

**Gender-Based Assessments of Science, Technology and
Innovation (STI) Ecosystem in Ethiopia**

Draft Report

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Acronyms

AU	African Union
CAES	College of Agriculture and Environmental Sciences
CCI	College Computing and Informatics
CHMS	College of Health and Medical Sciences
CNCS	College of Natural and Computational Sciences
DVM	Doctor of Veterinary Medicine
EMIS	Education Management Information System
ESDP	Education Sector Development Program
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
GII	Global Innovation Index
GTP	Growth and Transformation Plan
HEI	Higher Education Institutions
HERQA	Higher Education Relevance and Quality Agency
HIT	Haramaya Institute of Technology
HRMDD	Human Resource Management and Development Directorate
ILO	International Labour Organization
MD	Doctor of Medicine
MoE	Ministry of Education
MoIT	Ministry of Innovation and Technology
MoSHE	Ministry of Science and Higher Education
n.d	No date
SDG	Sustainable Development Goals
STI	Science, Technology and Innovation
STEM	Science, Technology, Engineering and Mathematics
TVET	Technical and Vocational Education and Training
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization

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1. Introduction

Science, technology and innovations (STI) are important contributors to sustainable development. STI has been proved to be an important prerequisite for the social and economic transformations that enable sustainable economic growth, human development and poverty eradication (UN Secretary Report, 2013). The successful implementation of Sustainable Development Goal (SDG) will also be realized with the support of STI. Studies witness the contribution of STI-based strategies to economic and social development (Giovannini et al, 2015; UN, 2019), and countries that employed and promoted STI have exhibited more economic growth and industrial dynamism (Bokova, 2012; Ihueze et al, 2015). Moreover, because of the crucial role of STI, the African Union has taken it as part of its development strategy Agenda 2063 (Bobadoye, 2015).

In sub-Saharan African countries like Ethiopia, technology and innovation has played a significant role in improving the livelihood of their citizens. Science, technology and innovation has improved the health, working and living condition of people, and it also contributes to increase their income and amount of leisure time (Amha and Mekuriaw, 2008). Above all, in a country where food insecurity prevails and impacted by climate change, the need for science, technology and innovation is enormous.

The first half of the 20th century is considered as the beginning of application of modern science and technology in Ethiopia, along with the establishment of higher education institutions (Amha and Mekuriaw, 2008). Ethiopia established Ministry of Science and Technology for the first time in 1975 as a commission and currently it is renamed as Ministry of Innovation and Technology (MoIT). The Ministry was established with the aim of providing study-based recommendations to the government of Ethiopia for adopting and revising policies, strategies, laws and directives for the development of STI that support the realization of the country's development objectives (Tesfa, 2015). Ethiopia applies STI as an instrument to achieve the long-term vision to be among the middle-income countries (MoE, 2015).

One of the cross cutting issues in STI ecosystem is gender. In a country where gender inequality prevails, ensuring gender equality in all spheres of life is the corner stone for sustainable development. More importantly, ensuring gender equality in STI plays a crucial role in meeting the needs of the country through the contribution made by women. Despite this fact, gender imbalance exists in such fields particularly in higher education institutions in Ethiopia. Though various measures have been taken to redress the gender inequality by enhancing the participation of female students and instructors in higher education institutions in science, technology, engineering and mathematics (STEM), the result obtained has not been satisfactory as only few women are shown up in such fields of study.

2. Objectives

The overall objective of the assignment is to conduct gender-based assessment of science, technology and innovation ecosystem in Ethiopia.

The specific objectives are to

- map the key actors of the STI eco-system in Ethiopia
- assess participation of women in STI ecosystem in Ethiopia
- investigate gender-based capacity gaps, challenges, opportunities and future prospects for women's participation in STI.

3. Methodology

The assessment was done with the data obtained from literature and primary data collected from eight key informants. The literature essential for this paper were reviewed from different sources. Reports of Ministry of Science and Higher education of Ethiopia (MoSHE) and Ministry of Education (MoE) were among the sources consulted. Policy documents and statistical data of student enrolment and academic faculty were also reviewed. In order to see the changes in students' enrolment of undergraduate and postgraduate programs in higher education institutions and Technical and Vocational Education and Training (TVET) colleges in the country, trend analysis was done. Comparisons between male and female students and academic

staff in STEM fields in higher education institutions were also made. The primary data were collected through phone calls and email correspondences. These data were mainly employed to identify the gender-based capacity gaps, the major challenges that inhibit women from participating in STI and the opportunities that motivate them to STEM fields of study. Case study was also conducted taking Haramaya University, one of the top ten public higher education institutions that offer engineering and technology programs in Ethiopia.

The data collection process is summarized in Table 1.

Table 1: Process of data collection and analysis

Data collected	Method used to collect the data	Source of the data	Methods of data analysis
STI policy and strategies of Ethiopia STI actors in Ethiopia	Document review Literature review	National Science, Technology and Innovation Policy of Ethiopia Report of UN agencies (UNICEF, UNDP) World Bank, AU	Content analysis
Sex disaggregated data of enrolment of students at Undergraduate and postgraduate level Sex disaggregated data of academic staff by field of study Sex disaggregated data of enrolment of students TVET students and trainers Sex disaggregated data of researchers	Document review	Reports of ministry of education (MoE) of Ethiopia Reports Ministry of Science and Higher education (MoSHE) of Ethiopia Directorate of human resource management and development, Haramaya University EMIS office of Haramaya University Quarterly reports of higher education institutions	Descriptive statistics (frequency and percentage)
Participation of women in STI Gender-based capacity gaps, opportunities and challenges	Literature review Semi-structured interview checklist	Journal articles Study participants	Content analysis

4. Findings

4.1. Key actors in the STI eco-system in Ethiopia

The contribution of STI in the economic, social and political development of the country depends on the appropriate STI policies and active participation of stakeholders. Ethiopia developed its STI policy in 2012 with a vision of establishing the capabilities which enable rapid learning, adaptation and utilization of effective foreign technologies by the year 2022/23 (Federal Democratic Republic of Ethiopia, 2012). To realize the vision of the policy, a number of stakeholders (actors) are contributing their own share. World Bank (2016) structured the STI key actors of Ethiopia in three broad stakeholder categories namely: public sector, academic institutions and industry. All actors are depicted in Figure 1.

