H	E,Md,Sp
Annona squamosa L.	Annonaceae	T	E
Arachis hypogaea L.	Fabaceae	H	Fo
Arundinaria alpine K.Schum.	Poaceae	H	Co,Fw
Balanites aegyptiaca (L.) Dell.	Balanitaceae	T	E,Co,Fw
Balanites rotundifolia (van Tieghem) Blatter	Balanitaceae	T	E,Co,Fw
Beta vulgaris L.	Chenopodiaceae	H	Fo
Boswellia neglecta S. Moore	Burseraceae	T	E
Brassica carinata A.Braun	Brassicaceae	H	Fo
Brassica oleracea L.	Brassicaceae	H	Fo
Brassica rapa L.	Brassicaceae	H	Fo
Cajanus cajan (L.) Millsp.	Fabaceae	Sh	E
Canavalia ensiformis (L.) DC.	Fabaceae	Cl	Fo
Capsicum annuum L.	Solanaceae	H	Fo
Capsicum frutescens Rodsch.	Solanaceae	H	Fo
Carica papaya L.	Caricaceae	H	Md,Fo
Casimiro aedulis La Llave & Lex.	Rutaceae	T	E
Catha edulis Forssk.	Celastraceae	T	St,Is,Md,Co
Citrus aurantiifolia (Christm.) Swingle	Rutaceae	T	E,Is,Md
Citrus aurantium L.	Rutaceae	T	E,Is
Citrus reticulate Blanco	Rutaceae	T	E
Coffea arabica L.	Rubiaceae	T	St,Md, Is
Colocasia esculenta (L.) Schott	Araceae	H	Fo
Combretum collinum Fresen.	Combretaceae	T	Co,Fw
Combretum molle R.Br. ex.G.Don	Combretaceae	T	Co,Fw
Cordia africana Lam.	Boraginaceae	T	E,Co,Fu,Fw,Is
Croton macrostachys Hochst. ex. A.Rich.	Euphorbiaceae	T	Co,Fw,Md
Cucurbita pepo L.	Cucurbitaceae	H	Fo,Md
Curcuma longa L.	Zingiberaceae	H	Fo,Sp
Cymbopogon citrates (DC.) Stapf	Poaceae	H	Or,Md
Daucus carota L.	Apiaceae	H	Fo
Delonix regia (Bojer ex. Hook.) Raf.	Fabaceae	T	Sh,Or
Dioscorea bulbifera Russ. ex Wall.	Dioscoreaceae	Cl	Fo
Dodonaea angustifolia Roxb.	Sapindaceae	Sh	Md,Fw
Ensete ventricosum (Welw.) Cheesman	Musaseae	H	Fo,Md,Or
Eragrostis tef (Zuccagni) Trotter	Poaceae	H	Fo,Is
Eucalyptus camaldulensis Dehnh.	Myrtaceae	T	Co,Fw,Is
Eucalyptus globules Labill	Myrtaceae	T	Co,Md,Fw,Is
Euphorbia tirucalli L.	Euphorbiaceae	T	Fw,Co

Botanical Name	Plant Family	Habit	Uses
Ficus lutea Vahl.	Moraceae	T	Md,Fw
Ficus sycomorus L.	Moraceae	T	Co,Fw,Sh
Grevillea robusta A.Cunn.	Proteaceae	T	Or,Sh
Hagenia abyssinica (Bruce) J.F.Gmel.	Rosaceae	T	Md,Co
Hordeum vulgare L.	Poaceae	H	Fo
Ipomoea batatas (L.) Lam.	Convolvulaceae	H	Fo
Juniperus procera Hochst. ex. Endl.	Cupressaceae	T	Co,Fw,Or
Lepidium sativum L.	Brassicaceae	H	Md
Lycopersicum esculentum Mill.	Solanaceae	H	Fo
Malus sylvestris Mill.	Rosaceae	T	E
Mangifera indica L.	Anacardiaceae	T	E,Is
Manihot esculenta Crantz	Euphorbiaceae	Sh	Fo
Moringa stenopetala (Baker fil.) Cufod.	Moringaceae	T	Fo,Md
Morus alba L.	Moraceae	T	E
Musa paradisiacal L.	Musaseae	H	Fo
Nicotiana tabacum L.	Solanaceae	H	St,Is
Ocimum basilicum L.	Lamiaceae	H	Sp
Ocimum lamiifolium Hochst. ex. Benth.	Lamiaceae	Sh	Md
Olea europaea subsp. *cuspidate* (Wall. & G.Don) Cif.	Oleaceae	T	Co,Fw
Passiflora caerulea L.	Passifloraceae	Cl	Or
Persea americana C.Bauh.	Lauraceae	T	E
Phoenix reclinata Jacq.	Arecaceae	T	Co,Or,Fw
Pisum sativum L.	Fabaceae	H	Fo
Podocarpus falcatus (Thunb.) R.Br.	Podocarpaceae	T	Co,Fw,Fu,Or
Psidium guajava L.	Myrtaceae	T	E
Rhamnus peinoides L'Hér.	Rhamnaceae	Sh	Cd
Ricinus communis L.	Euphorbiaceae	H	Fw
Rosa abyssinica Lindley	Rosaceae	Sh	Or
Ruta chlepensis L.	Rutaceae	Sh	E,Md
Saccharum officinarum L.	Poaceae	H	Fo
Solanum nigrum Lesch.	Poaceae	H	Fo
Solanum tuberosum L.	Solanaceae	H	Fo
Sorghum bicolor Kuntze	Poaceae	H	Fo
Sorghum dochna (Forssk.) Snowden	Poaceae	H	Fo
Spathodea campanulata Buch.-Ham. ex DC.	Bignoniaceae	T	Sh,Or
Syzygium guineense (Willd) Dc.f	Myrtaceae	T	Co,Fw
Triticum aestivum L.	Poaceae	H	Fo
Vangueria apiculata K. Schum.	Rubiaceae	T	Md,Fw
Vernonia amygdalina Del.	Asteraceae	Sh	Md,Co
Vicia faba L.	Fabaceae	H	Fo
Vigna unguiculata (L.) Walp.	Fabaceae	Cl	Fo
Zea mays L.	Poaceae	H	Fo,Fw,Is
Zingiber officinale Roscoe	Zingiberaceae	H	Sp

Key: T=Tree, Sh=shrub, H=Herb, Cl=Climber, E=Edible, Md=Medicinal, Co=Construction of houses, Fw=Fire wood, Or=Ornamental, Lf=Live fence, Fo=Fodder, Fu=Furniture, Sh=Shade, Bh=Bee hive making, Is=Income source/cash crops, St=Stimulants, Sp=Spice, Cd=Condiment.

EJED 2022 4(2):39–55
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj

Response of Growth and Yield of Bread Wheat Varieties to Blended NPSB Fertilizer Application Rates

Muzayin Kamil Haji[1], **Dargie Tsegay Berhe**[*2] **and Semu Moshago Shahebo**[1]

[1] *College of Agriculture & Natural Resources, Werabe University, Werabe, Ethiopia*
[2] *Department of Horticulture, College of Agriculture & Natural Resources, Dilla University, Ethiopia*
[*] *Corresponding author, Email: tsegadar@yahoo.com; P.O.Box. 419 Dilla, Ethiopia*

Received: 17th November 2022 *Accepted: 02nd September 2022*

DOI: **10.20372/ejed.v04i2.03**

Abstract

Low soil fertility and poor crop management practices are among the major constraints limiting the productivity of bread wheat in Ethiopia in general and Hulbareg District in particular. Therefore, a field experiment was conducted in Hulbareg District during the 2019 main cropping season to evaluate the effect of blended NPSB fertilizer rates on yield and yield components and to determine the economically feasible rates for bread wheat production. Factorial combination of three improved bread wheat varieties (Ogolcho, Kekeba and Kingbird) and five rates of NPSB fertilizers (0, 50, 100, 150 and 200) were laid out in randomized complete block design with three replications. The results revealed that the plant height, number of kernels per spike, thousand kernel weight, straw yield, number of total tillers and productive tillers were substantially ($P < 0.01$) affected by the main effects of NPSB.. The interaction effect of fertilizer and variety was also statistically affected the days to physiological maturity, total aboveground dry biomass and grain yield. The maximum grain yield (6500 kg ha^{-1}) and above ground dry biomass kg ha^{-1} (15389), were recorded at the combination of the highest rates of NPSB, i.e., 200 kg with variety Ogolcho. Generally, the economic feasibility of the fertilizer over varieties combination indicated that application of 200 kg NPSB ha^{-1} to Kekeba variety resulted in maximum marginal rates of return of 4202%. The partial budget analysis revealed that the highest net return (72, 495 Birr ha^{-1}) with MRR 2711.9% was obtained for Ogolcho from application of 200 kg NPSB ha^{-1}. Based on the result of this study, it can be concluded that bread wheat variety Ogolcho and NPSB rate of 200 kg ha^{-1} to be appropriate for bread wheat production in the study area.

Keywords/Phrases: Blended fertilizer, Biomass, Bread wheat, Grain yield, NPSB

1 Introduction

Wheat (*Triticum aestivum* L.) belongs to the family Poaceae, subfamily Pooideae and tribe Triticeae (Clayton *et al*., 2015). Synonyms include *Triticum vulgare* and there are also many synonyms for subspecies and cultivars (Clayton *et al*., 2015). Wheat is the world's leading cereal grain where more than one-third of the population of the world uses as a staple food (Curtis, 2002). Bread wheat is the most widely grown food crop in the world. Wheat Production in 2018 was 731.46 million tons. This year's (2019) production of 764.49 million tons could represent an increase of 33.03 million tons or 4.52% in wheat production around the globe. It ranks first in the world cereal crops accounting for 30% of all cereal food worldwide (USDA, 2022).

Wheat is an important staple food crop all over the world (Mathpal *et al*., 2015). It is one of the most important cereals cultivated in Ethiopia (Jemal *et al*., 2015). Ethiopia is one of the largest wheat producers in the Sub-Saharan Africa, with yearly estimated production of 4.5 million tons on 1.69 million hectares of land in 2018/19 (CSA, 2019) with 2.66 ton yield per hectares (CSA, 2019). Durum and bread wheat

are the two major wheat species produced in the country. However, bread wheat surpasses durum wheat in recent years (Godebo *et al*., 2021) due to its wide agro-ecological adaptation and better productivity. Wheat is a leading source of protein in human food (Yong *et al*., 2011). It is one of the daily diets of the Ethiopian population that contributes significantly to the calorie and protein intake. In terms of caloric intake, it is the second most important food in the country next to maize (FAO, 2014).

Wheat is one of the most important cereals cultivated in Silte Zone and ranks first in area coverage and total production. The total wheat area and production in the Silte Zone is 55,063.25 *ha* and 132,151.8 tons respectively with the productivity of 2.4 tons ha^{-1} in 2018/19 cropping season (CSA, 2019) which is lower than the national average 2.66 tons ha^{-1} (CSA,2019) and the world 2.8 tons ha^{-1} (USDA, 2022).

There are several factors that lowered the wheat productivity in Ethiopia and in the experiment area such as lack of knowledge about improved wheat production technologies by farmers, poor extension support, biotic stress, low soil fertility, and lack of improved management practices, high cost and inadequate supply of agri-inputs (Demeke & Di Marcantonio, 2013). The yield gap of Silte zone suggests the potential for increasing production through improved soil and crop management practices, particularly increased use of fertilizers and adequate soil fertility maintenance program with the appropriate varieties for the area. Continuous cropping and inadequate replacement of nutrients, nutrients removed in crop harvest or lose through erosion and leaching are the major causes of soil fertility decline in Ethiopia (Hillette *et al*., 2015).

Among the above constraints, low soil fertility and slow progress in developing wheat cultivars with durable resistance to diseases are considered the most important constraints limiting wheat production in Ethiopia (Teklu & Teklawold, 2009). Crop growth requires sufficient, but not excessive supply of essential mineral elements for optimal productivity. An insufficient supply of mineral elements may limit plant growth and development (Godebo *et al*., 2021; Nadian *et al*., 2010). Thus, addition of nutrients such as *N*, *P*, *S* and *B* to less fertile soil is important to increase wheat yield.

For the last four to five decades, Ethiopian agriculture depended solely on urea and Di-ammonium phosphate (DAP), as sources of *N* and *P*, respectively. However, recently it is perceived that the production of such high protein cereals like wheat can be limited by the deficiency of *S* and other nutrients (Assefa *et al*., 2015). It is true that farmers and Agriculture extension workers can aim at increasing crop yields only in quantity by applying significantly higher amounts of *N* from urea and DAP. But, in such conditions, failure to supplement *S* in balanced-fertilizer programmes can rapidly deplete available soil reserve leading to hidden *S* deficiency (Assefa *et al*., 2015).

Nitrogen is considered as the most deficient nutrients in soils of Ethiopia (Asnakewet al., 1991). Nitrogen fertilizer may not be fully utilized if *S* is deficient and correct *S* fertilization improves quality of grains. The capability of nitrogen fertilizer is to increase protein content, while sulfur fertilizer affects protein composition (Luo *et al*., 2000). Further, Boron is essential for cell division and elongation in meristematic tissues, floral organs and for flower male fertility, pollen tube germination along with its seed/fruit formation. Boron deficiency impairs grain setting in wheat, resulting in increased number of open spikelet's and decreased number of grains per spike (Marschner, 1995).

Varieties are one of the factors which play an important role in producing higher yield of wheat (Alam & Jahan, 2013). Efficient use of fertilizers depends on performances of variety. So that cultivar selection that optimally utilizes the applied fertilizers plays a very important role in determining grain yield and quality (Brian *et al*., 2007). A study was conducted to know the response of three wheat cultivars (Ogolcho, Kekeba and Kingbird) and five NPSB rates (0, 50, 100, 150 and 200 *kg* NPSB ha^{-1}) at Hulbareg. The result showed that variety Ogolcho out smart variety Kekeba and Kingbird in grain yield at fertilizer rate of 200 *kg* NPSB ha^{-1}.

Recent studies have indicated that elements like *N*, *P*, *K*, *S* and *Zn* levels as well as *B* and *Cu* are becoming depleted and deficiency symptoms are being observed on major crops in different areas of the coun-

try (ATA, 2014). Further studies showed that most Ethiopian soils are deficit in macronutrients (*N*, *P*, *K* and *S*) and micronutrients (*Cu*, *B* and *Zn*) (EthioSIS, 2014). Macro-nutrients as well as micronutrients are of primary importance in our agriculture system but due to unawareness of the farmers about importance of applying micronutrients and unavailability, the soils are becoming deficient in micronutrients (Muhammad *et al*., 2009). Micronutrients are essential for plant growth and play a vital role in increasing crop yields as they develop plant nutrition and increase soil efficiency (Hamzeh & Florin, 2013). The increases in crop yields from application of *B*, *Cu*, *Fe*, *Mn*, *Mo*, and *Zn* occur in many parts of the world (Martens & Westermann, 1991). Therefore, this study was aimed to assess the effect of blended (NPSB) fertilizer rates on yield and yield components of bread wheat varieties, and to estimate its economic feasibility.

2 Materials and Methods

2.1 Description of the Study Site

The field experiment was conducted at AngamoYede Farmers Training Center (FTC) in Hulbareg District from July to November 2019 under rain fed conditions. Hulbareg Districtis located in the Southern Nations Nationalities and Peoples Region (SNNPR). The Districtis located at 7^o45'42"N latitude and 38^o46'41"E longitude. The elevation at study area is 2100 *m* above sea level. The District has two Agro-ecological Zones; 95% *Weinadega* and 5% *Kolla* climatic type. The soil of the experimental site is classified as sandy loam in texture with *pH* of 5.1. The mean annual rainfall of the area ranges between 800 and 1200 *mm* and the annual average minimum and maximum air temperatures are 9.84^oC and 23.57^oC, respectively.

2.2 Soil Sampling and Analysis

Soil samples were taken in zigzag pattern before planting from the experimental site at a depth of 0 - 30 *cm* across the experimental field from 10 spots using auger before planting and was composited. Then, the composite sample was air-dried at room temperature under shade and the samples were mixed thoroughly to produce 1.0 *kg* of a representative sample. The composite sample was submitted to Soddo soil testing laboratory and Areka Agricultural Research Center. Then in the laboratory, it was ground to pass through a 2 *mm* sieve for soil analysis whereas for organic carbon (*OC*) and nitrogen (*N*) determination, the soil was ground to pass through a 0.2 *mm* sieve. The soil sample was analyzed for selected physico-chemical properties mainly for soil texture, soil *pH*, organic carbon, cation exchange capacity (*CEC*), total *N*, and available *P* following standard laboratory procedures at Wolaita Soddo soil testing laboratory and the available *S* and *B* was analyzed at Areka Agricultural Research Center soil testing laboratory.

Organic carbon was determined by Walkley and Black oxidation method (Walkley & Black, 1934). Total nitrogen was analyzed by Kjeldhal method (Dewis & Freitas, 1975). The *pH* of the soil was determined by potentiometric test method on 1:2.5 (weight/volume) soils to water ratio using a pH meter (Motsara & Roy, 2008). The *CEC* was measured after saturating the soil with 1N ammonium acetate (NH_4OAc) and displacing it with 1N $NaOAc$ (Chapman, 1965). Available phosphorus was determined by the Olsen method (Olsen *et al*., 1954) and the available sulfur ($mg/kg\ SO_4^{-2}$) was measured by ammonium acetate method (Chapman, 1965). The available *B* was done by dilute HCl methods and azomethine reducing agent (Havlin *et al*., 1999).

Plant Material
Seeds of three bread wheat varieties, which were adapted to the agro-ecology of the areawere used as test/experimental material. The varieties where released by Kulumsa Agricultural Research Center (KARC) and their detail description is provided in Table 1.

Fertilizer Materials
The blended NPSB fertilizer (18.9% of *N*, 37.7% of P_2O_5, 6.95% of *S* and 0.1% of *B*) and urea (46% *N*) as *N* sources were used for the experiment.

Table 1. Description of bread wheat varieties used in the experiment

Variety	Year of release	Rainfall	Maturity (days)	Adaptation (m.a.s.l.)	Yield (t ha^{-1})
Ogolcho	2012	400-500	102	1600-2100	3.3-5.0
Kekeba	2010	500-800	90-120	1500-2200	3.3-5.2
Kingbird	2015	500-800	90-120	1500-2200	3.3-5.2

Source: (MOA, 2012).

2.3 Treatments and Experimental Design

The experimental treatments consisted of factorial combination of three bread wheat varieties (Ogolcho, Kekeba, and Kingbird), and five levels of blended NPSB (0, 50,100, 150, 200 $kg\ ha^{-1}$) fertilizer in which treatments arranged in a randomized complete block design (RCBD) with three replications (Table 2). The experimental field was ploughed with oxen to a fine tilth four times and the plots were leveled manually. Then, a field layout was made and each treatment was assigned randomly to the experimental units within a block. Bread wheat seed was sown at the recommended seed rate of 150 $kg\ ha^{-1}$ in rows of 20 *cm* spacing manually by drilling. The currently recommended 100 kg ha-1 of urea was applied for all treatments equally except for the control. The gross plot size was 10 rows of three meter length (3 m×2 m =6 m^2) and the net plot/ harvestable rows consist of 8 with 2.8 m length (2.8 m×1.6 m=4.48 m^2). The spacing between rows, plots and blocks were 0.20, 0.5 and 1 m, respectively. The whole amount of blended (NPSB) and 1/2 of the urea were applied at sowing, and the remaining 1/2 urea top-dressed at tillering. Weeding was done as needed; and harvesting and threshing was done manually.