The public sector includes government ministries (such as Ministry of Science and Higher Education (MoSHE), Ministry of Education (MoE) and Ministry of Innovation and Technology (MoIT) and its relevant agencies). Non-profit organizations are also playing a significant role in the STI ecosystem of the country. The other actors, Academic, TVET and research institutions, include researchers in various STI fields affiliated with higher education and research institutions in the country. Research and education system have the capabilities to learn, absorb and develop new applied knowledge, and to supply human capital to the innovation system (United Nations, 2019). Reports show that the global expenditure on research and development of Ethiopia increased from 0.24% in 2009 to 0.61% in 2013 (African Union, 2019; UNESCO, 2015). Industry, as a key actor, constitutes corporations, small and medium enterprises, etc.

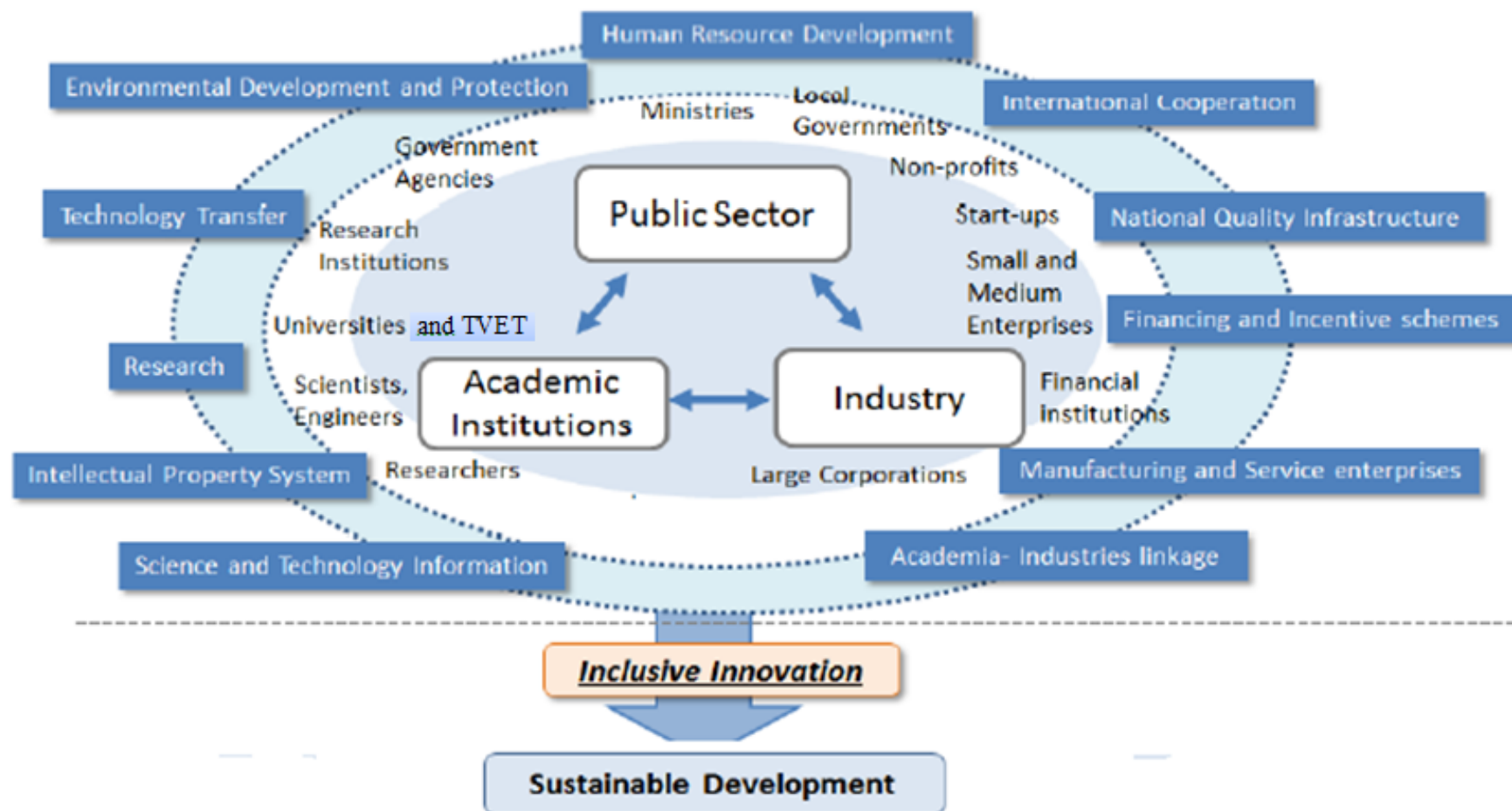


Figure 1: Key actors and policy issues in STI eco-system in Ethiopia

Source: Adopted from World Bank (2016)

The STI policy of Ethiopia underscores the need for having strong relationship among higher education institutions, private and public sectors (industries) (FDRE, 2012). The collaborative effort of these stakeholders/actors leads to the realization of the policies that are needed to achieve the objectives of the science, technology and technology need of the country. Universities provide qualified professionals that work in both private and public manufacturing industries and other sectors. The higher education institutions, in turn, get technical support and facilities that could be used for educational and research purposes (James, 2004 as cited in Kahsay, 2017). In support of this, Singh and Tolessa (2019) argue that the linkage among these actors is helpful to maintain professional competencies of graduates and the industrial output cannot grow without qualified and competent human resources. Moreover, the collaboration could benefit in terms of 'income generation, access to technology and equipment, practical experience, curriculum development, community service and image building, and employment opportunities for students' (Tamrat, 2014).