Table 2. Rates of fertilizer treatment used with their nutrient contents in $kg\ ha^{-1}$ for the experiment

S. No.	**Treatments**	**Total composition of the respective nutrients in the treatment** ($kg\ ha^{-1}$)			
	Fertilizer rates	*N*	P2O5	*S*	*B*
1	0 *kg* NPSB ha^{-1} + 0 *kg* urea ha^{-1}	0	0	0	0
2	50 *kg* NPSB ha^{-1} + 100 *kg* urea ha^{-1}	55.45	18.85	3.475	0.05
3	100 *kg* NPSB ha^{-1} + 100 *kg* urea ha^{-1}	64.9	37.7	6.95	0.10
4	150 *kg* NPSB ha^{-1} + 100 *kg* urea ha^{-1}	74.35	56.55	10.425	0.15
5	200 *kg* NPSB ha^{-1} + 100 *kg* urea ha^{-1}	83.8	75.4	13.9	0.20

2.4 Data Collection Procedures

Days to Physiological Maturity (DTM): Days to physiological maturity was determined as the number of days from sowing to the date when 90% of the panicles turned to yellow straw color. It was recorded when no green color remained on glumes and panicles of the plants, i.e. when grains are difficult to break with thumb nail.

Plant Height (PH): Plant height was measured from the soil surface to the tip of the spike (awns excluded) of 10 randomly tagged plants from the net plot area at physiological maturity.

Number of Total Tillers (NTT): number of total tillers was determined from 0.5 m length of two rows from the net plot and converted to per meter square of net plot at physiological maturity by counting the number of tillers.

Number of Productive Tillers (NPT): number of productive tillers was determined at maturity by counting all kernel bearing spikes from 0.5 m length of two rows from the net plot and converted to per meter square of net plot at physiological maturity.

Number of Kernels per Spike (NKPS): Ten main plants were taken randomly from the net plot area

of each plot and number of kernels per spike was counted carefully and then the mean was determined.

Thousand Kernels Weight (TKW): The TKW was determined by weighing 1000 kernels sampled from the net plot yield of wheat after moisture content is measured using grain moisture meter and weighed using a sensitive balance and the seed mass was adjusted to 12.5% moisture content.

Aboveground Dry Biomass (AGB): The above ground dry biomass was determined from plants harvested from the net plot area after sun drying and converted to $kg\ ha^{-1}$.

Grain Yield (GY): Grain yield was taken by harvesting and threshing the grain yield from net plot area. The grain yield was adjusted to 12.5% moisture content as:

$$\text{Adjusted grain yield} = \frac{Grain\,yield\,obtained\,(kgha^{-1})^{*}(100-MC)}{100-12.5}$$

Where, MC is the moisture content of bread wheat grains at the time of measurement and 12.5 is the standard moisture content of bread wheat in percent. Finally, yield per plot was converted to $kg\ ha^{-1}$

Straw Yield (SY): Straw yield was obtained by subtracting grain yield from the total above ground dry biomass yield for respective treatment and expressed in $kg\ ha^{-1}$.

2.5 Statistical Data Analysis

The experiment was subjected to two-way (NPSB rates x Variety) analysis of variance (ANOVA) in RCBD design. The significance level was set at $\alpha = 0.05$ and means were separated using Tukey's honestly significant difference test. The statistical analysis was performed using R-Software (version 4.2.1, 2022).

2.6 Partial Budget Analysis

The economic analysis was carried out by using the methodology described in CIMMYT (1988) in which prevailing market prices for inputs at planting and for outputs at harvesting were used. All costs and benefits were calculated on hectare basis in Birr.

Actual yield was adjusted downward by 10% to reflect the difference between the experimental yield and the yield that the farmers could expect from the same treatment. Adjusted grain yield (AGY) ($kg\ ha^{-1}$) was the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers.

Gross field benefit (GFB) ($ETB\ ha^{-1}$) was computed by multiplying field/farm gate price that farmers receive for the crop when they sell it as GFB = AGY x field/farm gate price for the crop. Total variable cost (TVC) ($ETB\ ha{-}1$) was calculated by summing up the costs that vary, including the cost of NPSB, Urea and the application costs. The cost of each variable was as follows; NPSB (*Birr* 12.20 kg^{-1})), urea (*Birr* 10.42 kg^{-1}) and bread wheat seed (*Birr* 16 kg^{-1}) during sowing time (July 22, 2019). The labour cost for application of NPSB was 7 persons ha^{-1}, each 60 ETB day^{-1}, and two split of urea application was 8 persons ha^{-1}, each 60 ETB day-1). The costs of other inputs and production practices such as the cost of seed, labour cost for land preparation, planting, weeding, harvesting and threshing were considered the same for all treatments or plots. The average open price of bread wheat grain at Hulbareg market was *Birr* 12.50 kg^{-1} and straw price was *Birr* 0.50 kg^{-1} in December 2019 during harvesting time.

The net benefit (NB) was calculated as the difference between the gross benefit and the total cost that vary (TCV) using the formula:

NB = (GY x P) – TCV

Where GY x P = Gross Field Benefit (GFB), GY = Adjusted Grain yield per hectare and P = Field price per unit of the crop.

Marginal rate of return refers to net income obtained by incurring a unit cost of fertilizer. For each pair of ranked treatments based on net income, % marginal rate of return (MRR) was calculated using the formula:

$$\text{MRR}(\%) = \frac{Change\,in\,NB\,(NB_b - Nb_a)}{Changes\,in\,TCV\,(TCV_b - TCV_a)}\ \text{x}\ 100$$

Where NB_a is NB with the immediate lower, NB_b is NB with the next higher, TCV_a - is the immediate lower TCV and TCV_b is the next highest TCV.

The dominance analysis procedure as described in CIMMYT (1988) was used to select potentially prof-

itable treatments from the range that was tested. The discarded and selected treatments using this technique were referred to as dominated and undominated treatments, respectively. Then the treatment with the highest net benefit and marginal rate of more than 100% was considered for the recommendation as described by CIMMYT (1988).

3 Results and Discussions

3.1 Soil Physicochemical Properties

Soil physicochemical properties analysis indicated that the soil textural class was sandy loam with a particle size distribution of 60% sandy, 23% silt and 17% clay (Table 3). According to Hailu (1991), soil types used for wheat production vary from well-drained fertile soils to waterlogged heavy Vertisols. Thus, the soil of experimental site is suitable for the production of wheat. The *pH* of the soil was 5.1, which is highly acidic (Ethiosis, 2013). FAO (2019) reported that the preferable *pH* ranges for most crops and productive soils are 4 to 8. Mengel and Kirkby (1996), reported optimum *pH* range of 4.1 to 7.4 for wheat production. Thus, the *pH* of the experimental soil was within the range for productive soils for wheat.

The soil of the study site had 2.16% of organic carbon (*OC*) (Table 3), which is low according to the rating of Tekalign (1991), who rated soils having *OC* value in the range of 0.86 to 2.59% as low, indicating low potential of the soil to supply nitrogen to plants through mineralization of organic carbon. The low amount of soil organic carbon might be due to low addition of crop residues as smallholder farmers use the biomass of wheat for animal feed in the study area. Tekalign (1991) has classified soil total *N* content of <0.05% as very low, 0.05-0.12% as poor, 0.12-0.25% as moderate and > 0.25% as high. According to this classification, the soil samples were found to have moderate level of total *N* (0.13%) (Table 3) that indicating the nutrient as a limiting factor for wheat production in the study area.

The analysis revealed that the available *P* of the soil was 13.73 $mg\ kg^{-1}$ (Table 3). Indicative ranges of available phosphorus have been established by Olsen *et al*. (1954), as <5 $mg\ kg^{-1}$ (very low), 5-15 $mg\ kg^{-1}$ (low), 15-25 $mg\ kg^{-1}$ (medium), and >25 $mg\ kg^{-1}$ of soil (high). Thus, the soil of the experimental site was considered as low in available *P* content. The medium available phosphorus in the soil is not satisfactory to get potential yield from the crop. Thus, it is important to apply phosphorus fertilizer from external sources based on the recommended rate. The analysis for Available sulfur value of the study area was 19.16 $mg\ kg^{-1}$ (Table 3). Based on EthioSIS soil classification for *S* values lies on low range. The classification is < 9 very low, 10-20 low, 20-80 optimum, and > 80 $mg\ kg^{-1}$ high. So, addition of fertilizer which contains *S* is relevant. This low in sulfur content of the soil may be due to loss of *OM* and lacking of using *S* source mineral fertilizer. It was also related to continuous cultivation which result intensive mining of *S* from the soil. This might be mainly due to poor sulfur containing parent material of soil, land degradation, crop residue removal, crop uptake, low soil organic matter, use of non-*S* containing fertilizers (only *N* and *P* containing fertilizers used). The results of the analysis also indicated that the soil has medium available Boron (0.67 $mg\ kg^{-1}$) according to the rating of Horneck *et al*. (2011).

Cation exchange capacity (*CEC*) is an important parameter of soil, because it gives an indication of the type of clay mineral present in the soil and its capacity to retain nutrients against leaching. According to Landon (1991), top soils having *CEC* greater than 40 cmol (+) kg^{-1} are rated as very high and 25-40 cmol kg^{-1} as high, and 15-25, 5-15 and <5 cmol kg^{-1} of soil are classified as medium, low and very low, respectively, in CEC. According to this classification, the soil of the experimental site had low CEC (8 cmol kg^{-1} soil), indicating its low capacity to retain cations.

Table 3. Selected physicochemical properties of the soil of the experimental site

Parameter	Values	Rating	Reference
Soil texture			
Clay (%)	17		
Sand (%)	60		
Silt (%)	23		
Textural Class	**Sandy loam**		
pH (1:2.5 H_2O)	5.10	highly acidic	Tekalign (1991)
Total *N* (%)	0.13	moderate	Tekalign (1991)
Organic Carbon (%)	2.16	low	Tekalign (1991)
CEC [cmol kg^{-1} soil]	8.00	low	Landon (1991)
Available *P* ($mg\ kg^{-1}$)	13.73	low	Olsen (1954)
Available *S* ($mg\ kg^{-1}$)	19.16	low	Ethiosis (2014)
Available *B* ($mg\ kg^{-1}$)	0.67	medium	Horneck *et al.* (2011)

3.2 Days to physiological maturity

The main effect of varieties as well as the interaction effect of fertilizer treatments and varieties showed significant (p <0.01) effect on days to physiological maturity and main effect of NPSB fertilizer did not show significant effect on days to physiological maturity. The longest days to physiological maturity (108 days) was recorded at the NPSB rate of 150 $kg\ ha^{-1}$ whereas the shortest (103 days) was obtained from 50 *kg* NPSB ha^{-1}. The number of days required to 90% physiological maturity varied between 103.0 for variety Kingbird to 108.00 for variety Ogolcho (Table 4). The significant difference between varieties might be due to genetic difference among the varieties coupled with the favourable environmental condition and as a result there is difference on enhancing or delaying the physiological maturity of wheat varieties. In line with this study, Rai *et al.* (2012) reported a significance effect of physiological maturity among wheat varieties.

Generally, the number of days to physiological maturity recorded at the highest rate of NPSB was significantly higher than that of unfertilized plot and lower rate of NPSB fertilizer. The increase in days to maturity of wheat at the highest rate of NPSB might be due to the three nutrients interaction and synergetic effect of them, especially *N* and *S*. Nitrogen is involved in all major processes of plant development and yield formation. Besides, a good supply of nitrogen to the plant stimulates root growth and development as well as uptake of other nutrients (FAO, 2019; Weil and Brady, 2017). An adequate supply of *N* is associated with high photosynthetic activity, vigorous vegetative growth, and dark green colour as result it delayed the crop maturity. On the other hand sulfur is an essential element best known for its role in the synthesis of proteins, oils, vitamins and flavored compounds and it is essential not only for plant growth and quality produce, but also enhances other nutrients use efficiency. The current result is in line with the study by Melesse Harfe (2017) who reported that increasing the *N*/*P* fertilizer from zero level to 69/30 kg $N/P_2O_5\ ha^{-1}$ for wheat, prolonged the physiological maturity from 124.87 to 127 days. Similarly, Manna *et al.* (2007) reported that combined application of *NP* and organic fertilizers promoted vegetative growth, leading to prolonged days to maturity. Legesse (2004) have also reported that *N* fertilization delayed the physiological maturity of tef due to extended vegetative growth instead of reproductive growth.

Table 4. Days to physiological maturity (days) of bread wheat as influenced by the interaction of blended NPSB fertilizer and bread wheat variety

Blended NPSB ($kg\ ha^{-1}$)	**Variety**		
	Ogolcho	**Kekeba**	**Kingbird**
0	103.33^{de}	104.67^{bcde}	105.33^{bc}
50	104.33^{cde}	103.00^{e}	104.00^{cde}
100	106.33^{ab}	103.67^{cde}	103.33^{de}
150	108.00^{a}	104.00^{cde}	103.00^{e}
200	104.67^{bcde}	105.00^{bcd}	104.00^{cde}
Mean	6.37		
LSD	1.86		
CV	11.0		
P value	***		

Means in columns and rows followed by the same letters are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of variation

3.3 Plant height

The result showed that, the main effect of fertilizer and variety had significant (p <0.001) effect on plant height. Variety Ogolcho had the tallest plant height of 92.75 *cm*, whereas, variety kekeba had the shortest plant height of 81.88 *cm* (Figure 1). In case of fertilizer rates, plant height was reduced at the lowest fertilizer rates. Whereas the highest plant height (89.74 *cm*) was recorded from 150 *kg* NPSB ha^{-1} fertilizer rate (Figure 2).

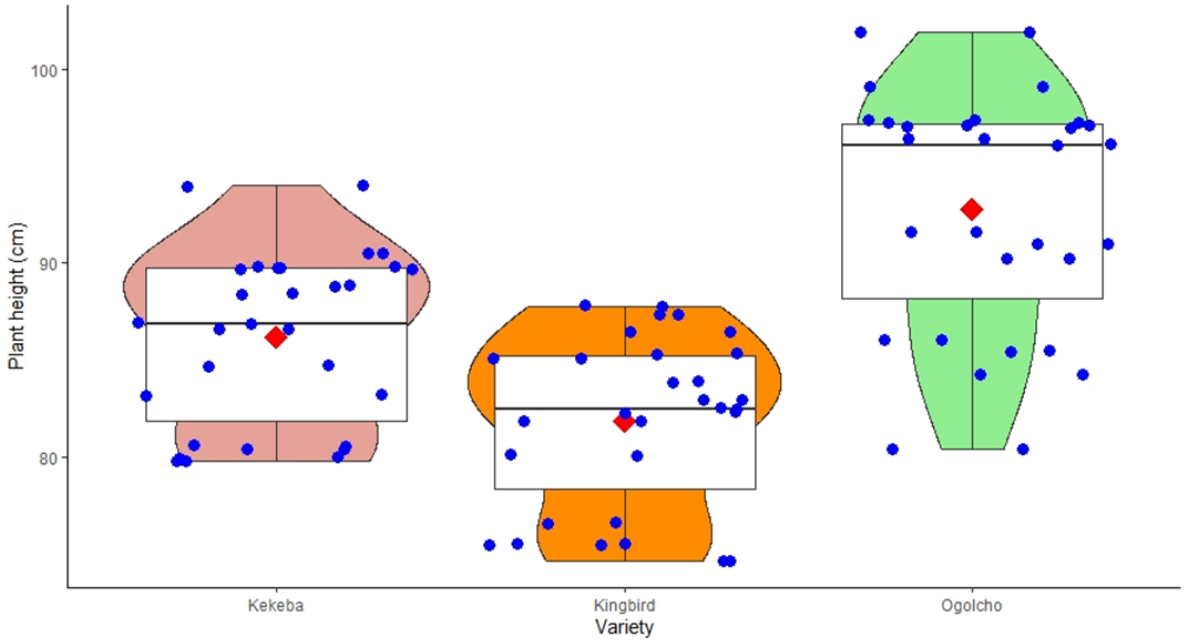


Figure 1. Response of plant height to different wheat varieties

This could be due to the adequate soil fertility resources in the soil required by the wheat crop for growth and development. These results supported by the findings of Khan *et al*. (2010) who reported that increasing the level of nitrogen increased the plant height. Application of the highest dose of phosphorus contributed to maximum dry matter and physiological attributes towards the yield attributes in wheat and therefore, helped in achieving highest number of grains per spike, 1000 grain weight and ultimately yield of wheat (Alam & Jahan, 2013). Non-significant variation for plant height among bread wheat varieties was reported by (Fano & Tadeos, 2017).

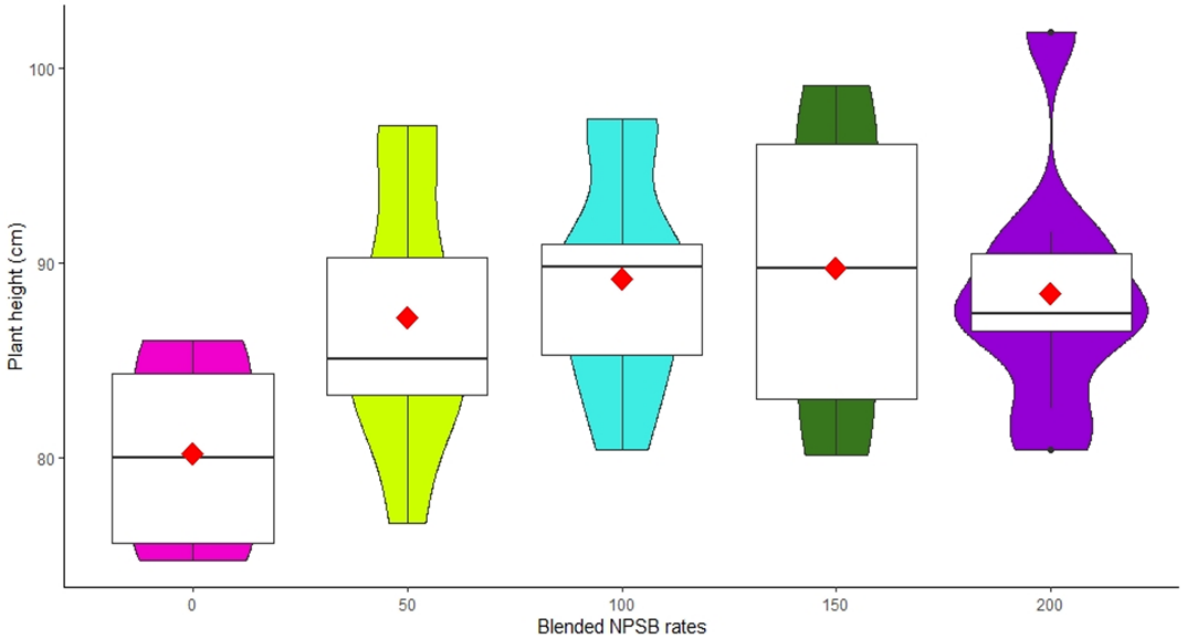


Figure 2. Main effects of blended NPSB fertilizer on plant height

3.4 Number of total tillers and productive tillers

The analysis of variance indicated that the main effect of fertilizer rate had highly significant (p <0.01) effects on the number of total and effective tillers per plant. However, main effect of variety and the interaction effect of variety and fertilizer rates were not significant (Table 5). Application of 200 kg NPSB ha^{-1} resulted into maximum number of total and effective tillers of 476.1 and 451.7 per m^2, respectively and no fertilized treatment resulted into minimum number of total and effective tillers of 240 and 218.9 per m^2, respectively (Table 5). In line with this result, Hameed *et al*. (2003) observed that increasing nitrogen application significantly increased the number of tillers m^{-2}. Jaenisch *et al*. (2022) also found a significant increase in the number of total tillers per plant with the increase of NPK level from 0 to150 $kg\ ha^{-1}$. Muhammad *et al*. (2009) reported that the significant variations on number of tillers per plant with the increased level of phosphorus application and the maximum numbers of tillers per plant (6.67) were found in the 80 $kg\ P\ ha^{-1}$.

3.5 Number of kernels per spike

The result revealed that fertilizer rates showed highly significant (p <0.01) effect with respect to the number of kernels per spike. While, the main effect of varieties and the interaction between the two factors were not significant to the number of kernels per spike. Variety Ogolcho had the highest number of kernels per spike (47.28) while lowest number of kernels per spike (41.97) recorded in variety kingbird (Table 5). The difference among varieties might be due genetic differences among the varieties. In agreement with this result Knezevic *et al*. (2015) reported that highly significant differences among the tested cultivars for number of kernels per spike with largest impact belongs to the genetic variability

(63.92%). Similarly, Akmal *et al*. (2000) observed significant differences among the wheat varieties for number of grains per spike. In contrast to this result, Hussain *et al* .(2002) reported non- significant difference among wheat cultivars for number of grains per spike in response to *NPK* fertilizer treatments which on an average varied only from 43.9 to 44.25. The effect of fertilizer also showed that the highest number of kernels per spike (50.43) was recorded from NPSB fertilizer rate of 150 $kg\ ha^{-1}$ (Table 5). Such response can be attributed to the adequate nitrogen availability which might facilitate the tillering ability of the plants, resulting in a greater spike population. The current study is in agreement with Jaenisch *et al*. (2022) who observed that number of grains per spike was significantly increased with each increment of NPK fertilizer. Geleto *et al*. (1995) also reported higher number of spikes per unit area at 120 $kg\ N\ ha^{-1}$ fertilized plots than the control.

3.6 Thousand kernels weight (TKW)

The result revealed that fertilizer rate and the varieties showed highly significant (p <0.01) effect on the thousand kernels weight and the interaction effect was not significant. Variety Kekeba had the highest thousand kernels weight (40.28 g) whereas variety Kingbird had the lowest thousand kernels weight (37.91 g) (Table 5). This might be due to good grain filling period and favorable environmental condition increases the thousand seed weights differ among the varieties. The reason is due to genetic variability in the parameter among the varieties. In line with this result the significant variation with the highest 42.96 g and lowest 39.58 g thousand seed weight among the varieties was reported by Shirinzadeh *et al*. (2018).

Table 5. Main effects of variety and blended fertilizer on number of total and productive tillers, Number of kernels per spike and straw yield of bread wheat

Treatments	Number of total tillers/m^2	No. of productive tillers/m^2	Number of kernels per spike	Thousand kernels weight	Straw yield ($kg\ ha^{-1}$)
Variety					
Ogolcho	329.0^{ns}	302.0^{ns}	47.28^{a}	38.76^{b}	5259^{b}
Kekeba	315.0^{ns}	297.7^{ns}	45.66^{a}	40.28^{a}	5244^{b}
Kingbird	355.3^{ns}	329.0^{ns}	41.97^{b}	37.91^{b}	6264^{a}
NPSB Fertilizer ($kg\ ha^{-1}$)					
0	240.0^{d}	218.9^{c}	32.46^{c}	36.97^{c}	3033^{c}
50	277.2^{cd}	250.6^{c}	43.52^{b}	39.03^{ab}	4269^{b}
100	340.0^{b}	310.6^{b}	48.81^{ab}	38.68^{b}	6293^{a}
150	332.2^{bc}	316.1^{b}	50.43^{a}	40.7^{a}	7130^{a}
200	476.1^{a}	451.7^{a}	49.62^{a}	39.53^{ab}	7222^{a}
LSD	58.19	54.38	2.88	1.67	1126.6
CV	5.80	8.00	13.60	4.40	20.9
P value	**	**	**	**	*

LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of Variation; NS= non-significant, means in column followed by the same letter are not significantly different at 5% levels of Significance

The effect of fertilizer rate showed that the highest thousand kernels weight (40.7 g) was recorded from NPSB fertilizer rate of 150 $kg\ ha^{-1}$ while the lowest thousand kernels weight (36.97 g) was obtained with no fertilizer application (Table 5). This may be due to the provision of balanced nutrients application have enhanced accumulation of assimilate in the grains and thus resulting in heavier grains of wheat. This could also be due to adequate and better nutrition of the plants resulted in good grain filling and development of better seed size. The fact that higher amount of nitrogen application resulted in higher percentage of weight gain in grain filling stage in kernels and there by thousand kernel weight increased (Kauser *et al*., 1993). Makowska *et al*. (2008) also reported that 1000 kernels weight increased with the increase in nitrogen rate up to 100 $kg\ ha^{-1}$. In similar to this result, Bereket *et al*. (2014) also reported that in-

creasing *N* rate from 92 *kg N* ha^{-1} to 138 *kg N* ha^{-1} decreased thousand kernels weight of bread wheat by about 3.7%.

3.7 Grain yield (*kg* ha^{-1})

The analysis of variance showed that the main effects of blended NPSB fertilizer and variety and their interactions significantly ($P < 0.01$) affected the grain yield of bread wheat Thus, the highest grain yield (6500 *kg* ha^{-1}) was obtained at the rates of 200 *kg* NPSB ha^{-1} for Ogolcho whereas, the lowest grain yield (2330 *kg* ha^{-1}) was recorded at 0 fertilizer application in combination with Kekeba (Table 6). The increase in grain yield at increasing NPSB rate might have resulted from improved root growth and increased uptake of nutrients and better growth favored due to the synergetic effects of both nutrients which enhanced yield components and yield. In agreement with this result, Haile *et al.* (2012) found that increasing *N* rate from 0 to 120 *kg N* ha^{-1} increased grain yield of bread wheat. Bereket *et al.* (2014) also reported that increasing *P* rate from 46 to 69 *kg* P_2O_5 ha^{-1} increased grain yield of bread wheat by about 6.8%. Similarly, Guja *et al.* (2020) reported that application of nutrients like *K*, *S*, *Zn*, *Mg* and *B* used in experiments significantly increased grain yield and yield component of bread wheat as compare to the control (no fertilizer).

Table 6. Mean grain yield (*kg* ha^{-1}) of bread wheat as influenced by the interaction of blended NPSB fertilizer and variety

Blended NPSB (*kg* ha^{-1})	**Variety**		
	Ogolcho	**Kekeba**	**Kingbird**
0	2444^{g}	2330^{g}	3078^{fg}
50	2650^{g}	4444^{de}	4039^{e}
10	4167^{de}	4178^{de}	5833^{abc}
150	5000^{cd}	3889^{ef}	5556^{bc}
200	6500^{a}	6222^{ab}	5944^{ab}
LSD	915		
CV	12.4		
P value	***		

Means in columns and rows followed by the same letters are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of variation

3.8 Straw yield

The result showed highly significant ($p < 0.01$) difference among the varieties of wheat and the fertilizer rate and the interaction between the two factors were not significant. Variety Kingbird had the highest straw yield (8056 *kg* ha^{-1}) whereas variety Kekeba had the lowest straw yield (2611 *kg* ha^{-1}) (Table 5). This might be due to differences in genetic make-up of the varieties. Similarly, Ghafari *et al.* (2017) and Gul *et al.* (2012) found that straw yield of wheat significantly varied among the varieties. The result showed that an increase in straw yield when fertilizer rate increased from the lowest to the highest rate. The highest straw yield of 7222 *kg* ha^{-1} was obtained at the highest NPSB rate of 200 *kg* ha^{-1} whereas the lowest straw yields of 3033 *kg* ha^{-1} was from the control (Table 5). The significant increase in straw yield in response to the highest rate of blended NPSB might be attributed to the synergistic roles of the nutrients that enhanced growth and development of the crop. The result is consistent with that of Nasser (2009) who reported increased straw yield of wheat with increase in *NP* fertilizers rates up to 90/45 *kg* ha^{-1}. Bereket *et al.* (2014) also reported that the highest straw yield was recorded at the highest nitrogen rate of 69 *kg N* ha^{-1}. On top of this, Gul *et al.*, (2012) reported that higher nitrogen application (160 *kg* ha^{-1}) has more contribution in higher straw yield production (9098.65 kg ha-1) as compared to control treatment (5302.97 *kg* ha^{-1}).

3.9 Aboveground biomass yield ($kg\ ha^{-1}$)

Analysis of variance showed that the main effects of variety, fertilizer rates and the interaction effect of variety and fertilizers had a highly significant effect (p <0.01) on aboveground dry biomass yield. Variety Ogolcho produced the highest aboveground dry biomass yield (15389 $kg\ ha^{-1}$) treated with 200 $kg\ ha^{-1}$ NPSB while the lowest above ground dry biomass yield (5056 $kg\ ha^{-1}$) was produced from variety Kekeba at 0 level application of the fertilizer (Table 7). This result agrees with that of Dawit *et al*., (2015) who reported that increasing N from 0 to 184 $kg\ ha^{-1}$ and P from 0 to 138 $kg\ ha^{-1}$ increased the aboveground dry biomass yield of wheat by about 70.1% and 40.6%, respectively. Similarly, Workineh *et al*., (2015) reported that the highest biomass yield (11890 kg ha-1) of wheat was observed with 138/115 $kg\ N/P_2O_5\ ha^{-1}$ while the lowest (9780 $kg\ ha^{-1}$) was recorded with 46/46 $kg\ N/P_2O_5\ ha^{-1}$. Likewise, Melesse Harfe (2017) reported that increasing the N/P fertilizer rate from 46/20 $kg\ N/P_2O_5\ ha^{-1}$ to 69/30 $kg\ N/P_2O_5\ ha^{-1}$ for wheat biomass yield was increased from 10417 $kg\ ha^{-1}$ to 11233 $kg\ ha^{-1}$. The increase in aboveground dry biomass at the highest rates of NPSB might have resulted from improved root growth and increased uptake of nutrients favoring better growth and delayed senescence of leaves of the crop due to synergetic effect of the nutrients. In conformity with this result, Jasemi *et al*., (2017) reported vegetative growth and biological yield has much dependence to consumption of chemical fertilizers, application of the fertilizers led to increasing biological yield of wheat. Similarly, Bekalu and Mamo, (2016) also reported that increasing N rates from 23 to 69 $kg\ ha^{-1}$ increased aboveground dry biomass of wheat by about 22.6%. Likewise, Wakene *et al*. (2014) stated that supply of P_2O_5 at rate of 69 $kg\ ha^{-1}$ in wheat found to be adequate to produce maximum aboveground dry biomass. Yasir *et al*. (2015) also reported the maximum aboveground dry biomass of wheat have obtained with application of 140 $kg\ N\ ha^{-1}$ at sowing and 20 $kg\ S\ ha^{-1}$ at anthesis.

Table 7. Mean Above ground biomass ($kg\ ha^{-1}$) of bread wheat as influenced by the interaction of blended NPSB fertilizer and variety

Blended NPSB ($kg\ ha^{-1}$)	**Variety**		
	Ogolcho	**Kekeba**	**Kingbird**
0	5208^{ij}	5056^{j}	6689^{hij}
50	7122^{ghi}	8611^{fg}	8206^{gh}
100	8669^{fg}	10844^{de}	13611^{abc}
150	11944^{cde}	10278^{ef}	13611^{abc}
200	15389^{a}	12611^{bcd}	14278^{ab}
LSD	1919.3		
CV	11.3		
p value	**		

Means in columns and rows followed by the same letters are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV = Coefficient of variation

3.10 Partial Budget Analysis

The partial budget analysis showed that highest net benefit of (72, 495) *Birr* ha^{-1} was obtained for variety Ogolcho that received 200 kg NPSB ha^{-1} (Table 8). However, the lowest net benefits of 27,651 *Birr* ha^{-1} was obtained from the unfertilized treatment with the variety Kekeba. The variety Ogolcho gave economic benefit of 72,495 *Birr* ha^{-1} with marginal rate of return of 2711.9% at 200 kg NPSB ha^{-1} fertilizer rate. Therefore, on economic grounds, application of 200 kg NPSB ha^{-1} with variety Ogolcho would be best and economical for production of bread wheat in the study area and other areas with similar agro-ecological conditions. In line with this result, (Bekalu & Mamo, 2016) reported that N application at 69 $kg\ ha^{-1}$ is effective in attaining higher grain yield and economic benefit of wheat in southern part of Ethiopia.

Table 8. Marginal rate of return analysis for response of bread wheat varieties to blended NPSB fertilizers in Hulbareg District, Southern Ethiopia

Treatments		Wheat yield ($kg\ ha^{-1}$)			Income ($ETB\ ha^{-1}$)					2MRR (%)
Variety	NPSB	UGY	AGY	SY	Grain	Straw	GFB	TVC	NB	
Ogolcho	0	2444	2199.6	2611	27495	1305.5	28800.5	0	28800.5	D
Ogolcho	50	2650	2385	4472	29812.5	2236	32048.5	2550	29498.5	72.45
Ogolcho	100	4167	3750.3	4502	46878.75	2251	49129.75	3160	45969.75	2700
Ogolcho	150	5000	4500	6944	56250	3472	59722	3770	55952	1636.4
Ogolcho	200	6500	5850	7500	73125	3750	76875	4380	72495	2711.9
Kekeba	0	2330	2097	2878	26212	1439	27651.5	0	27651.5	D
Kekeba	50	4444	3999	4167	49995	2083.5	52078.5	2550	49528.5	812.9
Kekeba	100	4178	3760	6667	47002.5	3333.5	50336	3160	47176	D
Kekeba	150	3889	3500.1	6389	43751.25	3194.5	46945.75	3770	43175.75	D
Kekeba	200	6222	5599.8	6389	69997.5	3194.5	73192	4380	68812	4202
Kingbird	0	3078	2770.2	3611	34627.5	1805.5	36433	0	36433	D
Kingbird	50	4039	3635.1	4167	45438.75	2083.5	47522.25	2550	44972.25	334.9
Kingbird	100	5833	5249.7	7711	65621.25	3855.5	69476.75	3160	66316.75	3499
Kingbird	150	5556	5000.4	8056	62505	4028	66533	3770	62763	D
Kingbird	200	5944	5349.6	7778	66870	3889	70759	4380	66379	592.8

Where, AGY= adjusted grain yield; SY = Straw yield; GFB = gross field benefit; TVC= total variable costs; NB = net benefit, MRR = marginal rate of return; $ETB\ ha^{-1}$= Ethiopian Birr per hectare; D = dominated treatments. Cost of bread wheat seed= 16.00 $ETB\ kg^{-1}$; Cost of NPSB= 12.20 kg^{-1}; Cost of Urea =10.40 $ETB\ kg^{-1}$; Labour cost for NPSB application = 7 persons ha^{-1}, each 60 ETB day-1; Labour cost for urea top dress fertilizer application at tillering = 8 person ha^{-1}, each 60 ETB day^{-1}. Market price of bread wheat grain =12.5 $Birr\ kg\ ha^{-1}$ and straw=0.5 $Birr\ kg^{-1}$ in Hulbareg town at harvesting time in December 2019.

4 Conclusion

For the last four to five decades, Ethiopian agriculture depended solely on imported fertilizer products; only urea and Di-ammonium phosphate (DAP), as sources of *N* and *P*, respectively. However, recently it is perceived that the production of such high protein cereals like wheat can be limited by the deficiency of *S* and other nutrients. Thus, addition of nutrients such *N*, *P*, *S* and *B* to low fertile soil is important to increase yield, yield components and quality of wheat whether it is for consumption or industrial purpose. Therefore, from the result of present study that the application of the 200 $kg\ ha^{-1}$ blended NPSB fertilizer in addition to 46 $kg\ N\ ha^{-1}$ with variety Ogolcho can be recommended to farmers for production of wheat in the study area and other areas with similar agro-ecology.

Acknowledgments

This study is financially supported by Haramaya University.

Authors' Contributions

*** and *** designed the experiment and collected the data. *** analyzed the data and interpreted the results. *** prepared the manuscript. *** and *** revised and edited the manuscript. All authors read and approved the final version of the manuscript.

Conflict of Interest

The authors declares that there is no conflict of interest.

Data Availability

The data that support the findings of this study are available upon request to the corresponding author.

References

Akmal MS, Shah M, & Asim M. (2000). Yield performance in three commercial wheat varieties due to flag leaf area. *Pakistan J. Biol. Sci.*, 3(12):2072-2074.

Alam, M. S. & Jahan, I. (2013). Yield and yield components of wheat as affected by phosphorus fertilization. *Rajshahi University Journal of Life and Earth and Agricultural Sciences*, 41:21-27.

Asnakew, W., Tarekegn, M., Mengesha, B. & Tefera, A. (1991). Soil fertility management studies on wheat in Ethiopia. Wheat Research in Ethiopia: A Historical Perspective. Addis Ababa, *IAR/CIMMYT*: 137-172.

Assefa Workineh, Yemane Nega & Dawit Habte (2015). Planting density and nitrogen and phosphorus fertilization effect on different bread wheat (*Triticum aestivum* L.) genotypes in South Tigray, Ethiopia. *World Journal of Medicine and Medical Science Research* Vol. 3 (2): 020-028.

ATA (Agriculture Transformation Agency) (2014). Wheat Sector Development Strategy working document.

Bekalu Abebe & Mamo Manchore (2016). Effect of the rate of n-fertilizer application on growth and yield of wheat (*Triticum aestivum* L.) at Chencha, southern Ethiopia. *International Journal of Plant, Animal and Environmental Sciences*, 6(3): 168-175.

Bereket Haileselassie, Dawit Habte, Mehretab Haileselassie & Gebremedhin Gebremeskel (2014). Effects of mineral nitrogen and phosphorus fertilizers on yield and nutrient utilization of bread wheat (*Tritcum aestivum*) on the sandy soils of Hawzen District, Northern Ethiopia. *Agriculture, Forestry and Fisheries*, 3(3): 189-198. https://doi.org/10.11648/j.aff.20140303.18

Brian N. Otteson, Mohamed Mergoum & J. K. R. (2007). Seeding rate and nitrogen management effects on spring wheat yield and yield components. *Agronomy Journal*, 99(6):1615-1621.

Chapman, H. D. (1965). Cation exchange capacity by ammonium saturation. 891-901. In: Black, C.A., L.E. Ensminger and F.E. Clark (ed.), Method of soil analysis. American Society of Agronomy, Madison Wisconsin, USA.

CIMMYT (Centro International de Mejoramiento de Maiz y Trigo /International Maize and Wheat Improvement Center) (1988). From agronomic data to farmer recommendation: An Economic work Book. Mexico, D.F.: CIMMYT.

Clayton, W.D., Govaerts, R., Harman, K.T., Williamson, H. & Vorontsova, M. (2015). World Checklist of Poaceae. (Royal Botanic Gardens, Kew) Accessed on 5 Jul 2022.

CSA (Central Statistical Agency) (2019). Agricultural sample survey Report on area and production for major crops. Central Statistical Agency, Ethiopia

Curtis, B.C. (2002). *Wheat in the World*. In: Bread Wheat: Improvement and Production, Curtis, B.C., S. Rajaram and H.G. Macpherson (Eds.) Food and Agriculture Organization of the United Nations, Rome, Italy, ISBN-13: 9789251048092, pp: 1-18.

Dawit Hapte, Kasu Tadese, Wubengeda Admasu, Tadese Dessalegn & Asrat Mekonen (2015). Agronomic and Economic Evaluation of the *N* and *P* Response of Bread Wheat Grown in Moist and Humid Mid highland Vertisols Areas of Arsi Zone, Ethiopia. *African Journal of Agricultural Research*, 10 (3):89-99

Demeke, M. D: Marcantonio, F. (2013). Analysis of incentives and disincentives for Wheat in Ethiopia. Techical notes series, MAFAP, FAO, and Rome.

Dewis J, Freitas P. (1975). Physical and chemical methods of soil and tissue analysis. FAO Bulletin No. 10. Rome. pp. 275.

EthioSIS (Ethiopia Soil Information System). (2014). Soil fertility status and fertilizerrecommendation atlas for Tigray regional state, Ethiopia.