The critical policy issues to be addressed, as to the STI eco-system of the country, are technology transfer; human resource development; manufacturing and service enterprises; research; financing and incentive schemes; national quality infrastructure; academia- industry linkage; intellectual property rights; science and technology information; environmental protection and development; and international cooperation. All actors and policies are contributing to come up with an inclusive innovation that supports the country to achieve sustainable development.

All the actors are expected to improve the current status of the country's innovation performance. As to the Global Innovation Index (GII) ranking, Ethiopia stood 111th among 129 countries (Cornell University et al, 2019). Country's capacity for and success in innovation is ranked using Global Innovation Index (GII).

4.2. Higher Education in Ethiopia

Academic institutions are the prime source of knowledge and innovation at national, regional and international levels (Kearney, 2009). Higher education provides a conducive environment for the development of STI and a suitable exploitation of the

full potential of STI to support sustainable development (African Union, n.d). Higher education in Ethiopia includes education programs offered as undergraduate degree for three, four or more years, second degree (Master's and specialty programs) and third degree (PhDs and subspecialty programs). The focus areas of higher education institutions of the country are teaching, research and community services (MoE, 2018a). Higher education institutions in Ethiopia have been managed by Ministry of Science and Higher Education (MoSHE) since its establishment in October 2018. It was Ministry of Education (MoE) that had been responsible for higher education institutions (HEI) in the country before MoSHE was founded. Higher Education Relevance and Quality Agency (HERQA), which is under MoSHE, supervises the relevance and quality of education offered by the HEI.

Due to the demand for skilled manpower of the country, the number of higher education institutions has increased since 1992. Until 1992, there were only two Universities in the country. Between 1992 and 2009, 21 more universities were established and by the year 2013, the country had 33 universities (Gizaw, 2019). Currently there are 49 government and 128 accredited non-government higher education institutions in Ethiopia (MoE, 2018b).

The field of studies given in higher education institutions in Ethiopia are divided in to six bands. Table 2 shows the classification.

Table 2: Programs of the Ethiopian Higher Education System

Band	Fields of Study
Band 1	Engineering and Technology
Band 2	Natural and Computational Sciences
Band 3	Medicine and Health Sciences
Band 4	Agricultural and Life Sciences
Band 5	Business and Economics
Band 6	Social Science and Humanities

The overall enrolment of students in Ethiopian higher education institutions are increasing. The number of undergraduate students in both government (public) and non-government (private) institutions increased from 309,092 in 2008/09 academic year to 825,003 in 2017/18 (Figure 2). The proportions of female students increased

throughout these years. The percentage of female students was 29% and 36.9% in 2008/09 and 2017/18 academic years, respectively.

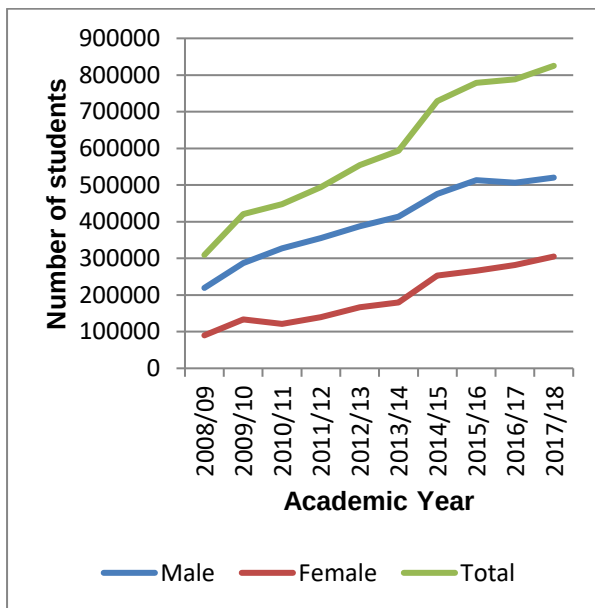


Figure 2: Trends of enrolment of undergraduate program students

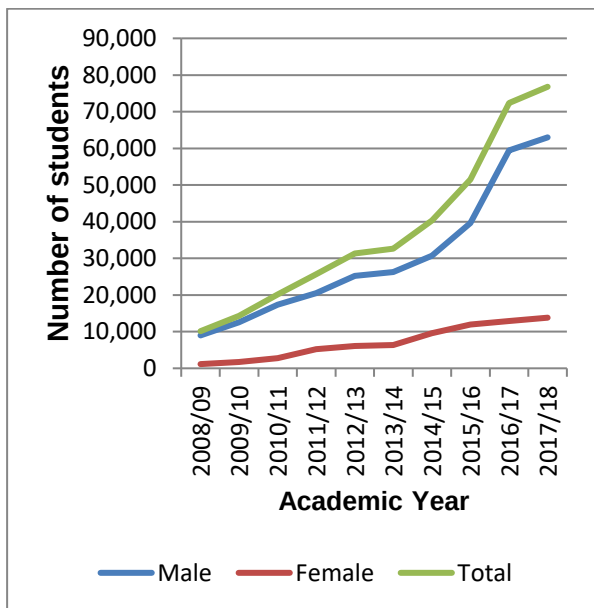


Figure 3: Trends of enrolment of postgraduate program students

Source: MoE (2018b)

The number of postgraduate (masters and PhD) students also increased from 10,125 in 2008/09 to 76,795 in 2017/18 (Figure 3). In terms of female enrolment, only 11.3% of the students were female in 2008/09 whereas as it increased to 18% in 2017/18 academic year.