EthioSIS (Ethiopian Soil Information System). (2013). Soil analysis report. Agricultural Transformation Agency (Unpublished)

Fano Dargo and Tadeos Shiferaw (2017). Participatory Varietal Selection of Bread Wheat Cultivars (*Triticum aestivum* L.) for Moisture Stress Environment of Somali Regional State of Ethiopia. *Journal of Biology, Agriculture and Healthcare*: 7(5):58-67.

FAO (Food and Agriculture Organization) (2014). Food Balance Sheets. Rome, Italy.

FAO (Food and Agriculture Organization) (2019). Strategic analysis and intervention plan for wheat and wheat products in the Agro-Commodities Procurement Zone of the pilot Integrated Agro-Industrial Park in Central Eastern Oromia, Ethiopia. FAO, Addis Ababa

Geleto, T., Tanner, D.G., Mamo, T. *et al.* (1995). Response of rainfed bread and durum wheat to source, level and timing of nitrogen fertilizer on two Ethiopian Vertisols: II. *N* uptake, recovery and efficiency. Fertilizer Research 44: 195–204. https://doi.org/10.1007/BF00750926

Ghafari, H., Gorji, M., Arabkhedri, M., Ali, GR., Heidari, A. & Akhavan, S. (2017). Identification and prioritization of critical erosion areas based on onsite and offsite effects. Catena. 156:1-9. https://doi.org/10.1016/j.catena.2017.03.014

Guja U., Abreham K., Mekuria T. & Tsegaye H. (2020). Evaluation of different blended fertilizer types and rates for better production of bread wheat (*Triticum aestivum* L.) at Adiyo District, South Westhern Ethiopia. *Agricultural and Veterinary Sciences* 8(1): 12-18.

Gul, H., Said, A., Saeed, B., Ahmad, I. & Ali, K. (2012). Response of yield and yield components of wheat towards foliar spray of nitrogen, potassium and zinc. *ARPN J Agric Biol Sci* 6:23–25

Haile Deressa, Nigussie Dechasa & Amsalu Ayana (2012). Nitrogen use efficiency of bread wheat: Effects of nitrogen rate and time of application. *Journal of Soil Science and Plant Nutrition*, 12 (3): 389-409.

Hailu Gebremariam (1991). Wheat production and research in Ethiopia. pp. 1-15. In: Hailu G.M., Tanner, D.G., Mengistu, H. (eds.). Wheat Research in Ethiopia: A Historical Perspective. IAR/CIMMYT, Addis Ababa, Ethiopia.

Hameed, E., W.A. Shah, A.A. Shad, J. Bakht & T. Muhammad (2003). Effect of different planting dates seed rate and nitrogen levels on wheat. *Asian J. Plant Sci*., 2(6):467-474.

Hamzeh Mohmmed. Rawashdeh & Florin Sala (2013). The effect of foliar application of iron and boron on early growth parameters of wheat (*Triticum aestivum* L.). *Research Journal of Agricultural Science*, 45(1):21-26.

Haun, J. R. (1973). Visual quantification of wheat development. *Agronomy. J*. 65:116–119.

Havlin, J.L., Beaton J.D., Tsdale, S.L. & Nelson W.L. (1999). Soil fertility and fertilizer: an introduction to nutrient management Prentice Hall, New York, 499p.

Hillette Hailu, Tekalign Mamo, R. Keskinen, E. Karltun, Heluf Gebrekidan & Taye Bekele (2015). Soil fertility status and wheat nutrient content in Vertisol cropping systems of central highlands of Ethiopia. *Agriculture and Food Secure* 4:19-23.

Horneck, D. A., Sullivan, D. M., Owen, J. S. & Hart, J. M. (2011). Soil Test Interpretation Guide. EC 1478. Revised July 2011, Oregon State University Extension Service.

Hussain M. Iftikhar, Shah Shamshad H., Hussain Sajjad & Iqbal Khalid. (2002). Growth, Yield and Quality response of three Wheat (*Triticum aestivum* L.) varieties to different levels of *N*, *P* and *K*. *International Journal of Agriculture and Biology*, 4(3):362-364.

Jaenisch R. B., Munaro B. L., Jagadish K. V. & Lollato P. R. (2022). Modulation of Wheat Yield Components in Response to Management Intensification to Reduce Yield Gaps. *Front. Plant Sci.*, https://doi.org/10.3389/fpls.2022.772232

Jasemi M., Valizadeh L., Zamanzadeh V. & Keogh B. (2017). A Concept Analysis of Holistic Care by Hybrid Model. *Indian J Palliat Care*, 23:71-80.

Jemal Abdulkerim, Tamado Tana & Firdissa Eticha (2015). Response of Bread Wheat (*Triticum aestivum* L.)Varieties to Seeding Rates at Kulumsa, South Eastern Ethiopia. *Asian Journal of Plant Sciences,* 14: 50- 58.

Kausar, K., M. Akbar, E. Rasul & A.N. Ahmad (1993). Physiological responses of nitrogen, phosphorus and potassium on growth and yield of wheat. *Pakistan J. Agric. Res*., 14: 2-3.

Khan, M. B. Lone, M.I., Ullah R. & Kaleem S. (2010). Effect of different phosphatic fertilizers on growth attributes of wheat (*Triticum aestivum* L.). *Journal of American Science*, 6(12):1256-1262.

Knezevic D., Radosavac A. & Zelenika M. (2015). Variability of grain weight per spike in wheat grown in different ecological conditions. *Acta Agriculturae Serbica*, 39: 85-951

Landon JR. (1991). Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and sub-tropics. *Longman Scientifc and Technical, Essex* , p 474

Legesse Amsalu (2004). Response of tef [*Eragrostis tef* (Zucc.) Trotter] to applied nitrogen and phosphorus in Sirinka, North Eastern Ethiopia. MSc. Thesis, Haromaya University. 68p.

Luo, J., Su, F., Chen, D., Shiloh, A. & Gu, W. (2000). Deacetylation of p53 modulates its effect on cell growth and apoptosis. *Nature*, 408: 377–381.

Makowska A., Obuchowski W., Sulewska H., Koziara W., Paschke H. (2008). Effect of nitrogen fertilization of durum wheat varieties on some characteristics important for pasta production. *Acta Sci. Pol., Technol. Aliment*. 7(1): 29-39.

Manna, M. C., Swarup, A., Wanjari, R. H., Mishra, B. & Shahi, D. K. (2007). Long-term fertilization, manure and liming effects on soil organic matter and crop yields. *Soil & Tillage Research*, 94, 397–409.

Marschner, H. (1995). Functions of Mineral Nutrients: Micronutrients. In: Mineral Nutrition of Higher Plants, 2nd Edition, Academic Press, London, 313-404.

Martens, D.C. & Westermann, D.T. (1991). Fertilizer Applications for Correcting Micronutrient Deficiencies. Soil Science Society of America, 677 S. Segoe Rd., 50 Madison, WI 53711, USA. Micronutrients in Agriculture. 2nd ed. SSSA Hook Series, no. 4.pp. 549-553.

Mathpal, B., Srivastava, P. C., Shankhdhar, D. & Shankhdhar, S. C. (2015). Zinc enrichment in wheat genotypes under various methods of zinc application. *Plant Soil & Environment*, 61, 171–175.

Melesse Harfe (2017). Response of bread wheat (*Triticum aestivum* L.) varieties to *N* and *P* fertilizer rates in Ofla district, Southern Tigray, Ethiopia. *African Journal of Agricultural Science*, 12(19): 1646-1660. https://doi.org/10.5897/AJAR2015.10545

Mengel, K. & Kirby, E.A. (1996). Principles of plant nutrition. *Panima Publishing Corporation*, New Delhi, India.

MoA (Ministry of Agriculture) (2012). Ministry of Agriculture. Animal and Plant Health Regulatory Directorate. Crop variety register, Issue No. 15. Addis Ababa, Ethiopia.

Motsara., M. R. & Roy, R. N. (2008). Guide to laboratory establishment for plant nutrient analysis. FAO Fertilizer and Plant Nutrition Bulletin 19. Rome, Italy.

Muhammad Tahir, Asif Tanveer, Tajamal Hussain Shah, Naeem Fiaz & Allah Wasaya (2009). Yield Response of Wheat (*Triticum aestivum* L.) to Boron Application at Different Growth Stages. Pakistan journal of life and social science, 7(1):39-42.

Nadian, H., Najarzadegan, R., AlamiSaeid, K., Gharineh, M.H. & Siadat, A. (2010). Effects of boron and sulfur application on yield and yield components of *Brassica napus* L. in a calcareous soil. *World Applied Science Journal*, 11: 89–95.

Nasser, M. E. A. W. (2009). Effect of partial or complete replacement of cottonseed meal by jojoba meal on gas production, rumen fermentation and produced amylase and carboxymethylecellulase activity, *in vitro*. *Livest. Res. Rural Dev*., 21 (5) Article No.79

Olsen, S. R., Cole, C. V., Watanabe, F. S. & Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circular, Vol 939 (p. 19). Washington, DC: US Department of Agriculture.

Rai, B., Thandapani, V. & Chandrababu R. (2012). Physio-morphological and biochemical characterization of selected recombinant inbred lines of rice for drought resistance. *Indian Journal of Plant Physiology*, 17(2):189-193.

Shirinzadeh, A., Abad, S. H., Nourmohammadi, G., Haravan, M. E. & Madani, H. (2018). Yield Gap Associated with Crop Management in Wheat (Case Study: Ardabil Province-ParsabadMoghan). *Egypt. J. Agron.*, 40(3): 223 -236.

Tekalign Tadesse (1991). Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa.

Teklu Erkossa & Teklewold Hailemariam (2009). Agronomic and economic efficiency of manure and urea fertilizers use on vertisols in Ethiopian Highlands. *Agricultural Sciences in China*, 8(3):352-360.

Temesgen Godebo, Fanuel Laekemariam & Gobeze Loha (2021). Nutrient uptake, use efficiency and productivity of bread wheat (*Triticum aestivum* L.) as affected by nitrogen and potassium fertilizer in Keddida Gamela Woreda, Southern Ethiopia. *Environ Syst Res.*, 10:12

USDA (United States Department of Agriculture) (2022). Wheat Outlook: https://www.nass.usda.gov/Newsroom/2022/05-12-2022.php accessed on 03 July 2022.

Wakene Tigre Walelign Worku & Wassie Haile (2017). Effects of Nitrogen and Phosphorus Fertilizer Levels on Growth and Development of Barley (*Hordeum vulgare* L.) at Bore District, Southern Oromia, Ethiopia. *American Journal of Life Sciences*, 2(2):260-266. https://doi.org/10.11648/j.ajls.20140205.12.

Wakene Tigre, Walelign Worku & Wassie Haile (2014). Effects of nitrogen and phosphorus fertilizer levels on growth and development of barley (*Hordeum vulgare* L.) at Bore District, Southern Oromia, and Ethiopia. *American Journal of Life Sciences*, 2(5): 260-266.

Walkley, A.J. & Black, I.A. (1934). Estimation of soil organic carbon by the chromic acid titration method. Soil Science, 37:29-38.

Weil R. R. and Brady N. C. (2017). The Nature and Properties of Soils.15th edition. Pearson/Prentice Hall, USA.

Yasir Hayat, Zahid Hussain, Shad Khan Khalil1, Zafar Hayat Khan, Ikramullah, Muhammad Ali, Tariq Shah & Farooq Shah (2015). Effects of Nitrogen and Foliar Sulphur Applications on the Growth and Yield of Two Wheat Varieties Grown in Northern Pakistan. *ARPN Journal of Agricultural and Biological Science*, 10(4):139-145.

Yong L. D., Fam D. S. & Lum Shawn (2011). Reel Conservation: Can Big Screen Animations Save Tropical Biodiversity? Tropical Conservation Science 4(3):244-253. https://doi.org/10.1177/194008291100400302

EJED 2022 4(2):56–67
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj
E J E D

The Eco-cultural Shift in the Gede'o and Sidama Indigenous Agroforestry System

Abera Eyasu Gedecho*[1], Yetebarek Hizekeal Zekareas[1], Ongaye Oda Orkaydo[1] and Abiyot Legesse Kura[2]

[1]*Institute of Indigenous Studies, Dilla University, Dilla, Ethiopia*
[2]*Department of Geography, Dilla University, Dilla, Ethiopia.*
**Corresponding author, Email: aberaeyasu2011@gmail.com*

Received: 02nd September 2021 *Accepted: 23rd May 2022*

DOI: **10.20372/ejed.v04i2.04**

Abstract

The Gedeo and Sidama are neighboring communities well known in Ethiopia for their indigenous agroforestry system. Both communities have strong attachments to the indigenous agroforestry system. However, in recent years, there has been a dramatic change in the agroforestry system of both communities: a shift in the value system and economic engagements that reflects a departure from the culturally embedded local knowledge, belief, norms, and environmental ethics of regulating the human-nature relationships. This paper attempts to show the eco-cultural shift in the indigenous agroforestry systems of the Gedeo and Sidama communities. The paper specifically addresses the relationship between nature and culture, and their dynamics and the challenges related to the eco-cultural shifts in the everyday lives of the communities. Methodologically, qualitative research methods such as in-depth interviews, observation, focused group discussions; narrative interview and review of secondary sources have been employed to collect data. Purposive and snowball sampling techniques have been used to find key informants in the study areas. The results have shown that various factors such as disease to native crops, erosion of traditional social structures, urbanization, modernization, modern schooling and expansion of mainstream religions have been inducing adverse effects in the indigenous agroforestry system of Gedeo and Sidama communities. In addition, with the "monetization" of the production system in the area, the indigenous agroforestry system of the Gedeo and Sidama is now shifting towards cash-oriented cropping system. As a result, the communities have started to experience ecological, social and institutional challenges. Ecologically, the communities have started to experience loss of biodiversity, infertility of soil and food insecurity; socially, uncommon and abnormal behaviors such as beggary, snatching and prostitution are on the rise; institutionally, the decay of indigenous social institutions that preserved society-nature symbiosis is quite visible. The paper recommends necessary preventive measures to reduce drivers of eco-cultural shift in the indigenous land use systems of Gedeo and Sidama and their adverse effects on the harmonious relationship between society and nature in the areas.

Keywords/Phrases: Agroforestry system, Eco-culture shift, Gedeo, Sidama

1 Introduction

The relationships between human society and its natural environment are mediated by interrelated facets of culture, namely, the society's ontology, epistemology, normative orientations and practices. Nature and culture converge on many levels that span values, beliefs, norms, livelihoods, knowledge, and languages. The natural environment provides a setting for the development of cultural processes, activities, and belief systems, and the landscapes form a diverse cultural archive of human endeavors (Jules *et. el*., 2009). This close connection between nature and culture has helped indigenous or local communities to develop knowledge of the ecology around them

(Jules *et. el*., 2009). The traditional values, myths, taboos, beliefs and practices that local people possess relate them to nature. According to Cobett (2006), cultural contexts influence how we perceive, experience, and value the natural world and ultimately influence our entire belief systems. These harmonious relationships hold for the indigenous people who believe that humans are at an equal standing with the rest of the natural world; they are kindred relations. Agroforestry system is one type of indigenous ecological knowledge that depends on an integrated approach to land use characterized by deliberate maintenance of trees and other woody perennials in fields ingrained in the traditions and culture of the local communities (Miller & Nair, 2006).

The Gedeo and Sidama are two neighboring communities that speak Highland East Cushitic languages of the Afro-asiatic phylum. They share several linguistic and cultural features, and have a long history of interdependence and friendship. Their relationship ranges from sharing adjacent geographical landscapes, economic transactions and cultural practices. Most of their members living in vicinities that allow closer interactions are bilinguals, fluent both in Gedeo and Sidama languages.

The Gedeo and Sidama are well known in Ethiopia for their traditional agroforestry system that basically evolved from forest. The oral traditions of Gedeo and Sidama account that both ethnic groups have inherited the agro-ecological knowledge from their respective ancestors. This ancestral ecological knowledge has enabled the Gedeo and Sidama to develop knowledge about plants, animals, soils and water including rain, seasonality and so forth. They use this knowledge to manage the agroforestry system holistically in the sense that the practices involve the domestication of natural forests and the intensification of agriculture, and the tolerance of wildlife in general and weedy herbaceous vegetation in particular (Tadesse, 2002; Peter, 2008). At the heart of the land use system of the agroforestry is the presence of enset (*Ensete ventricosum*) with organic coffee (*Coffea arabica*) as a major cash crop. This indigenous agroforestry knowledge fits into what Natalia (2006) describes as eco-cogitation, a set of mental constrictions in specific ecology knowledge about plants, animals, soils water including rain, seasonality, and others which are used to manage agroforestry.

However, in recent years, the Gedeo and Sidama agroforestry system has demonstrated a dramatic change: shifts in the value system and economic engagements that reflect a departure from the culturally embedded local knowledge, belief, norms and environmental ethics of regulating the human-nature relationships. Scholars have already pointed out to the growing evidence of eco-cultural shifts in the Gedeo and Sidama agroforestry system. For example, Abiyot (2013) notes, that the exogenous western cultural values and attitudes have been critically changing the indigenous worldview, social organization, behaviors, traditional ecological knowledge and attitudes toward the culture-nature relationship. Asebe *et. el*. (2017) also states that the socio-economic values of tree in the Gedeo agroforestry system have been monetized and shifted from "a tree is life" to "a tree is cash in the pocket". Gessesse (2008) has also shown that the meaning, knowledge, understanding, philosophy, value and practice associated with the traditional agroforestry system have been dramatically declining among the Sidama due to excessive inflow of exogenous cultural practices like intensification in the cultivation of a mono-cash crop like chat, and clearing native trees and crops in the agroforestry system in favor of commercial trees and plants.

Although scholars have clearly expressed their concerns about the shifts in Gedeo and Sidama-environmental relations, they mainly focus on the context of tree/forest aspects instead of comprehensively investigating the eco-cultural shifts. Moreover, the scholarly works often focus on either the Gedeo or Sidama agroforestry system separately rather than looking at the Gedeo-Sidama agroforestry continuum and what both communities have and experience in common in the human-nature relationships. Thus, this takes us to the main objective of this paper: focusing on the traditional agroforestry system that holds many components together among the Gedeo and Sidama in order to understand the holistic way of eco-culture notions and practices, on the one hand, and the eco-cultural shifts within the agroforestry system, on the other. We have identified the main drivers of change in the traditional agroforestry system, and the potential consequences regarding the

socio-political, cultural, and economic and livelihood aspects for local people. To fully and comprehensively understand the human-nature relationships and the eco-culture shifts in the indigenous agroforestry system of the Gedeo and Sidama, the paper addresses such issues as how the Gedeo and Sidama agroforestry system has evolved; the components and level of integration, management practices and traditional values and belief systems that the Gedeo-Sidama indigenous agroforestry system comprises; the driving forces responsible for the eco-cultural shifts in the in Gedeo-Sidama agroforestry system; the consequences associated with the eco-cultural shifts in the study area.

Following the introduction, this paper presents the description of the study area in section two. Section three presents the methodology of the study. Section four provides the analyses and discussions of the data. Data for this paper were collected in 2021.