In addition to producing qualified graduates, higher education institutions contribute to the STI eco-system by conducting researches and publish articles in various journals. According to Salmi et al (2017), Ethiopian higher education institutions produce around 1,500 publications every year. There have also been improvements in the capacity of conducting researches in Ethiopia. For example, the citable research documents, which were mainly conducted by faculty of higher education institutions in Ethiopia, increased from 774 in 2010 to 1552 in 2015 (SCImago Journal and Country Rank as cited in Salmi et al, 2017). However, the contribution of the researches in terms of knowledge generation for national development has been generally low and they lack responsiveness in addressing societal challenges (Nega and Kassaye, 2018).

In order to redress the gaps in the research enterprise and avoid replication of efforts, a number of higher education institutions have already developed research thematic priority areas based on the specific reality of their context. Each research conducted by academic faculty or students have to be in line with the thematic areas identified in which STEM fields are among them. For example: information and communication technology, materials science and nanotechnology industrial process and product improvement, minerals and energy transport technologies and infrastructure development have been among the STEM related thematic priority areas of Addis Ababa University (Nega and Kassaye, 2018).

4.3. Technical and Vocational Education and Training (TVET) in Ethiopia

Technical and Vocational Education and Trainings (TVET) has been taken as a means of supporting youth develop skills essential to be engaged in various professions as well as promote entrepreneurship (AU, 2018). TVET are ‘those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge related to occupations in various sectors of economic and social life’ (UNESCO and ILO, 2002).

The emergence of Technical and Vocational Education and Training (TVET) in Ethiopia dates back to 1942 (Teklay, 2012). The first TVET institute is Addis Ababa Technical School which was named as Ecole National des Artes Technique during its establishment (Likisa, 2018). Since then different policies were enacted to promote TVET in Ethiopia, and in 1970s selected high schools were converted to comprehensive high schools where students could have both academic and vocational education (MoE, 2018a). In 2004, competency-based training was introduced to the TVET system in Ethiopia to respond to the skill needs of the labor market (Likisa, 2018). In 2008, the country developed national TVET strategy revising the older version which was prepared in 2002. The revised strategy was envisioned ‘to create competent and self-reliant citizens to contribute to the economic and social development of the country, thus improving the livelihoods of all Ethiopians and sustainably reducing poverty’ (MoE, 2008).

The importance of expanding and strengthening TVET has been justified because of the need to enhance the manufacturing sector and improve the employability of Ethiopian youth (Trines, 2018). Moreover, TVET in Ethiopia was designed to redress the challenges of poverty, unemployment, low technological development, and low productivity of the economy (MoE, 2008). It is categorized into five levels (level 1 to level 5) to provide relevant and demand-driven education and training (MoE, 2018b). An informant from Federal TVET Agency indicated that currently the fields of study in TVET are classified into eight major sectors: agriculture; industrial development; trade; health; culture, tourism and sport; mining; economic infrastructure; and community service. TVET is led by Ministry of Science and Higher Education. The overall implementation of the TVET strategy has been overseen by Federal TVET Agency and a Federal TVET Institute has been working to produce competent TVET trainers. Regional states of the country have their own TVET offices/agencies that are in charge of the TVET institutions in their respective regions. According to MoE (2017b) the country has 582 public and private TVET institutions.

Since the launch of the TVET program, it had expanded in terms of enrolment in which the number of students increased from 106,336 in 2004/05 to 352,144 in 2014/15 (MOE, 2018b). However, since 2014/15 academic year, the number of TVET students has declined. For example: the total enrolment decreased from a total of 352,144 in 2014/15 to 292,378 in 2017/18. The decline could be because of the fact that as some regions (Afar, Somali, Gambella and Addis Ababa) did not report the number of students in the TVET institutions of their regional states of 2017/18 academic year, the data of 2014/15 of these regions were used ((MOE, 2018b).

4.4. Women's participation in science, technology and innovation eco-system

People all over the world have benefited from STI. The value of STI outweighs when it supports women who have been disadvantaged throughout their life time. Giving the opportunity to women in the fields of studies such as science, technology, engineering and mathematics (STEM) contributes to have healthier family as well as they become more successful at their home and career (Egne, 2014). Polcuch et al (2018) justifies the need for gender equality in STI from the point of view that gender equality and

access to science are recognized as human rights; the need for participating women in the scientific workforce to have sustainable development; and the contribution of women to come up with varied and societally relevant research results. Moreover, STI policies and programs could not be effective unless it considers the concerns and abilities of both men and women (United Nations, 2011). Giving equal opportunity to women in STI is also justified as it assures better scientific and technological results and the best use of them (Lane, 1999), and the more inclusive the STI ecosystem, it becomes more innovative and productive (National Academy of Sciences, 2006).

The government of Ethiopia, with the aim of producing more graduates in the fields of STEM, developed a policy that 70% of students who join higher education to study natural sciences whereas the remaining 30% to enrol for social science fields. This policy has increased the number of science, technology and engineering students since its development in 2008. However, it has not been successful in terms of bringing gender equality in STEM fields of study. The new enrolment policy (70:30) excludes female students from science and engineering in higher education (Tsegai, 2010).

Figure 4 shows sex disaggregated enrolment of undergraduate programs in government (public) universities of Ethiopia in various field of study.