2 Materials and Methods

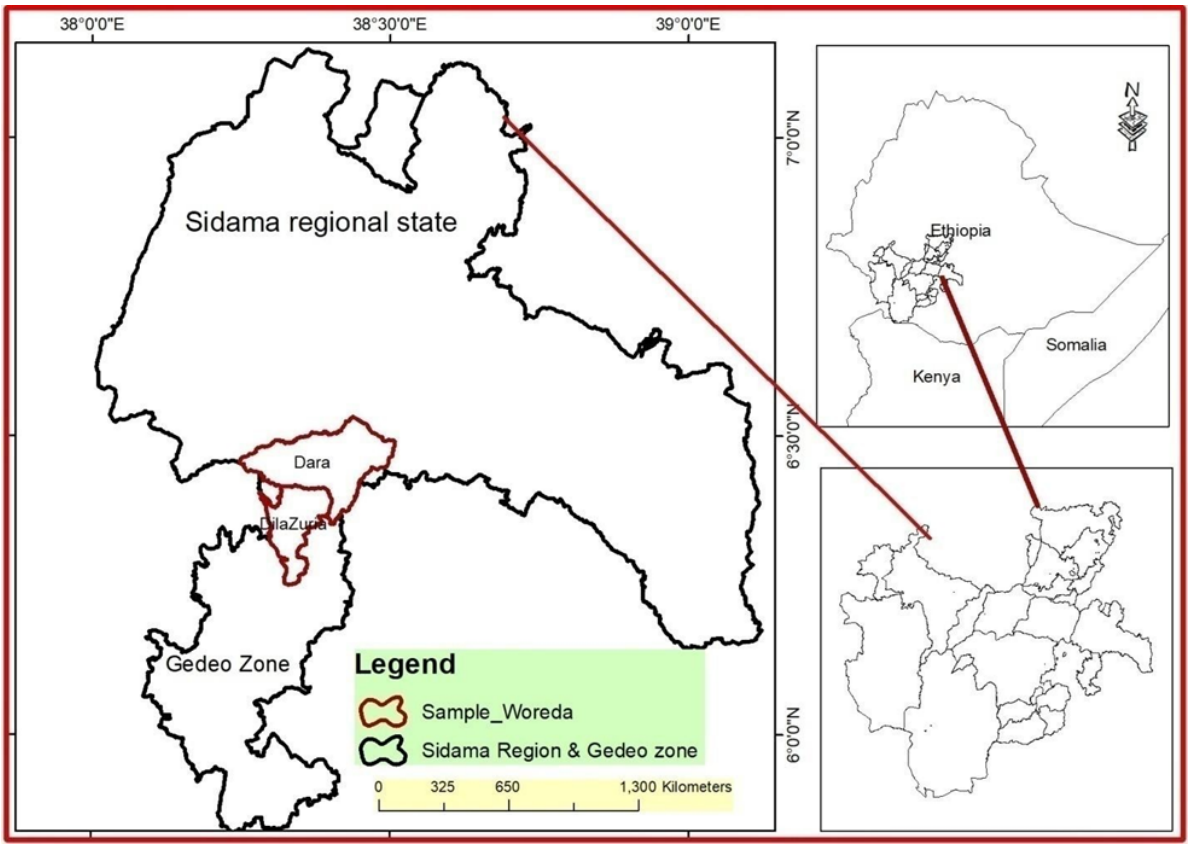
2.1 Description of the Study Area

The Gedeo and Sidama are found in the southeastern escarpment of the Great East African Rift Valley. Both Gedeo and Sidama share boundaries with each other as well as with the Oromia National Regional State (Beyene *et. el*., 2018). Moreover, as neighbouring communities, the Gedeo and Sidama share quite a number of linguistic and cultural features. For certain specific information, we briefly describe the Gedeo and Sidama communities separately below.

The majority of the Gedeo live in Gedeo Zone in the Southern Nations, Nationalities and Peoples' Regional State. The Gedeo Zone is located at 365 km from Addis Ababa, and at 5^o50'26"– 6^o12'48" N and 38^o 03'02"–38^o18'59" E. The zone has a total area of 1347 km2. The climatic condition in Gedeo is classified into three climatic classifications. The majority (62%) of the Gedeo land falls within the sub-tropical climate. This is followed by a high-altitude climate covering 37%. The hot tropical climate covers only 1% of the area. Rainfall ranges from 800 to 1800 mm while the mean annual temperature varies from 12.5^oC to 28 0C. March to May is the first rainy period while the second rainy season is from July to December (Getachew & Mulugeta, 2017).

Most of the Sidama live in Sidama National Regional State. The main town of the Sidama National Regional State is Hawassa located at 270 km from Addis Ababa. The coordinates of the Sidama National Regional State are 5^o45'–6^o45' N and 38^o15'–39^o E. The region has a total area of 7672 km2 with latitude ranges from 1800 to 2250 m a. s. l. The climate is semi-humid with the mean annual rainfall ranging between 1200–2500mm. The mean annual temperature ranges from 12 to 20^oC. The short rainy season lasts from mid-February to April whereas the long rainy season is from June to September (Tesfaye, 2008).

Both the Gedeo and Sidama are predominantly agriculturalists whose economic values are heavily dependent on agroforestry system. Both communities also have indigenous socio-cultural and political governance system and executing institutions. Moreover, both communities share many other similarities in terms of language, culture, values, and psychological make-up with their fellow Cushitic neighbors. Furthermore, they share the common history of conquest by the army of Menelik in the late nineteenth century. Resource exploitation was at the centre of the feudal system, and laid the foundation for the eco-cultural shifts. The eco-cultural shifts were sustained and even expanded in the subsequent regimes through modernization, monetization and commercialization of environmental resources.



The Map showing the study areas (developed by one of the authors)

2.2 Methodology

In order to carry out the fieldwork, the researchers purposively selected two districts (i.e., one district from each community): Dilla Zuria and Dara districts from Gedeo zone and Sidama National Regional State, respectively. The main reason for selecting these districts was that they have similar weather conditions, agro ecological zones, socio-cultural and economic ways of life, and are located at the border areas of the two administrations. We collected data from our key informants using a snowball sampling technique. Because our methodology is purely qualitative, the number of participants was determined by the level of data saturation. We first did in-depth interviews with key informants who have deep knowledge about the indigenous agroforestry system, and understand the trajectory and impact of the eco-cultural shifts. This method gave us the opportunity to gather detailed information on the traditional beliefs and belief systems, practices of ecological maintenance and regeneration, the dynamics of livelihood practices, perceptions of relations with nature, and shifts in eco-cultural meanings (O'Reily, 2012; Asebe *et. al.*, 2017). In addition to collecting data through in-depth interviews, the researchers conducted field observations to understand the practices, activities and emerging phenomena related to the study topic. Focus group discussions were also used to collect data basically to further examine information collected during in-depth interviews. This method is crucial because it helps researcher to collect information that cannot otherwise be well documented, and possibly missed from, individual in-depth interviews (Riesman, 2002). Information from secondary sources on the Gedeo and Sidama indigenous agroforestry system was consulted from published and unpublished materials.

In addition to what the data from the fieldworks and secondary sources show, this paper has benefited from the composition of the researchers. The first author is a native member of the Gedeo community who has been interacting with both communities since his childhood. His birthplace is located on the border between the Sidama and Gedeo. From his

life experiences, he knows that the multi-cropping culture is shifting to mono-cropping; the culture of substituting old and big trees with seedlings of their species after cutting is vanishing; monetization of cash crops like chat, eucalyptus and coffee, profaning of intruding to sacred spaces and so forth. The other three co-authors are non-native members of either community. However, as senior academic staff members of Dilla University, weekly commuters between Hawassa and Dilla, and their extensive research activities and personal contacts with the members of both communities, their observations and insights have contributed to understanding the views of the study participants, and the realities on the ground.

3 Results and Discussions

3.1 The Genesis of the Gedeo and Sidama Indigenous Agroforestry System

Oral traditions state that the Gedeo and Sidama were governed by a kind of Queen Dom governance system called *Akkomannoye/Furra* system. During that governance system, hunting and gathering activity was the dominant livelihood of these two communities. According to Christine & Pauline (1979), the practice of hunting and gathering economy goes back to around 9000 BC. If we adhere to this assumption, the Gedeo-Sidama hunter-gatherer livelihood must have started at the same time.

When we come to the genesis of the indigenous agroforestry system of the Gedeo and Sidama communities, we find no written document that provides an accurate time. Scholars (Paulina, 1974; Tadesse, 2002) estimate that the Neolithic period is generally thought to have occurred about 10,000 BC. During this period, humans learned to cultivate crops, keep domestic livestock and settle in permanent villages. Moreover, during the fieldwork period, our key informants also stated that parallel activities like domestication of animals and edible plants like enset were introduced when hunting and gathering began to decline.

The emergence and full-scale utilization of the agroforestry system helped the Gedeo and Sidama to produce surplus, and trade the agroforestry products with different communities such as the Arsi, Guji, Halaba, Wolayta, Konso, Borena, Hadiya, and the Kambata (MCllelan, 1988; Betena 1991; Taddese *et. al*., 2008). Originally, the mode of commodity exchange was bartering. Money was introduced to the communities in the late 19th century after they were incorporated into the Ethiopian empire.

3.2 The composition and management practices of the Gedeo and Sidama agroforestry system

The main characteristic feature of the Gedeo and Sidama agroforestry system is that it is a multi-species cultivation complex in nature and having multi-layered crop structures (King, 1989). We have mentioned earlier that the genesis of the Gedeo and Sidama agroforestry system is embedded in the identification and domestication of animals and plants. According to the key informants, '*enset*' is the first domesticated plant in the agroforestry system of Gedeo and Sidama. Coffee is the second most essential plant in the Gedeo and Sidama agroforestry system. Fruit bearing plants such as avocado, pineapple, banana, mango etc, and root crops such as yam also came into the agroforestry composition.

The introduction of agroforestry system and the subsequent domestication of plants shifted the livelihood strategy of the Gedeo and Sidama communities: from gather-hunters to settled agriculturalists. Enset guaranteed food security given its capacity to yield surplus in a small land (Tadesse, 2002). Coffee was originally grown for domestic consumption and small-scale exchange. At present, coffee produced in Gedeo and Sidama is one of the chief export commodities earning foreign currency for the federal government, and generating revenue for the Gedeo and Sidama administrations. Fruits and root crops are used for food diversity, and economic values in local and national markets.

The management practices of the Gedeo and Sidama indigenous agroforestry system fully depend on the indigenous knowledge that maintains the fertility of land, and sustains livelihoods, ecology and belief systems. In order to ensure the soil fertility, and sustain livelihoods, ecology and belief systems, there are various complementary types of the management practices of the Gedeo and Sidama agroforestry system. The first one is the ko'a practice. This practice

involves the digging of the soil to harvest rainwater, and, at the same time, protect soil erosion caused by flood. Key informants explained that this human intervention supports mulching- a natural process which protects the runoff of minerals from soil and erosion of upper fertile soil. '*Horehiribeesisa*' is another agroforestry management practice which involves allowing cattle, sheep, goats and other domestic animals to walk on tillage farms. The study participants explained that this practice is done because it is believed that the place or site trampled by the animals can hold rainwater and protect the runoff of fertile soil. The other agroforestry management practice is the '*worqa*' practice. This involves the mowing of unwanted grass, mainly when the coffee beans are ready for harvest. '*Qurqura*' is another practice. This involves the reduction and/or removal of many branches from large trees in overcrowded vegetations. Our study participants explained that this practice is conducted to allow middle and lower canopy trees and crops to get sunlight and free air. The '*followassa*' is another practice within the management of the Gedeo and Sidama agroforesty system. This agroforestry management practice involves the complete removal of crops or plants that refuse to grow, and affect the survival of other crops or plants in the system. According to the key informants, this practice gives the farmers the opportunity to learn the nature of compatibility between the nature of soil and the species of crops, plants and trees that the soil needs. Moona system is the practice of fertilizing infertile soil that is mostly practiced around the highland region of Gedeo and is not common in Sidama (Focus Group Discussions, Michele Holena kebele, Dilla Zuria district, 10 January 2021; Olticho kebele, Daara district, 15 January 2021).

3.3 Traditional values and belief systems and their association with agroforestry system

Gedeo and Sidama ancestral values and belief systems have a close connection with not only native trees/forests of agroforestry system but also with land, grass and water (Tadesse, 2002; Abiyot, 2013; Zerihun, 2014; Asebe *et. el*., 2017; In-depth interviews at Anidida and Oticho kebeles, 19 and 21 January 2021). The Gedeo and Sidama believe that maintaining harmony with their environment pleases the Creator (Mageno in Gedeo, and Magano in Sidama) who is source fertility, abundance, peace and health. They also believe that destroying the environment makes the Creator hold back rain, inflict death, cause diseases and famine upon people and animals (see Asebe *et. el*., 2017; Tesfatsion *et. el*., 2021). According to the key informants, any violation in the human-nature relationship requires performing ritual activities under the tree, in and around the river, mountain or forest. They added that the selection of the ritual site depends on the nature of the violation of the human-nature relationship. The Gedeo and Sidama believe that human beings as well as nature itself are creations of *Mageno/Magano*. The script of the belief interweaves humans into the fabric of nature, making the separation of human beings from nature impossible. This is vividly understood from the following expression:

'*dada duuchikaanna*'
father nature
'father to all nature'

In the expression, the Creator is perceived as father, and that nature entails human beings, vegetation, soil and terrain. Key informants expressed that any inappropriate nature and behavior between and among these components of nature make the Creator angry. They added that angering the Creator through violating the environmental harmony is not without consequences. He allows the land and human beings to experience unwanted phenomena. What is more, The Gedeo and Sidama elders state that the land is the mother, and clearing forests/trees from it is like "*removing clothing from a mother for rape*". (Focus Group Discussion, Michilegrisa and Dara, 13 and 15 January 2021, respectively).

Some grasses in the Gedeo and Sidama agroforestry system have social and spiritual values. For instance, when individuals or groups happen to fight in Sidama, community members who believe they are neutral to the fight hold a special type of grass in their hands and head to the fight site to let the fighting parties know that they are neutral, and the fight must stop immediately for the sake of peace. From the perspective of the fighting parties, the individuals holding grass in their hands are perceived as their ancestors. As a result, they are forced to stop the fight. Otherwise, the continuation of the fight after the arrival of the individuals carrying the grass in their hands carries with it the meaning 'fight with ancestors'. In Gedeo, when a family intends to slaughter a domestic animal, they have to first bring a grass called '*gorassanijo*' from the surrounding

forest, and tie it around the neck of the animal. The key informants added that doing this indicates that the family apologizes to the Creator as killing the life of the animal is eminent.

The Gedeo and Sidama perceive that trees give eternal life to human beings. Along this, the study participants explained this notion saying that starting from birth to death, human beings use trees for different socio-cultural, political, economic, ecological and religious purposes. They added that trees are perceived as life (Zerhun, 2014; Abiyot, 2013; Asebe *et. al*., 2017), and that the trees that grow on the burial sites represent dead people. This is, again, linked to the belief that "*there is life after death*". The Gedeo and Sidama believe that presence of a lot of trees is equivalent to having many children or escaping infertility. The key informants also expressed that both communities believe that tree is impartial and does not discriminate. That is why elders sit under big trees to deliberate on community issues such as solving conflicts, blessing members of the community, cursing diseases and evil acts, *etc*.

3.4 Driving forces of shifts in the indigenous agroforestry system

Change is inevitable. The Gedeo and Sidama indigenous agroforestry is no exception. The genesis of the Gedeo and Sidama agroforestry system itself is a result of change. The question now is what the forces behind the change and the impact of the change are. In what follows, we examine the driving forces of the shifts in the Gedeo and Sidama indigenous agroforestry, and the impact these forces present to the agroforestry, the human-nature relationship, and the very community.

3.4.1. Natural and demographic factors

Nature itself is in a constant state of change. The Gedeo and Sidama indigenous agroforestry is undergoing fundamental changes. Some of the changes are attributed to natural and demographic factors. Factors such as soil depletion (due to human activities), diseases and climate change show their impact on the Gedeo and Sidama indigenous agroforestry system (see Bantider, 2007). Because of changes in the weather conditions and climate, the Gedeo and Sidama farmers started to change their traditional mixed land use system to a mono-cropping land use system. Many key informants agree that because of the nature of topography and weather conditions, native plants and crops such as coffee, enset and trees are being replaced by such exotic trees and plants as eucalyptus and chat. Diseases such as '*koreera*', '*we'lo*' and '*xeta*' have spread around more than ever before. The former affects coffee while the latter two affect enset. The spread of '*koreera*' disease poses significant impact on the production of coffee: they damage its leaves and, consequently, its capacity to bear adequate and quality beans. Sometimes, the effect is extended to the dry up of the coffee tree. As mentioned above, *we'lo* and *xeta* are diseases that affect the production and productivity of the enset plant. The study participants were extremely concerned about the loss of coffee trees and enset plants saying:

The loss of these 'assets' that we inherited from our ancestors is suicidal but, then, because we should survive, we are being forced to plant crops and trees even if they are non-native to our land, and given some production.

The Gedeo and Sidama administrative areas are characterized by being densely populated. Put differently, the demographic change that is causing shifts in the Gedeo and Sidama agroforestry is the rapid increasing in the population size in both communities. The study participants explained that this factor is causing fragmentation of land. This shrinks in the land holding capacity per household makes the individual's plots of land unable to support the integration of different crops. This, the key informants added, results in food insecurity. Furthermore, the study participants explain that people are being reoriented to producing cash crops using mono-cropping system. What is worse, they explain, is that people are even forced to encroach into sacred spaces and community land holding (Focus Group Discussion, Dilla Zuria and Dara, 22 and 25 February 2021).

3.4.2. Decline of traditional social structure

During our fieldwork in Qawado and Amiba (5 and 7 February 2021), the participants of the Focus Group Discussion explained that the traditional social structure of both communities begins with family and extends to the community level. The social structures are governed by ethics, values, norms and regulations on socio-cultural, environmental and political issues (Abiyot, 20013; Asebe *et. al*., 2017; Tesfaye,

2019; Tesfatsion *et. al*., 2021). At the core of these issues are the ancestral values passed down from generation to generation through practices. Violations are regulated through social sanctions, and the community way of life was guided by social norms and principles.

However, now-a-days, due to contact with non-native ways of life, state structures, advocacy of individual rights, modernization, and expansion of urbanization, mainstream religions and modern schooling, a number of shifts in the social fabric and human-nature relationship are evident. According to the key informants, these factors have resulted in the degradation of traditional social cohesion, the decline in the functions of indigenous institutions such as 'textitSongo', the weakening of the culture of listening to the elders' advice, scrambling sacred spaces and forests, cutting down trees for the production of timber, house construction and charcoal making, etc. Overall, the effect of these factors is shown in the indentation of the traditional social structures. In what follows, we take these factors in detail.

3.4.3. Urbanization

Urbanization is expanding more than ever before in Ethiopia in general and in Gedeo and Sidama communities in particular. As is said earlier about modernization, the development and expansion of urbanization should be rooted in the local philosophies and values. The main resource in rural area is land and the natural resources therein. As urbanization expands without taking into account the preservation of the indigenous knowledge system, the consequences become obvious. Coupled with the very challenges in the rural areas, the economic opportunities in the urban areas attract people to migrate from the rural areas to the urban areas. The key informants expressed that, in addition to exposing children to child labour abuse, the expansion of urbanization creates irregular migration, decline of ancestral value-belief system, involvement in such activities as snatching, begging, burglary, textitetc.

3.4.4. Modernization

Modernization is undoubtedly important but only if it is rooted in the traditional values and evolves from there through natural growth. As it is now in the study area, the evolution of modernization began with weakening indigenous institutions. This fits into the observation made by Spencer (2010) who states that modernization is the process of replacement of local, traditional values and belief systems and practices. According to the key informants, any effect in the indigenous institutions has a direct impact on the community interaction within itself and with nature. In other words, the Gedeo and Sidama traditional belief system that supports the holistic composition of the agroforestry system is undergoing significant shifts.

Commercial transaction with money was introduced to the communities in the late 19^{th} century. As commodities kept exchange with money, bartering, the indigenous way of commodity exchange, began to give way. Money-mindedness gradually followed the use of currency for commodity exchange. According to the key informants, individualism is on the rise. They mention that, for instance, traditionally, requesting a relative or neighbor for materials and physical support cannot be declined (see Asebe *et. al*., 2017). What is more, access to transport and expansion of market centers exasperated the situation, and enhanced mono-cropping system. Currently, the introduction of telephone communication and mobile banking is reshaping business activities and human-nature dynamics (Focus Group Discussion, Michile and Olticho kebeles, 17 and 21 February 2021).