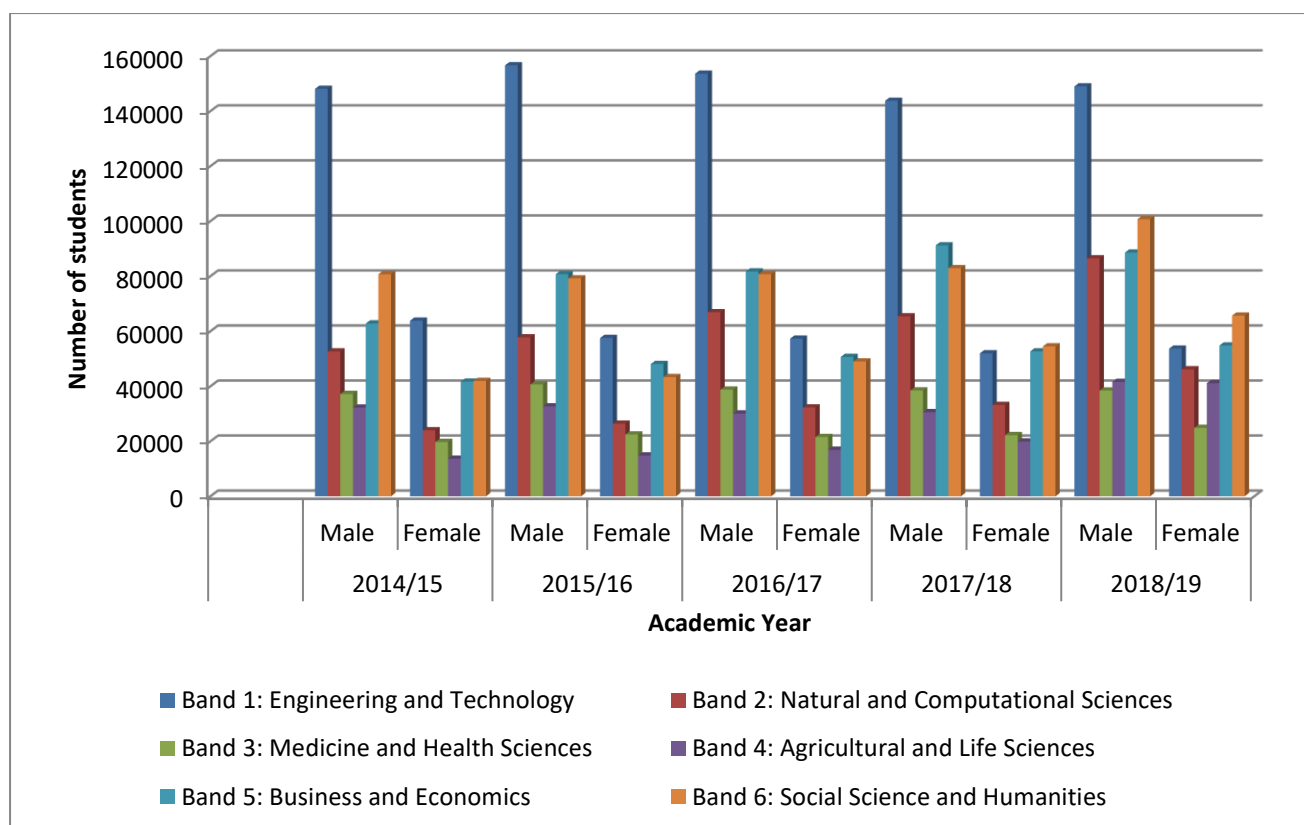


Figure 4: Enrolment in undergraduate programs in government/public universities, by field of study and gender

Source: MoE, 2016; MoE, 2017a; MoE, 2017b; MoE, 2018b; MoSHE, 2020

There has been gender disparity in most fields of study as figure 4 depicts. In 2018/19 academic year, the highest and lowest gender gaps were observed in the fields of engineering and technology (band 1) and agricultural and life sciences (band 4) respectively. Among engineering and technology, natural and computational sciences, medicine and health science, and agricultural and life sciences students 26.5%, 34.8%, 39.3% and 49.7% of the students in 2018/19 academic year were female respectively. The percentage of female students in the three STEM related fields (band 2, 3 and 4) increased between 2014/15 and 2018/19. In 2014/15 academic year the proportion of female students were 31.3% and 35%, 29.8% in natural and computational sciences, medicine and health science, and agricultural and life sciences respectively. Nevertheless, the participation of female students in engineering and technology (band 1) declined from 30.1% in 2014/15 to 26.5% in 2018/19.

The participation of female at postgraduate level, like the undergraduate program, was also lower than male students as shown in Figure 5.

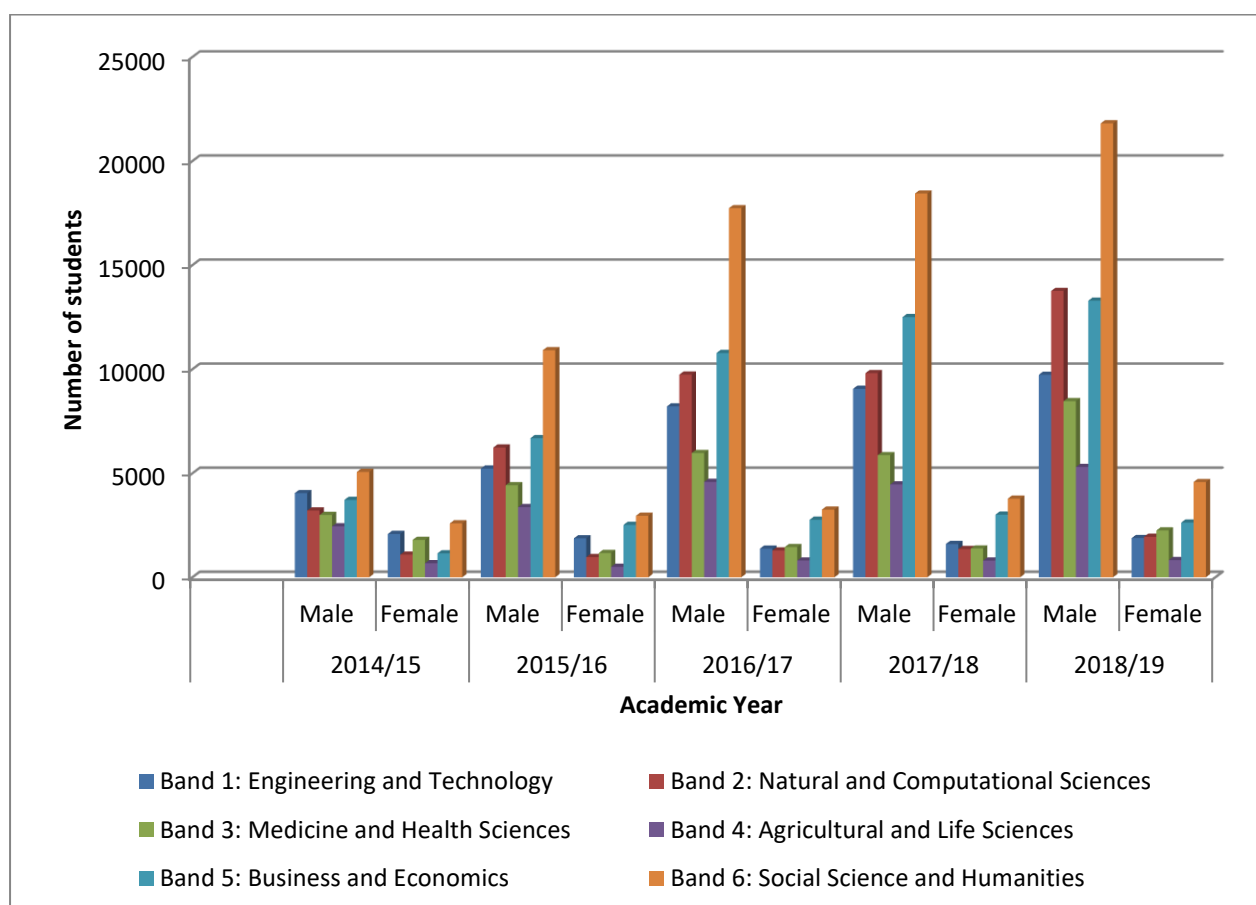


Figure 5: Enrolment in postgraduate programs in public universities, by gender and field of study

Source: MoE, 2016; MoE, 2017a, MoE, 2017b; MoE, 2018b; MoSHE, 2020

The percentage of female postgraduate students in engineering and technology in 2018/19 academic year was only 16.2%. Like the engineering and technology, there was a big gender gap in natural and computational sciences, agricultural and life sciences and medicine and health science in which females constituted 12.4%, 13.5% and 21% in 2018/19, respectively.

In spite of the expectations to increase the number of female in the recent years, the trend shows that their participation was decreasing. For example, in 2014/15, among the students, about 34% were female in the engineering and technology fields (band 1) which was more than the enrolment in 2018/19 (i.e. 16.2%).

The gender disparity in natural science and technology fields of study was also observed in the academic staff of higher education institutions. The proportion of women, like the students, was by far less than that of the men. Figure 6 shows the percentage of women academic staff at public universities by field of study.