3.4.5. Mainstream religions

All human societies have religious philosophies and practices. The Gedeo and Sidama are no exception. Both communities believe in the existence of a supernatural force and Creator, 'textitMageno' (in Gedeo) and 'textitMagano' (in Sidama). The Creator is perceived as the source of all good provisions, and punisher of all evil acts. Giving thanks to the Creator is the responsibility of elders (Abiyot, 2013; Asebe *et. al*., 2017; Tesfaye, 2019). Their indigenous religions are based on their ancestral spirit, spirituality, culture and nature around them. That is why the traditional religious practices involve the use of native terrains, trees, crops *etc*.

However, the introduction of mainstream religions to the Gedeo and Sidama land in the late 19^{th} century

gradually started to reduce the number of traditional belief system followers. In the 1990s, the number of traditional belief system followers significantly dropped. Along this, Tadesse (2002: 27-28) has the following to report:

According [to] the Central Statistical Authority (1996a), today, 43.2 % of the Gedeo population is protestant Christian, i.e., largely followers of either of the two protestant churches, whereas followers of the original Gedeo religion make up 24.6% of the population. Orthodox Ethiopian Christians, Catholics Christians and Muslims comprise 22.1, 2.8, and 2.8% of the population, respectively. The latter three religions are predominantly professed in the towns. The majority of the rural population (more than 83% of the total) either follows the indigenous religion or is protestant Christian.

The expansion of the mainstream religions gradually began to adversely affect the indigenous ways of practicing it. The key informants reported that converts think that they are superior to nature. With this new mindset, the converts claim that they have the right to dominate nature. And as a result, they began to encroach into cemeteries and sacred sites. They added that the functions of the Songo institutions are being replaced by the religious institutions (see also Abiyot, 2013; Asebe *et. el*., 2017. Tesfatsion *et. el*., 2021).

3.4.6. Modern schooling

Education is crucial for cognitive development as well as societal transformation. To that end, the content and context of education is crucial. According to the study participants, institutionalized education was introduced to Gedeo and Sidama areas in the 1960s. This institutionalized education replaced the indigenous education process and content. The traditional education system is transferred from generation to generation through oral mechanism. The *Songo* is a primary traditional institution where elders narrate stories to children about the traditional perceptions and practices in the evening through storytelling. On the contrary, government education system requires a formal setting with deliberately structured content. This kind of content fragments the holistic understanding of the indigenous knowledge system. The concern of the key informants is that the government education does not incorporate indigenous norms, knowledge, ways of life and values. In this manner, it detaches children from indigenous ways of thinking and knowledge acquisition (see Asebe *et. el*., 2017). This concern is also supported by Shiva (2002) who explains that scientific knowledge ignores and marginalizes local knowledge and posits itself as universal while ignoring its local origins.

3.5 Adverse effects of the shifts in indigenous agroforestry system

The indigenous management practices, belief system, values and ethics of the Gedeo and Sidama peoples related to nature and its diverse components help them to preserve and conserve different species of trees, crops, plants and animals (domestic as well as wild) in a sustainable way. However, any change in this system that adversely affects its nature and composition dooms to being unable to support the vitality and sustainability of the indigenous agroforestry. In what follows, we briefly present the adverse effects of the shifts in the Gedeo and Sidama agroforestry system.

One of the adverse effects of the shifts in the Gedeo and Sidama indigenous agroforestry system is a growing trend of mono-cropping. On the other hand, there is a fast-growing population and shrink in the creation of job opportunities. As a result, the Gedeo and Sidama communities are facing food insecurity. The key informants mentioned that cash gained from cash crops is not enough to cover the increasing price of food to meet household food and nutrition requirements.

Because of the decline in using the indigenous strategies of maintaining soil fertility, the government imposes the use of chemical-based fertilizer upon farmers. As a result, the key informants assert, the soil refuses to give adequate product if the farmers are not supplied with the “modern fertilizer”.

The health benefits of the Gedeo and Sidama indigenous agroforestry system is also significantly endangered. In other words, the traditional medicine, produced by using indigenous practices from the products of the agroforestry, is accessible, affordable and friendly. However, the loss of plant diversity in the agroforestry, negative attitude towards traditional healing practitioners and practices, spike in

the 'modern drug' prices etc. are exposing so many families to being unable to afford their medications.

4 Conclusion

Various societies in the world are known for certain unique heritages. In this respect, the Gedeo and Sidama communities in southern Ethiopia are known for the indigenous agroforestry system. This indigenous agroforestry system is a comprehensive system that combines social, political, economic, ecological and spiritual aspects of both communities. However, since their incorporation into the Ethiopian state building project in the late 19th century, this indigenous agroforestry system has undergone various stages and forms of change. The leading factors that contributed to the dynamics and transformation in the Gedeo and Sidama agroforestry system include modernization, urbanization, spread of mainstream regions and modern schooling. Consequences include the weakening of the native social structures and institutions, rise of monetization (intensification of cash crops production), signs of food insecurity, introduction of exotic and socially unacceptable behaviors in the urban areas, degradation of conservation systems and people-environment relationships, etc.

The impacts of the eco-cultural shifts are enormous. However, it is not too late at all to reverse the negative impacts of the eco-cultural shifts. Our proposals include promoting employment, indigenous based innovation, and off-farm activities that improve livelihoods and sustain local knowledge, practices, and resources. Moreover, maintaining fair prices for farm products like coffee, honey, livestock, and vegetables is critical for long-term traditional agricultural inheritance systems. Furthermore, using indigenous structures and institutions, techniques, knowledge etc. as alternative forms of food production is crucial for policy makers and government bodies.

Acknowledgments

The authors thank the editors and anonymous reviewers of the journal for their insightful comments on earlier drafts of the manuscript. We would also like to express our gratitude to the informants who embraced the authors as members of their families and shared their knowledge.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Abiyot Legesse. (2013). *The Dynamics of Indigenous Knowledge Pertaining to Agroforestry Systems of Gedeo: Implications for Sustainability. The Dynamics of Gedeo Agroforestry and Its Implications to Sustainability*. PhD Dissertation., UNISA, South Africa.

Asebe Regassa, Legesse, A., Milstein, T., & Orkaydo, O. O. (2017). "*Tree is life*": The rising of Dualism and the Declining of Mutualism among the Gedeo of southern Ethiopia. *Frontiers in Communication*, 2(7):173-190.

Beyene Teklu Mellisse, Gerrie W.J. van de Ven, Ken Giller & Katrien Descheemaeker. (2018). Home garden system dynamics in Southern Ethiopia. *Agroforestry systems*. 92(1).

Gessesse Desei. (2008). *Khat expansion and forest decline in Wondo Genet, Ethiopia*. Pp. 1-10.

Gessesse Dessie. (2013). Favoring a demonized plant chat and Ethiopian smallholder enterprise. Nordic Africa Institute. *Current African Issues*. No 51. Uppsala.

Jules Pretty, Bill Adams, Fikret Berkes, Simone Ferreira de Athayde, Nigel Dudley, Eugene Hunn, Luisa Maffi, Kay Milton, David Rapport, Paul Robbins, Eleanor Sterling, Sue Stolton, Anna Tsing, Erin Vintinner & Sarah Pilgrim. (2009). The Intersections of Biological Diversity and Cultural Diversity: Towards Integration. *Conservation and Society*. 7(2): 100-112.

Miller, Robert P & Ramachandran Nair. (2006). Indigenous Agroforestry Systems in Amazonia: From Prehistory to Today. *Agroforestry systems*. 66)2):151-164.

Natalie A Jones, Sylvie Shaw, Helen Ross & Kathy Witt. (2016). The study of human values in understanding and managing social-ecological &ecological systems. *Ecology and Society*. 21(1): 1-10.

Tadesse Kippie. (2002). *Five thousand years of sustainability? A Case Study on Gedeo's Land Use*.

Netherlands: Treemail Publishers: Wageningen University.

Tesfatsion Petros Golle, Yetebarek Hizekeal Zekareas & Ongaye Oda Orkaydo. (2021). The practices and dynamics of Baalle, an indigenous governance system of Gedeo (South Ethiopia). *Kervan-International Journal of African and Asiatic Studies*. 25(2).

Tesfaye Abebe. (2005). *Diversity in home garden agroforestry systems of Southern Ethiopia*. PhD Dissertation. Wageningen University.

Tesfaye Abebe. (2013). Determinants of crop diversity and composition in Enet-coffee home gardens of southern Ethiopia. *J Agr Rural Dev Trop Subtrop.* 114(1):29–38.

Tesfaye Abebe. (2019). Land-use changes in the enset-based agroforestry systems of Sidama, southern Ethiopia, and its implications for agricultural sustainability. Ethiopian Journal of Biological Sciences.

Zerihun Doda. (2014). *Dagucho [Podocarpus falcatus] Is Abbo! 'Wonsho Sacred Sites, Sidama Ethiopia: Origins, Maintenance Motives, Consequences and Conservation Threats*. Kent: University of Kent.

Author's Information

1. Abera Eyasu Gedecho did his master's degree in Indigenous Studies from the Institute of Indigenous Studies at Dilla University. Currently, he is a full time researcher in the Institute of Indigenous Studies. He also offers undergraduate courses in the Department of Social Anthropology. He can be contacted at aberaeyasu2011@gmail.com.

2. Yetebarek Hizekeal Zekareas is an Assistant Professor of Social Works, and a researcher in the Institute of Indigenous Studies at Dilla University, Ethiopia. He offered courses in the Department of Sociology at Dilla University, and has (co-)published articles in reputable journals. He also participated in several national and international research conferences. Currently, he is a Ph.D candidate in the Department of Applied Social Science (APSS) at the Hong Kong Polytechnic University (Hong Kong). His research interests include, but not limited to, Africa-China relations, cultural contact and dynamics, cross-border socio-economic relations, and state-society relations. He can be reached at: yetebarek-h.zekareas@connect.polyu.hk.

3. Ongaye Oda Orkaydo is an Associate Professor of Linguistics at Dilla University, Ethiopia. He received his PhD in Linguistics from the University of Leiden in 2013. Currently, he is a researcher in the Institute of Indigenous Studies (IIS) at Dilla University. He has national and international teaching experiences in linguistics. He has written grammars of Konso (2013), K'abeena (2014), Silt'e (2018), Hoor (Arbore) (2021), and (co-)published several articles in reputable international journals, and in conference proceedings. His research interests include grammar writing dictionary making, mother tongue education (planning, implementation and evaluation), language and nature, indigenous conflict resolution mechanism, cross-border trade, regional economic integration, and organizational performance. He was a visiting fellow at the University of Turin, 2016, and at the African Studies Centre, The Netherlands, 2018. He is a member of the scientific board of Kervan. He can be reached at: ongayeoda@yahoo.com.

4. Abiyot Legesse Kura is an Associate Professor of Geography and Land Resources Management at Dilla University. He is one of the senior researchers and a chief editor of the Ethiopian Journal of Environment and development hosted by Dilla University. The email address to contact him is abiyottura@gmail.com.

EJED 2022 4(2):68–81
Ethiopian Journal of Environment and Development
http://www.du.edu.et/duj
E J E D

Land Use Land Cover Change within Kessem watershed, Central Rift Valley of Ethiopia: The Case of Minijar-Shenkora Woreda

Eshetu Teklu[*1] **and Dubale Dagne**[2]

[1] *Department of Geography and Environmental studies, Dilla University, Ethiopia*
[2] *Department of History, Dilla University, Ethiopia*
[*] *Corresponding author, Email: abcdeshetu2019@gmail.com; P.O.Box. 419, Dilla, Ethiopia*

Received: 30th September 2021 *Accepted: 06th June 2022*

DOI: **10.20372/ejed.v04i2.05**

Abstract

Land-use land covers are not static rather they are dynamic in response to various driving forces. The main objective of this study was to assess land use land cover changes of Minjar-Shenkora Woreda during the three decades (1987–2017). Three different Landsat satellite data sets (Landsat 5 TM, 7 ETM+ and 8 OLI-TIRS) of 1987, 2003 and 2017 were used from the United States Geological Survey (USGS), respectively. The data were processed, and the land use land cover classes were also identified using ERDAS Imagine (ver. 2014) and Arc GIS (Ver.10.3). The study revealed that forest and shrub lands have diminished from 32885 hectaresto 16034 hectaresand 61939 hectaresto 32530 hectares, respectively while agriculture and bare lands have increased from 52524 hectaresto 90859 hectaresand 3018 hectares to7441 hectares, respectively. Moreover, built up areas also have encroached farm lands and bush lands. Over utilization of wood for fuel and construction materials, human induced fire and uncontrolled grazing, population and socio-economic changes are the main causes of the land use land cover changes. On the other hand, people's livelihood vulnerabilities and degradation are the main outcomes of the land use land cover changes. Thus, the concerned bodies of the Woreda along with the communities should discuss and formulate law that can help to protect and preserve natural vegetation, expansion of farm lands to marginal lands as well as prevent invading of farmlands by urban horizontal expansion.

Keywords/Phrases: Land use/land cover classes, land use land cover change, Landsat satellite image, Marginal land and urban horizontal expansion

1 Introduction

Land is the fundamental resource for housing, food production and infrastructure development. It provides substantial economic and social benefits. Land use land cover change is necessary and essential for economic development and social progress. However, it does not come without costs. Conversion of farmland and forests to urban built-up areas, for example, reduces open space, amount of land available for food and timber production (Wu, 2008). That means land use land cover changes are practices and strategies for using natural resources. From the time when humans have controlled fire and domesticated plants and animals, they have cut and cleared forests to meet their basic needs. Deforestation, horticulture expansion and increasing of built-up areas are putting tremendous pressure on the forest resources. Agriculture land has expanded into forests, savannas, and steppes in all parts of the world to meet food and fiber demands. Historically, humans have increased agricultural output mainly through (extensification) by converting woodlands, shrub lands and forests into agriculture lands (Lambin *et al.*, 2003).

Land use land cover changes are root cause for local, national, regional and global level of environmental changes, which can in turn, global cli-

matic change. Desertification, acidification, climate change, sea-level rise, greenhouse effect and biodiversity loss are some major environmental problems resulted from land use land cover changes (Briassoulis, 2000). These environmental problems have significant impacts on food security, human vulnerability, health and safety and even on the viability of the earth. However, the most important thing is that, with few exceptions, it is human practices and not nature which has brought these changes. Deforestation, expansion of urban areas and agricultural lands, and other human activities have substantially changed the Earth's landscape. Such disturbance of the land affects ecosystem processes and services which can have wide–ranging and long–term consequences. Land use and land management practices have an important impact on natural resources including water, soil, air, nutrients, plants, and animals (Wu, 2008). Agricultural expansion, wood extraction, infrastructure expansion and other human activities are causes for the change of the physical state of land use land cover (Geist & Lambin, 2001). Urbanization, expansion of built up areas, expansion of agricultural lands, political as well as socio-cultural factors are also driving forces for land use land cover changes (Haroon & Mohdi, 2012).

Socio-economic changes, technological advancement, demographic changes, political factors like state policies and practices are forces which have created pressure on natural resources such as land, forest and water. In Ethiopia, land use land cover patterns experience drastic change: severe loss of woodlands, grasslands, wetlands and substantial increases farmland and built-up lands (Efrem, 2010; Kefyalew *et al*., 2015). Assessment of land use land cover changes in South Central Ethiopia displayed that the last forty years was a period of agricultural expansion at the expense of forest, woodland, and grassland (Kefyalew *et al*., 2015). On the other hand, rural-urban built-up developments have expended significant amounts of farmland, grassland, woodlands and wetlands (Hualou *et al*., 2008). The expansions of urban and rural settlements have occurred mainly at the expense of farmlands, woodlands and grasslands. Urban-rural built-up area expansion causes for diminishing of agricultural lands. The conversion of agricultural lands to built-up areas occurred mostly at the urban peripheries. With urban horizontal expansion farm households who reside at the fringe of a town have been enforced to miss their farm lands and being relocated to new areas where agricultural lands are available or to change their livelihoods (Gerald & Olufunke, 2011). Hence, the land use/land cover changes have relation with people's livelihood.

Population pressure, declining household farm size, declining household income, deterioration of the remnant forest and worsening land degradation are the major problems prevalent in Kessem watershed, particularly Minjar-Shenkora Woreda. Moreover, the lack of fodder, scarcity of wood for various purpose, loss of forest resources, loss of biodiversity and decline of soil fertility and farm produce related to environmental degradation are prevailing in the study area. Lack of livelihood security has forced farmers to use shrub lands, grasslands, grazing lands for farmlands to cope with recurrent household shocks. Moreover, the rapid urban horizontal expansions due to the rise of population and economic growth have caused the conversion of farm land to built-up areas.

The key fundamentals for the better use of land are acquisition of information on existing land use land cover patterns and change through time. Having information about the present distribution land use land cover proportions and change is required for legislators, planners, state and local government officials for land use policy, for identifying future pressure areas and to predict future demands. However, there is lack of reliable and accurate information about land use land cover change in Ethiopia in general and in my study area in particular. Thus, the main objective of this study is to assess land use land cover changes during the past 30 years (1987 to 2017) within Minjar-Shenkora Woreda.