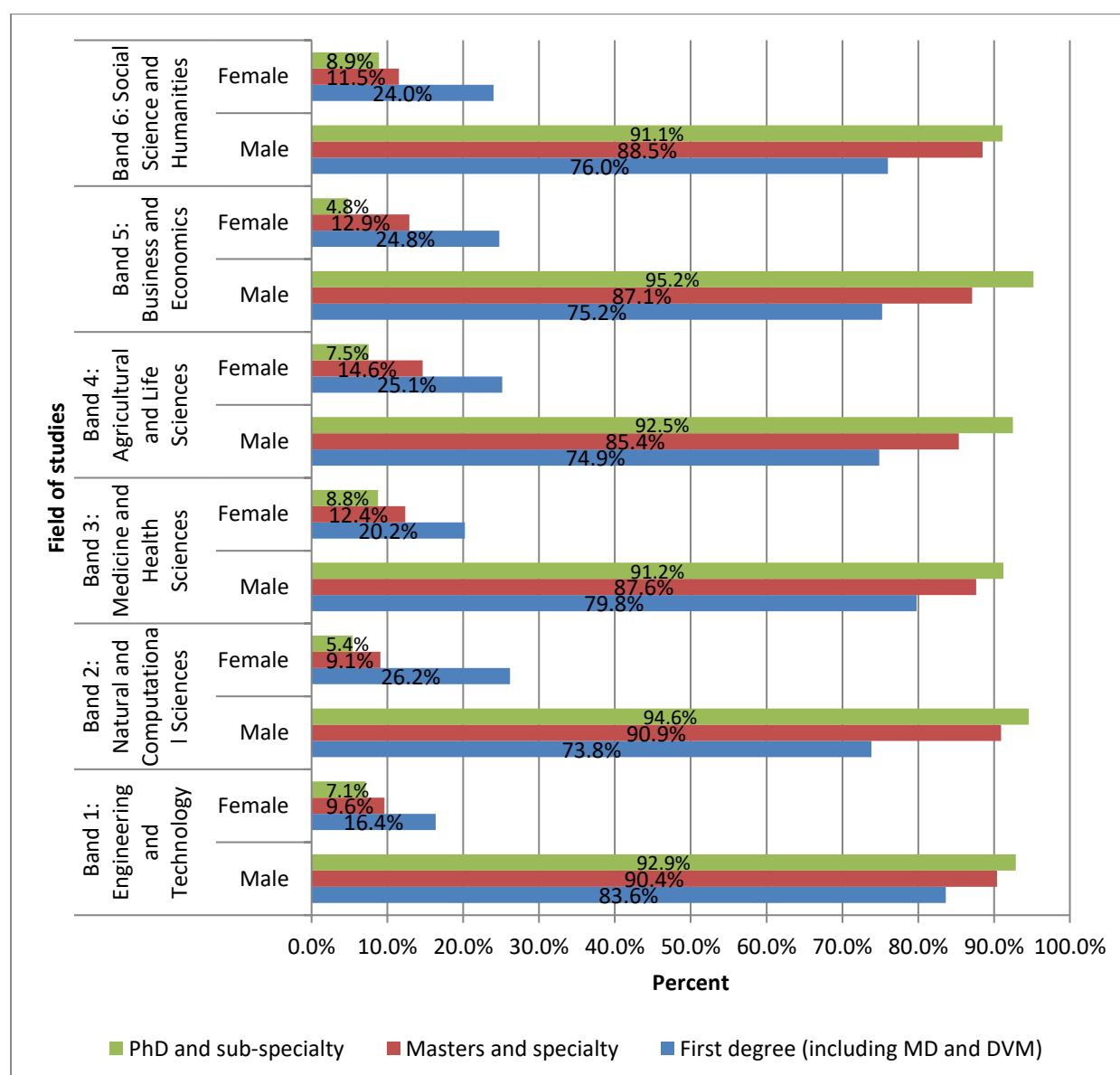


Figure 6: Percentage of academic staff at public universities, by gender and field of study (2017/18)

Source: MoE, 2018b

To see the gender gap in the participation of STI ecosystem among higher education staff members, statistics of 2017/18 was used. As the level of education increased, the proportion of female academic staff decreased. Among all PhD and masters degree holders in engineering and technology, women constituted only 7.1% and 9.6%

respectively. In natural and computational sciences, only 5.4% and 9.1% of women instructors earned PhD and master degrees, respectively. The gender disparity was also observed among first degree holder academic staff of higher education institutions in the country (Figure 6).

Unlike the higher education institutions, the participation of female students in the TVET institutions was better than that of men. Figure 7 shows the number of students from 2013/14 to 2017/18 academic year.

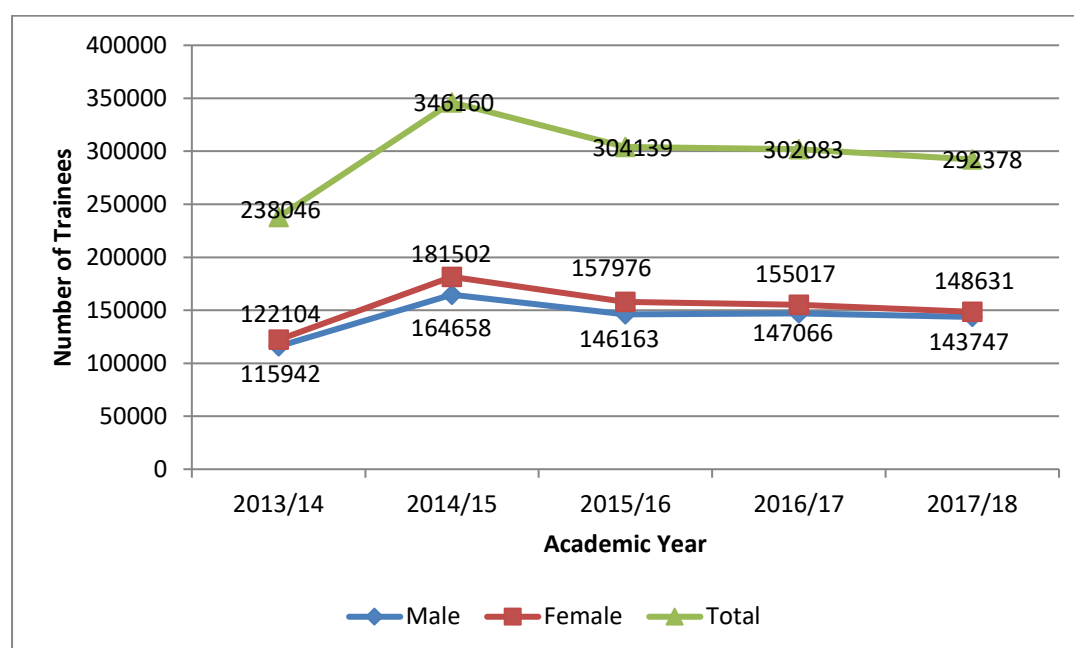


Figure 7: Trends of TVET enrolment by gender (2013/14- 2017/18)

Source: MoE, 2018b

As Figure 7 depicts the percentage of female students was higher than male between 2014/15 and 2017/18. Among all the students, females constituted 51.3%, 52.4%, 51.9%, 51.3% and 50.8% in 2013/14, 2014/15, 2015/16, 2016/17, 2017/18, respectively. Regarding TVET trainers, the trend analysis shows an increase until 2016/17. However, the number of the trainers declined in 2017/18 (Figure 8).

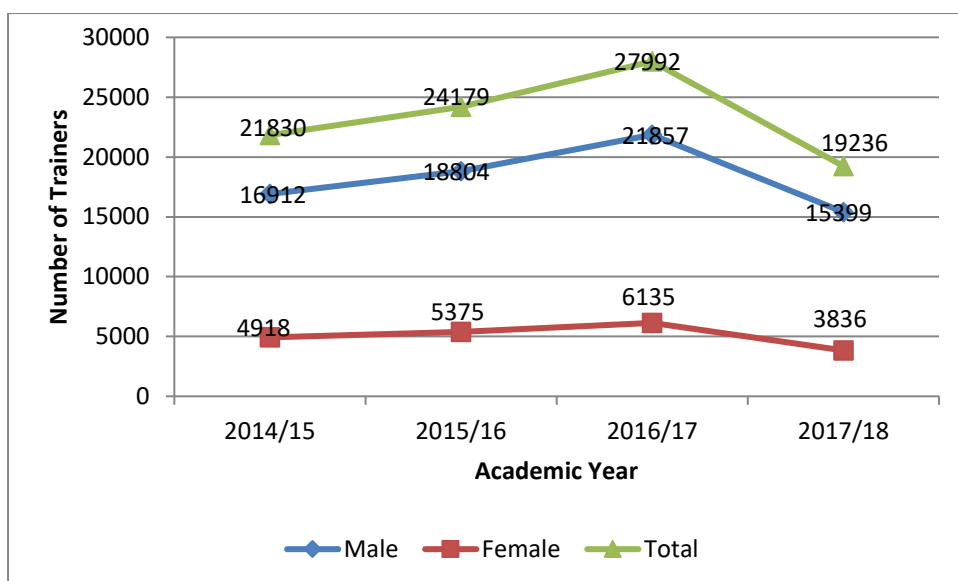


Figure 8: Trends of TVET trainers by gender ((2014/15-2017/18)