Therefore, the specific objectives of the study are to:

- generate the patterns of land use land covers of the study area of 1987, 2003 and 2017
- compare the current and the previous land use land covers of the study area
- find out the causes of land use land cover changes of the study area
- identify the impacts of land use land coverc hanges within the study area

2 Materials and Methods

2.1 Location of the Study Area

The study was conducted within Amhara Region, North-Shoa Zone particularly Minjar-Shenkora Woreda. The study area includes urban and rural settlements, farmlands, forests, shrub lands, rivers and road infrastructure. Minjar-Shenkora Woreda borders with the Woreda of Hugeremariam to the north, Boset and Adama Woredas to the south, Fentale Woereda to the east, Ginbichu and Lume Woredas to the west and Berehet Woreda to the northeast. Almost half of its area is situated in the floor and escarpment of the rift valley. Plain and undulating terrain are the dominant topography in the Woreda, which accounts 84%, and 14%, respectively and the rest 2% is mountainous landscape. The total area of the Woreda is about 150993 hectares (1510 square kilometers). Nearly 25%, 70% and 5% of the landscape of the Woreda is classified under Qolla, Woinadega and Dega agro-ecological zones, respectively see figure 1. Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), the Woreda has a total population of 128,879, of whom 66,918 are men and 61,961 women; 12,237 or 9.49

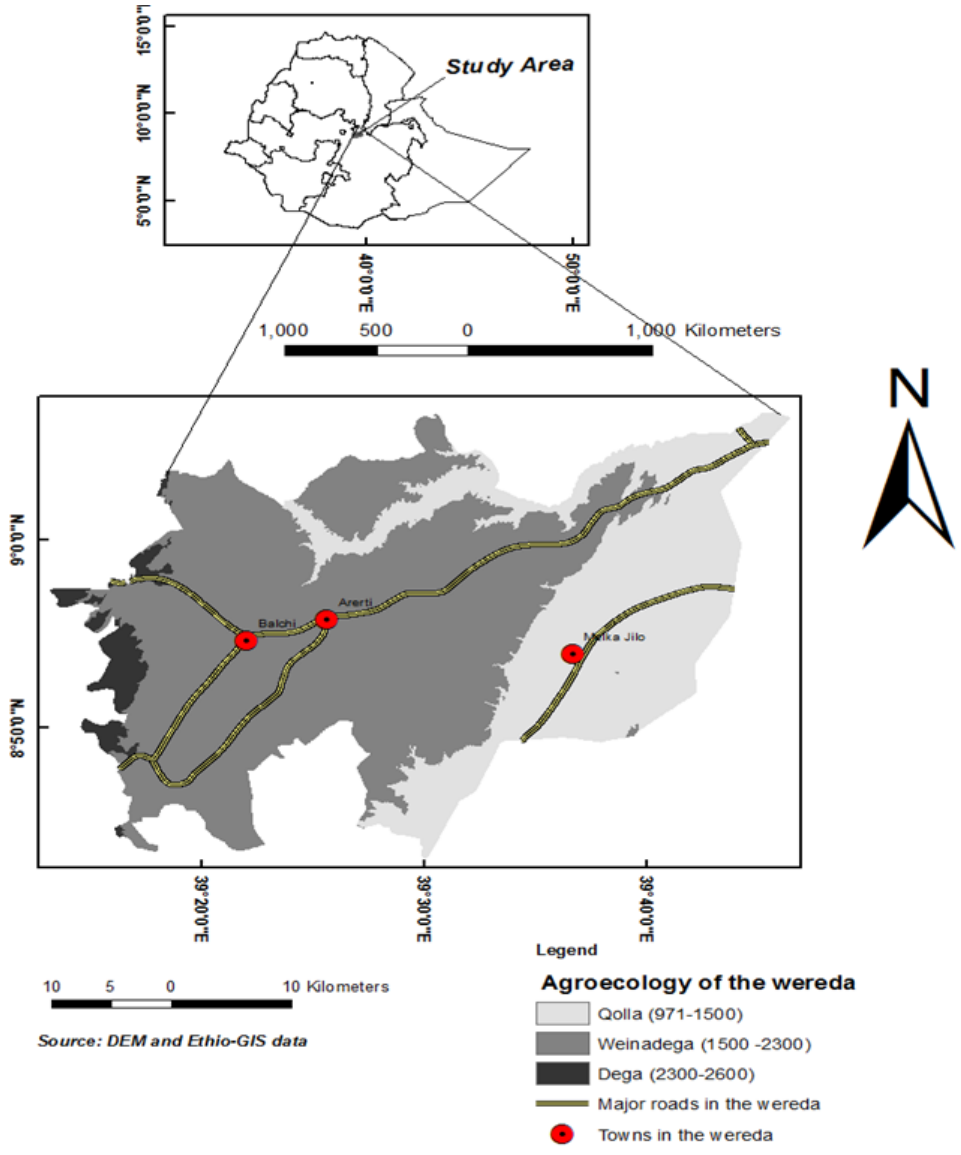


Figure 1. Map of the study area

Agriculture, trade and government employment are the most common economic activity of the rural and urban population, respectively. Mixed farming (both crop production and animal rearing) is dominant rural economic activities. The Woreda is well-known with its grain crop production particularly with *Teff* production. Crop production throughout the Woreda is entirely depended upon rain. The Woreda has a high potential in the production of cereal crops such as *Teff*, wheat, sorghum, chick pea and pea are (Minjar-Shenkora Woreda Agricultural Office, 2017). It also rich in various types of livestock resources such as cattle, goat, sheep, pack animals, camel and poultry.

The Woreda's Capital Arerti Town has interaction with its hinterlands with road transport network which facilitates rural-urban flow of people, goods, information and services. The developments of asphalt, gravel, and dry weather road networks are important to integrate rural and urban areas. Of course, this interaction can have impact on land use land cover change since it promotes supplying agricultural output and forest products to the markets through exploiting natural resources.

2.2 Data Sources

The study follows both quantitative and qualitative approaches and these enable researchers to explore the problem adequately. Thus, the study used both quantitative and qualitative data. The study used widely and freely available Landsat images of the study area having 30m resolution. The study used Landsat TM and ETM+ satellite images of 1987, 2003 and 2017 from the United States Geological Survey (USGS) website as main sources of data. These remotely sensed images are processed and used to detect land use/land cover changes in the study area. The study used images which are taken during the winter season when little or no cereal crops and cloud cover. Landsat satellite images and their characteristics have been presented and summarized in Table 1 below.

Table 1. Satellite Images/Data/ Used in the Study

Sensor type	Path-Row	Spatial resolution	Spectral resolution	Date of acquisition
Landsat (TM) 5	168-054	30*30	8 bands	1987/02/09
Landsat (ETM+)7	168-054	30*30	8 bands	2003/01/12
Landsat (OLI_TIRS)8	168-054	30*30	11 bands	2017/01/26
Google Earth	1987- 2017			
Topographic map (Toposheet)				
Ground observation	2017			

In addition, the study also used ancillary data obtained from primary sources with interview, FGD and secondary data obtained from published and unpublished sources.

2.3 Data Acquisition Methods

The first task in collection of data for the study was the acquisition of images. The study used 1987, 2003 and 2017 Landsat satellite images of Minjar-Shenkora district. These Multi temporal Landsat images are downloaded freely from Earth explorer web server. Multi-temporal data is useful to examine land use/land cover changes since it provides multi dated land cover information. Therefore, the study used Landsat images of 1987, 2003 and 2017 to detect the land use land cover changes during the three decades in the study area.

The study used ERDAS IMAGINE 2014 and Arc GIS 10.3Softwares to process the data and to produce map. The study used ERDAS IMAGINE 2014 software for image processing, enhancement, classification and post classification processes (matrix union and recode). The study also used Arc GIS 10.3 to analysis land-use and land cover data and to produce map. Moreover, the study used Microsoft Word for the final presentation of research output.

Data is also collected for the study using interviews

and focus group discussions. To assess causes and impacts of land use land cover change during the three decades (1987-2017), the study takes three sites from the Woreda (Arerti-zuria kebele, Sekawachona-Dodota and Erarate kebele and (Dire and Amora bet kebeles). The three sites are selected where land use land cover changes are really prevailed. Hence, the study uses purposive sampling for selecting specific sites for focus group discussion and interview. To select participants of the focus group discussion and interview, snow-ball sampling techniques were employed to get participants having better information about land use/land cover change in the study area. The study used 5 focus group discussions (one FGD in each rural kebele) in which 5-8 people were included in each FGD and the participants were selected based on their age and experiences.

Interviews are conducted with the key informants on land use and land covers conditions in the study area. Hence, semi-structured interviews were conducted with local elders and Woreda officials working in various sectors like agriculture, urban planning, and natural resources about causes and impacts of land use land cover changes. Thus, the study used data acquired from remote sensing, Google earth and from people reside in the study area. Moreover, the study used socio-economic data from CSA.

2.4 Digital Image Processing

Band stacking
Once the data in the format geo-tiff is imported and changed into image in ERDAS IMAGINE 2014, band stacking is performed. Band stacking is the process of combing the spectral layers to get a multispectral image. It ties up the spectral layers to comprise an image. The process of band stacking is executed using ERDAS IMAGINE 2014.

Image Enhancement
Remotely sensed images contain noise which makes the image difficult to interpret. Image enhancement is a means which increases the visual distinctions between the features in an image. Objective of image enhancement is to make new image from original image which give more information. This task is performed using image enhancement utility of ERDAS IMAGINE 2014 for all the images 1987, 2003 and 2017 of the study area.

Sub Setting
Sub setting utility is a useful mechanism of extracting area of interest from a large dataset. In case of Minjar-Shenkora Woreda, Landsat satellite one scene preserve an area of 185 km with 185 km, which is relatively larger than our area of interest. Sub setting utility in ERDAS IMAGINE 2014 was executed to get image of Minjar-Shenkora Woreda from a large image dataset of 185 km with 185 km.

Image Classification
Remotely sensed images can be digitally classified through Supervised or Unsupervised approaches. Supervised classification algorithm is used to classify each of the three Landsat images. Various land use land cover classes are identified from the 1987, 2003 and 2017 images. A field visit, topo sheet, Google earth were used as a guide for identifying land cover features of the 1987, 2003 and 2017 images during classifications. Finally, five land use/ land cover classes are identified from 1987 and 2003 Landsat images such as agricultural land, barren land/soil, shrub land, forest and Kessem river (water). At the same time six land use/ land cover classes are identified from the Landsat image of 2017 such as agricultural land, barren land/soil, shrub land, forest, Kessem river (water) and built up area. The study adapts Fish (2007) land use/land cover classification scheme.

2.5 Detection of Land Use /Land Covers Changes

Geospatial technologies have provided essential tools which can be applied in the analysis of land use land cover changes. Time series land use land cover data obtained from digital image processing and classification of 1987, 2003 and 2017 were integrated in GIS data structure and were analyzed. Finally land use land cover change detection was undertaken using area changes of each land use land cover during the three decades.

3 Results and Discussions

3.1 Land use/Land Covers Classes

The major land use/land cover classes of 1987 include forest, bare land, agriculture, bush /shrub lands/ and water. As indicated in the Table 2 the

greatest share of land use/land cover from all classified land use/land cover is bush/shrub lands, which covers an area of 61938.73 hectares (40.97%). Agriculture lands and forest lands cover areal size of 52523.48 hectares (34.7%) and 32884.75 hectares (21.8%), respectively. The least areal coverage is covered by water, which has only 810.68 hectares (0.54%) from the total size of the Woreda. Moreover, the land use/land cover classes of 2003 include forest, bare land, agriculture, bush /shrub lands/ and water. From the land use land cover classes of 2003, agriculture land is the greatest share from all classified land use land cover classes which covers an area of 71665.60 hectares (47.4%). Bush/shrub lands and forest lands cover areal size of 52480.73 hectares (34.72%) and 23029.97 hectares (15.23%), respectively. The least areal coverage still covered by water, which has only 746.44 hectares (0.49%) from the total size of the Woreda.

Furthermore, the land use/land cover classes of 2017 include forest, bare land, agriculture, bush /shrub lands/, water and built-up area. From the land use land cover classes of 2017, agriculture land is the greatest share from all classified land use land cover classes which covers an area of 90859.34 hectares (60.10%) from the total size of the Woreda. Bush/shrub lands and forest lands cover areal size of 32529.53 hectares (21.52%) and 16033.48 hectares (10.60%), respectively. The least areal coverage still covered by water, which has only 1240.85 hectares (0.82%) from the total size of the Woreda. Figure 2, here below depicts the land use land cover classes of the 1987, 2003 and 2017 of the study area (see figure 2).

From 1987 output map, it is noticed that about 40.97%, 34.7% and 21.8% of the land use land covers were bush/shrub lands, agriculture lands and forest lands, respectively. This implies that more than 60% of the Woreda's land use land covers during 1987 were bush lands and forest lands. During the time, agricultural land use land cover size was less than bush /shrub lands. In 2003, the proportion of land use land cover of the 1987 is changed as agriculture 47.4%, bush land 34.72% and forest 15.23%. In 2003, agriculture occupies the greatest land use land cover proportion. On the other hand, the land use/land cover proportions of 2017 were agriculture 60.1%, bush lands 21.52%, forest 10.6%, bare land 4.92% and built up 2.03%.

Built up area land use land covers which was not evident in the land use land cover map of 1987 and 2003 appeared on the map of 2017. This is the indication for the growth and the expansion of built-up areas or settlements from 1987 to 2017 in the study area. These different land use land cover of the study area showed vivid change from 1987 to 2017. It is noticed that the size of agricultural lands, bare lands, built up lands have displayed increment while the size of forest land and bush/shrub lands are diminished significantly in the past three decade (1987 to 2017). Table 2 depicts statistics of multi-temporary image classification of 1987, 2003 and 2017.

Table 2. LUC classe's statistics in 1987, 2003 and 2017 in the Woreda

Land use/ cover class	Area in 1987 (Ha)	Percent (%)	Area in 2003 (Ha)	Percent (%)	Area in 2017 (Ha)	Percent (%)
Bush/shrub land	61938.73	40.97	52480.73	34.72	32529.53	21.52
Agriculture	52523.48	34.7	71665.60	47.4	90859.34	60.10
Forest	32884.75	21.8	23029.97	15.23	16033.48	10.60
Bare land	3017.32	1.99	3252.22	2.15	7441.27	4.92
Water/kessem River	810.68	0.54	746.44	0.49	1240.85	0.82
Built up	-	-	-	-	3070.49	2.03
Total	151174.96	99.99	151174.96	99.99	151174.96	99.99

Source: Landsat image of 1987, 2003 and 2017

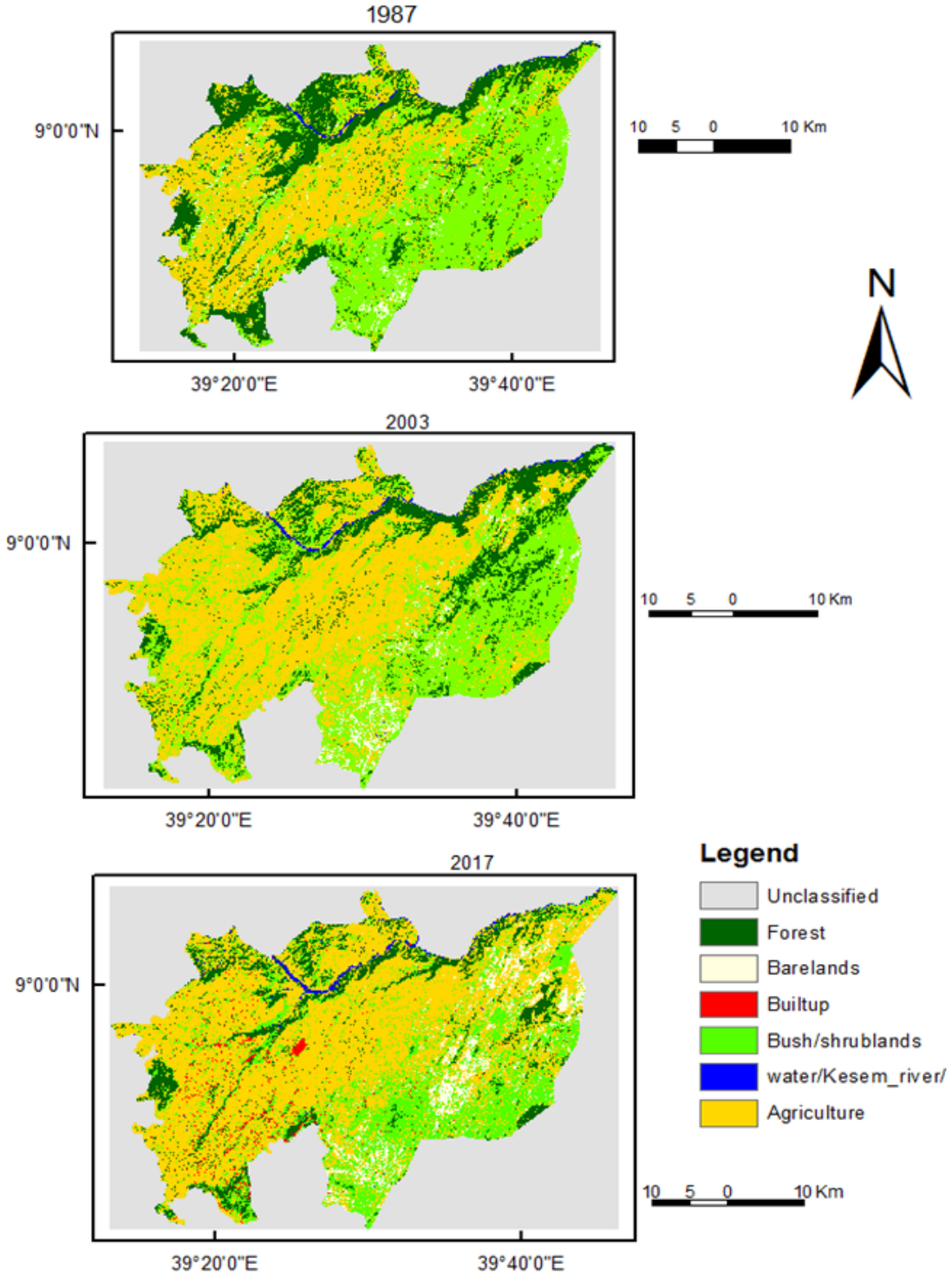


Figure 2. Land use Land cover classes in 1987, 2003 and 2017. (Source: Landsat image of 1987, 2003 and 2017)

3.2 Land Use/ Land Cover Change

Land Use/ Land Cover change (LUCC) simply means (quantitative) changes in the areal extent (increment or decrement) of a given type of land use or land cover, respectively. But in the analysis of land use land cover change, it is crucial to conceptualize the meaning of change to notice it in real world situations. Conversion and modification types of land use land cover changes are documented on the existed literature (Briassoulis, 2000). Conversion involves

a complete replacement of one land use land cover by another while modification involves change of structure or function without a wholesale change from one type to another; it could involve changes in productivity and biomass.

The land use land cover changes of the study Woreda are examined and identified as follow from 1987 to 2017. Through the process of image classification, matrix union and recode, the different land use land cover changes are identified. Land use land cover classes such as agriculture, forest, shrub lands, bare lands, water (Kessem River) and built up areas have displayed significant changes during the three decades. From 1987 to 2003 agricultural land use increased from 52523.48 hectares to 71665.6 hectares. That means agricultural lands augmented by 19142.12 hectares (36.4%) within the specified time. Moreover, bare lands also have increased from 3017.32 hectares to 3252.22 hectares during 1987 to 2003. It means bare lands amplified by 234.9 hectares (7.8%) during the specified time. On the other hand, the sizes of forest and shrub land use land covers diminished by 9854.78 hectares (42.8%) and 9458 hectares (18.02%) from 1987 to 2003, respectively. The least land use land cover change is observed by water/Kessem River, which loss only 64.24 hectares (8.6%) from the total size of 810.68hectares. The reasons for the prevailed land use land cover changes can be population growth, economic change and the improvement of the life of the people. When population size increases, the demands of agricultural lands will rise along with demands of food crops. When the demands of food crops increase, crops producers tend to be encouraged to produce more food crops by increasing the size of their farmlands by clearing forests, shrubs since at the time crops production growth was mainly depend upon farmland extensification rather than intensification. Table 3 depicts area gain vs. loss in land use land cover classes from 1987 to 2003.

Table 3. Area gain vs. loss under land use/land cover classes from 1987 to 2003

Land use/cover class	Area in (Ha) 1987	Area in (Ha) 2003	Gain in Ha (%)	Loss in Ha (%)
Forest	32884.75	23029.97	-	9854.78 (42.8)
Bare land	3017.32	3252.22	234.9 (7.8)	-
Agriculture	52523.48	71665.60	19142.12 (36.4)	-
Bush/shrub land	61938.73	52480.73	-	9458 (18.02)
Water/Kessem River	810.68	746.44	-	64.24 (8.6)
Total	151174.96	151174.96	-	-

Source: Landsat image of 1987 & 2003

Apart from land use/ land cover change from 1987 to 2003; the study also examined land use land cover change of the Woreda from 2003 to 2017. As shown on Table4, from 2003 to 2017 agriculture land increased from 71665.6 hectares to 90859.34 hectares. It implies 19193.74 hectares of forest and bush/shrub lands are converted into agricultural lands. Moreover, bare land also has increased by 4189.05 hectares from 3252.22 hectares to 7441.27 hectares. On the other hand, built up area land use land cover emerged on the map of 2017 which was invisible on the map of 2003. Even if, the type of sensor could be important for the invisibility and visibility of built up area 2003 and 2017, respectively, the size of built up area can also play important role for its visibility on Landsat images. This indicates the growth and expansion of Arerti Town which is the capital Town of the Woreda today.

On the other hand, forest lands have decreased from 23029.97 hectares to 16033.48 hectares while bush/shrub lands have declined from 52480.73 hectares to 32529.53 hectares during the specified time. That means the former decreases by 6996.49 hectares (43.6%) while the later decreases by 19951.2 hectares (61.3%). It implies the amount of shrub lands which is converted into other land use land covers is higher than forest lands.

Table 4. Area gain vs. loss under land use/land cover classes from 2003 to 2017

Land use/land cover classes	Area in (Ha) 2003	Area in (Ha) 2017	Gain in Ha (%)	Loss in Ha (%)
Forest	23029.97	16033.48	-	6996.49 (43.6)
Bare land	3252.22	7441.27	4189.05 (128.8)	-
Agriculture	71665.60	90859.34	19193.74 (26.8)	-
Bush/shrub land	52480.73	32529.53	-	19951.2 (61.3)
Kessem river	746.44	1240.85	494.41 (66.2)	-
Built up	-	3070.49	3070 (100)	
Total	151174.96	151174.96		

Source: Landsat image of 2003 and 2017

The study also has shown a dramatic change of land use/ land cover during the three decades (1987 to 2017). During the past 30 years agriculture land use land covers gained or increased by 38335.81 hectares (72.98%). Moreover, bare land and built-up land use land cover also augmented by 4423.95 hectares (146.62%) and 3070 hectares (100%), respectively. In contrast, forest and shrub land use land cover lost or declined by 16851.3hectares (105.1%) and 29409.2 hectares (90.41%), respectively (see table 5 and figure 3).

Table 5. Area gain vs. loss under land use/land cover classes from 1987 to 2017

Land use/land cover classes	Area in (ha) 1987	Area in (ha) 2017	Gain in ha (%)	Loss in ha (%)
Forest	32884.75	16033.48	-	16851.27 (105.1)
Bare land	3017.32	7441.27	4423.95 (146.62)	-
Agriculture	52523.48	90859.34	38335.81 (72.98)	-
Bush/shrub land	61938.73	32529.53	-	29409.2 (90.41)
Kessem River	810.68	1240.85	430.17 (53.06)	-
Built up	-	3070.49	3070 (100)	-
Total	151174.96	151174.96		

Source: Landsat image of 1987 and 2017

Apart from Table 4, Figure 2 has also displayed the land use land cover changes of the study area during 1987 to 2017. The land use land covers such forest land, shrub land, agriculture land and kesem river course are observed on figure 3A while agriculture, shrub lands, bare lands, forest, built-up land and kesem river course are observed on figure 3B. When Figure 3A is compared with Figure 3B, it can be noticed that forest and shrub lands have decreased while agriculture lands, bare lands and built-up land have increased from 1987 to 2017. As the legend of the Figure 3C to Figure 3H depict, blue color indicates gained, red color specifies loss, cyncolor indicates no change and white color shows other land uses. As shown on Figure 3C and Figure 3G agriculture and bare landuse land cover have gained (increased), respectively while on Figure 3D and Figure 3E shrub land and forest land loss (reduced), respectively during the period 1987 to 2017 (see the figures).

Figure 3 shows the reduction of forest and shrub lands as well as the augmentation of agriculture and bare lands from 1987 to 2017. It has also shown the expansion of built up area and Kesem river course during the same period. Thus, land use land covers such as agriculture land, built up area, bare land and Kesem river course gained or increased while forest and shrub lands lost or diminished during the three decades in the study area. The augmentation of agriculture land use land cover in the study area: it was mainly at the expense of forest land and shrub/bush

lands. Based on the survey conducted, the community Association leaders point out that the agricultural activity has been increasing during recent periods due to population increment and the rise of the price of food crops in the study area. Moreover, they said that the inhabitants are forced by poverty to involve in cutting and clearing forests resources to get income to sustain their lives.

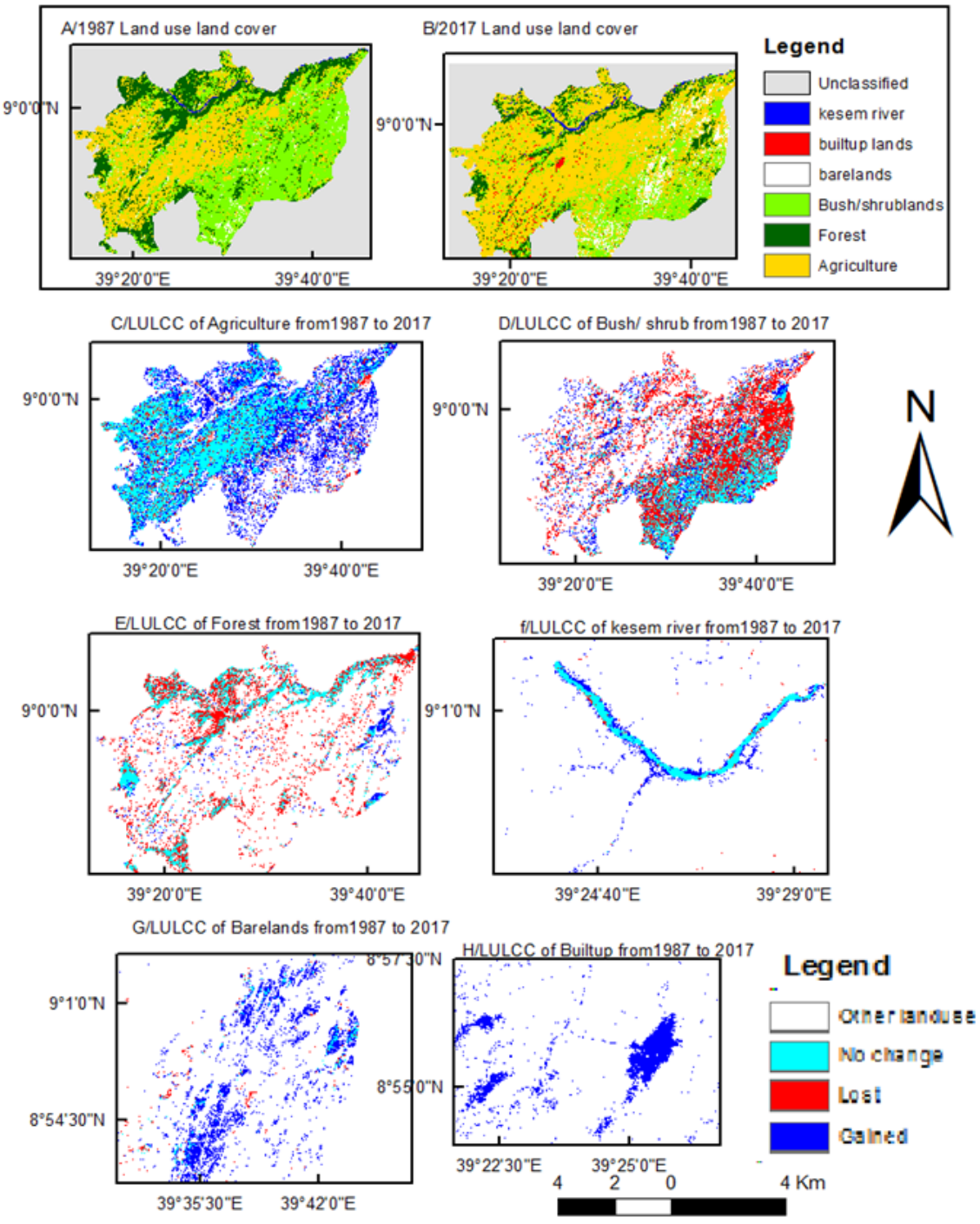


Figure 3. land use land cover change from 1987 to 2017 (Source: Landsat image of 1987and 2017)

3.3 Causes and Consequences of Land Use/ Land Cover Change

Land-use land covers are not static rather they are dynamic in response to various driving forces. Land-use land covers are influenced by multiple interacting factors operating at the different spatial scales of human environment systems. These driving forces of land-use land cover change are classified into two main categories: bio-physical and socio-economic drivers (Turner *et al*., 1994). The bio-physical drivers include characteristics and processes of the natural environment such as weather and climatic variations, landform, topography, and geomorphic processes, volcanic eruptions, plant succession, soil types and processes, drainage patterns and availability of natural resources. The socio-economic factor, on the other hand, comprises demographic, social, economic, political and institutional factors and processes. Hence, population change, industrial structure and change, technology and technological change, family, market, the various public sectors and the related policies and rules, values, community organization and norms are the socio-economic driving forces of land use land cover changes.

The observed land use land cover changes in the study area are the result of the expansion of agricultural land, bare land and built-up areas at the expense of forest and shrub lands. The study has identified major driving factors for land use land cover changes in the study area during the three decades. The data acquired through interviews and FGD have revealed that manifold factors contributed for the land use land cover changes of the study area. In fact, the findings of the study are consistent with the driving factors of LUCC which are identified from secondary sources. Based on the interviews and FGD conducted with community associations' leaders, the rising of rural population size resulting from higher fertility with low mortality, decreasing of infectious disease and malaria is one important cause for the prevailing land use land cover changes in the study area.

The rises of population size have created additional demands of agricultural and residential lands and these lead to cutting and clearing forest and shrub lands and change to farmland and residential land use land covers. The other causes of land use land cover changes are economic and technological growth, improvement of transportation facilities and accessibilities, increasing of standard of living, and improvement of market accessibilities also have played important role for the expansion of farm lands as well as the destruction of forests and shrub lands. When people's income increases, their demands of different basic items also increases. This condition makes people to exploit the nearby natural resources with maximum effort to get more money to satisfy their needs. Moreover, unwise use of forest resource for source of income, construction and housing tools, wood and coal for cooking in rural and urban areas along with absence of keeping and protecting forest from informal cutting and destruction are causes for the depletion of forest and shrub lands.

Climate change and drought are also the other factors for cutting and devastation of forest and shrub resource due to rural livelihood deprivation. During such seasons a large amount of forest and shrubs are devastated with informal cutting and fire to get agricultural lands, grazing lands and honey. The absence of forest owner/ public owner and lack of people's awareness of the impact of the depletion of forest resources are reasons for destruction of these shrubs and forest resources by informal cutting and fire. People's low tradition of planting and protecting trees also contributed for the destruction of forest and shrubs of the study areas. Moreover, livestock rearing like goat, ox, cow, sheep and camel on the same grazing land for long period also aggravated environmental degradation and land use land cover changes of the study area. On the other hand, rural-urban settlement expansion, establishment and expansion of infrastructure consumed a significant amount of farm lands, forest lands, shrub lands and therefore caused for land use land cover changes.

The impacts of land use land cover changes have increasingly thought from significant to threatening extent. Conversions of farm land into rural-urban settlement (built up area) have reduced farmlands necessary for the economic survival of local agricultural economies. This affects the livelihoods of individuals and the ways in which they are organized. This may lead to invading of new shrub and forest lands for farmlands. The change of forest, shrub and grazing land into farm land have caused for soil

erosion, flooding and land degradation. Furthermore, loss of biodiversity, scarcity of livestock fodder, soil erosion and environmental deterioration are largely outcome of land use land cover change. The land use land cover changes in the study area are articulated by loss of biodiversity both plants and animals on the one hand, widespread of crop pests, insects and disease on the other.

For example: wild animals such as impala (Dikula), Deer (Agazen), Tigire (Nebir), Wart hog (Kerkero), Hog (Asama), Jackal (Kebero), Sesi, Midako and Qorke were resided in the study area before 30 years ago out-migrated and disappeared. Due to land use land cover changes of the past three decades, several water sources like streams and rivers have declined such as Kesem River and its tributaries, Shenkora River and Beadle River and even some of them dried up, for example Tebo River is evidence among others. The decline of agricultural output per unit of land from time to time in the study area is also other effects of land use cover changes. This could be due to the deterioration of soil fertility with soil erosion over continuous cultivation and deforestation. The decline of agricultural output can also be the result of widespread of crop pests, insects and climate change which are the outcome of environmental deterioration.

Shortages of wood for construction, agricultural tools, for cooking and grazing land for livestock rearing are also other consequences of land use land cover changes in the study area. The rearing of livestock is being difficult due to shortage of grazing lands and hence benefits which can be acquired from livestock farming like milk, butter, honey, and meat are declined. As population size increases household energy consumption also increases. For the poor in rural areas, wood is not only a source of energy as fuel wood and charcoal, but it is also a means of income generation. Expansion of agricultural lands toward marginal lands, grazing and preserved public lands have resulted for lack of public land for various public services, increased soil erosion, formation of gully erosion and hindered social interaction of the people.

4 Conclusion

This study assessed and quantified land use land cover changes during the past three decades using geographic information system and remote sensing techniques. The study used various data sources, tools, software and techniques. The measure that the study used to detect the land use land cover changes is area variations of the various land use land covers during the three decades (1987 to 2017). The study also collected data with interview and FGD to assess causes and consequences of land use land cover changes.

From the analysis made so far on land use land covers, the results indicate that the study Woreda's land uses land covers are changed considerably during the past three decades (1987 to 2017). Analysis of the study revealed that forest and shrub lands have diminished from 32885 hectares and 61939 hectares to 16034 hectares and 32530 hectares, respectively during 1987 to 2017. During the three-decades 16851 hectares of forest has been changed into bush land, farm land and residential areas mainly in Bichashina-Tafa, Erarati, Seka-wachona Dodota, Kirstos-Semira, Dire, Choba and Amora-bet Kebeles of the Woreda. Moreover, about 29409 hectares of bush land are converted into agriculture, bare lands, built up area in many Kebeles of the Woreda such as Bichashina-Tafa, Erarati, Seka-wachonaDodota, Kirstos-Semira, Dire, Choba, Finanajo and Amora-Bet.

On the other hand, agriculture and bare lands have increased from 52524 hectares and 3018 hectares to 90859 hectares and 7441 hectares, respectively. This implies that 38335 hectares of new farm lands are added on the existed farm lands of the Woreda. Moreover, about 4423 hectares of new bare lands has been created mainly in Finanajo, Chele, Dire and Choba Kebeles of the Woreda during the three decades. Moreover, built up areas also have expanded into farm lands and bush lands in the peripheries of Arerti town, Balchi town and new town is also emerged nearby the famous Yohanse Church and Tsebel in Kirstos-Semira Kebele. Nowadays, built up area expansions have encroached a significant amount of fertile farm lands in the above three areas of the Woreda.

The major causes of land use land cover changes in Minjar-shenkora Woreda include: unwise exploitation of wood for fuel and construction materials, human induced fire and uncontrolled grazing. The absence of public law for protecting and preserving natural vegetation and for controlling illegal cutting and burning of natural vegetation are causes for the deforestation of forest and shrub lands. Moreover, socio-economic changes such as rising of population size, improvement of transport and market accessibility, increasing of people's standards of life and needs, rising of people demands of better housing and clothing enforce people to exploit natural resources more and these can lead to land use/cover changes.

On the other hand, people's livelihood vulnerability and degradation are the main outcome of the land use land cover changes of the study area. Decreasing of forest resources and shrub lands have resulted in the deterioration environmental resources such as water, grazing lands, and streams. Rivers, streams and other water sources have been dried up due to environmental deterioration. The different benefits and opportunities obtained from forest and shrub lands are vanished. Moreover, various insects and pests have appeared and affected crop production while bio-diversities have been impaired. Places name has been disappeared along with the destruction of forest or bigger trees.

The study forwarded the following suggestions based on the findings of the study.

- The concerned body of the Woreda needs to create awareness on the communities about the effects of deforestation and expansion of farmlands into marginal lands. The communities should preserve and protect the natural vegetation from grazing and illegal cutting.
- The people should have information about importance of planting trees to provide wood for housing tools, construction materials, cooking and charcoal production and hence should plant a tree in his/her residential and around farm plot.
- The farm households should have adequate knowledge about the contribution of keeping and preserving natural vegetation for protecting soil erosion, keeping biodiversity, keeping and preserving water sources of streams and rivers.
- Urban areas of the Woreda such as Arerti, Balchi, Yohanse have encroached large amount of fertile farm lands and this has affected the livelihoods of many households. Hence, it must be considered by the concerned bodies and it needs new direction that can reduce consumption of farm lands.
- The communities along with the concerned body should formulate law that can help to protect and preserve natural vegetation and to control illegal cutting of natural vegetation and expansion of farm lands to marginal lands.

Acknowledgments

The authors would like to thank Dilla University for financial support for the research. We would like also to thank United States Geological Survey (USGS) for accessing the Satellite imageries. We would like also to thank people at Minijar-Shenkora Woreda Agriculture office and districts where we undertook the survey for facilitating our work and for providing useful information.

Conflict of Interest

The authors declares that there is no conflict of interest.

References

Briassoulis, H. (2000). Land use, land cover changes and global aggregate impacts. Land use land cover and soil sciences- vol.1

Central Statistical Agency (CSA). (2007). The 2007 Population and Housing Census of Ethiopia: Statistical Report for Southern Nations, Nationalities and Peoples' Region; Part I: Population Size and Characteristics

Efrem, G. (2010). *Land-use and land-cover dynamics and rural livelihood perspectives, in the semi-arid areas of Central Rift Valley of Ethiopia* (Vol. 2010, No. 7)

FAO (1993). Food and Agriculture Organization. Forest Resources Assessment 1990: Tropical Countries. FAO Forestry Papers 112. Rome, Italy.

FAO (2001). Food and Agriculture Organization. Global Forest Resources Assessment 2000: Main Report. FAO Forestry Paper 140. Rome, Italy.

Fish, L.O. (2007).U SGS Anderson Land Classification Scheme.

Geist, H. & Lambin, E. (2001). What drives tropical deforestation. *LUCC Report series*, 4, 116

Gerald, F. & Olufunke, C. (2011). Dynamics of land-use and landcover change in Freetown, Sierra Leone and its effects on urban and peri-urban agriculture – a remote sensing approach, *International Journal of Remote Sensing*, 32:4, 1017-1037, https://www.doi.org/10.1080/0143116090350530

Gezahegn, W. & Anteneh, D. (2013). Assessing Land-Use/Land-Cover Changes and Spatio-Temporal Expansion Process of Assela Town, Arsi Zone, Ethiopia

Haroon, S. & Mohd, I. (2012). Impact of urbanization on land use/ land cover of Dudhganga watershed of Kashmir Valley, India, International Journal of Urban Sciences, 16:3, 321-339, https://www.doi.org/10.1080/12265934.2012.743749

Hualou, L., Xiuqin, W., Wenjie, W. & Guihua, D. (2008). Analysis of Urban-Rural Land-Use Change during 1995-2006 and Its Policy Dimensional Driving Forces in Chongqing, China; Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences, Beijing 100101, China journal homepage: https://www.elsevier.com/locate/rsase.

Kefyalew, S. Carsten, M. & Georg, C. (2015). Assessment of land use and land cover change in South Central Ethiopia during four decades based on integrated analysis of multi-temporal images and geospatial vector data. *Remote Sensing Applications: Society and Environment*, Vol. 3, pp. 1-19.

Lambin, E, Geist, H. & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. *Annual review of environment and resources*, 28(1), 205-241

Nanda, A., Hajam, R., Hamid, A. & Ahmed, P. (2014). Changes in land-use/land-cover dynamics using geospatial techniques: A case study of Vishav drainage basin. *Journal of Geography and Regional Planning*, 7(4), 69-77

Solomon, M. (2016). Effect of Land Use Land Cover Changes on the Forest Resources of Ethiopia, *International Journal of Natural Resource Ecology and Management*. Vol. 1, No. 2, 2016, pp. 51-57

Temesgen, G. & Tesfahun F. (2014). Evaluation of Land Use/ Land Cover Changes in East of Lake Tana, Ethiopia, Journal of Environment and Earth Science, Vol.4, No.11,

Turner, B., Meyer, W. & Skole, D. (1994). Global land-use/land-cover change: towards an integrated study. *Ambio. Stockholm*, 23(1), 91-95

Verheye, W., Koohafkan, P., & Nachtergaele, F. (2009). The FAO guidelines for land evaluation. *Land Use, Land Cover and Soil Sciences-Volume II: Land Evaluation*, 78. regions. *Annual review of environment and resources*, 28(1), 205-241.

Wu, J. (2008). Land use changes: Economic, social, and environmental impacts. *Agricultural and Applied Economics Association*, 23(4), 6-10.