Source: MoE, 2016; MoE, 2017a; MoE, 2017b; MoE, 2018

Looking into the gender dimension, unlike the students, the number of women was very much less than that of men trainers. The percentage of women were 22.5%, 22.2%, 21.9% and 19.9% in 2014/15, 2015/16, 2016/17 and 2017/18 respectively.

Women in higher education institutions are also contributing in the research enterprises, and the percentages of women researchers increased. In spite of this, they have not still been adequately represented in the research endeavor. Female researchers were 13.3% in Ethiopia in 2014 (UNESCO Institute for Statistics, 2019, which was more than that of 2005 (i.e 6%) (UIS, Education Database and Science and Technology Database, 2007 as cited in UNICEF, 2007). In terms field of study, the lowest percentage of women researchers was found in technology and engineering. In 2013, female researchers in Ethiopia were 12.2%, 7.1%, 26.1%, 7.6% and 13.2% in natural sciences, engineering and technology, medical sciences, agricultural sciences, social science and humanities respectively (UNESCO, 2015).

The participation of women in the industry sector, the other major actor in the STI ecosystem, has been also low in the country. Mostly women tend to participate in occupations that require fewer skills. Higher-skilled positions are occupied by men. For instance, it was reported that, in Ethiopia, the proportion of women that work as

high-skilled production workers decreases as the tasks become more skill-intensive; 35% in textiles and garments and 15% in chemical and pharmaceutical industries (UNDP, 2018).

4.5. Gender-based capacity gaps and challenges of women to participate in STI in Ethiopia

Scientists, based on brain structure and function, hormonal modulation, human cognitive development, and human evolution, have not found any significant biological difference in men's and women's ability to perform in science and mathematics (Ceci and Williams, 2007 as cited in Castillo et al, 2014). Despite this fact, only few women have been shown up in the STEM fields in Ethiopia. The low participation of women has been attributed to various gender-based capacity gaps and challenges. The major gaps and challenges are discussed as follows.

- **Lack of academic preparation for science, technology, engineering and mathematics (STEM) fields**

To be successful in science, technology, engineering and mathematics fields at higher education institution, it is essential to have preparation from the early stages of schooling. However, most females in Ethiopia do not get such opportunities since they are expected to engage in household activities. Due to this fact, they lack the preparation to join the fields of study that need strong background in science. A study conducted in Ethiopia among students of Addis Ababa University and Adama Science and Technology University proves the same. Among the students who were studying science, technology, engineering and mathematics, and social sciences, 75% and 85% of them respectively indicated most Ethiopian female students show little interest towards hard sciences due to lack of academic preparations (Egne, 2014). In support of this Tamrat (2017) asserts that the poor academic background of female students is the major obstacle for their success. A university mathematics lecturer, in an interview conducted, commented that due to the poor science methods of teaching at elementary school, many students especially females are not equipped with the required knowledge and skill for their grade level.

- **Attitude toward science**

The attitude of female students to science, technology, engineering and mathematics subjects is among the factors that hinder females not choose these fields of study. Traditionally, the sciences, such as mathematics have been perceived as a masculine domain while the arts, like languages, and the humanities, have been constructed as feminine (Francis, 2000) and scientists as predominantly male (Makarova et al, 2019). MoE (2014) and UNESCO (2018) also share the prevalence of stereotypes on girls and women to engage in natural science streams, technology and mathematics. An interviewee (statistics graduate) indicated that female students usually assume science field such as mathematics the most difficult subjects so that they prefer to study social sciences. Based on the information obtained from a women official in MoIT of Ethiopia, Beyene (2015) also indicated that only few Ethiopia women participate in STI mainly because of the ‘prevailing belief that science is not a suitable field for women’. The students’ enrollment and the proportion of female academic staff in Ethiopian higher education prove this situation. For instance, among the public higher education students enrolled in 2018/19 academic year, 17.3% of female students were studying social science and humanity fields (band 6) whereas the percentage of female students in the same year who were studying Engineering and Technology (Band 1) and Natural and Computational Sciences (Band 2) were 16.2% and 12.4%, respectively. Regarding the academic faculty, among the staff members with postgraduate degree (Masters and PhD) the percentage of females in the fields of engineering and technology (Band 1) and Natural and Computational Sciences (Band 2) were 9.2% and 8.3% respectively. On the other hand, about 11% of the female academic staff had postgraduate degree in social science and humanity fields (band 6) in the same year (2018/19).

- **Lack of self confidence**

Due to various socio-cultural factors, women are not considered as confident enough to perform challenging tasks. As science, technology, engineering and mathematics are taken as difficult subjects; women are not usually expected to study such fields. It is men who are assumed to have self-confidence and skills in fields like engineering

(UNDP, 2018). Interviewed key informant mentioned that female students are not confident enough to study STEM fields at higher education institutions as they feel they are not good at it. A female faculty also indicated that females do not opt for STEM fields because of frustrations that they feel they could not be successful. Moreover, a woman respondent in a study conducted by Asmamaw (2017) commented that 'women are not expected to excel in the sciences. In support of this, MoE (2014) asserted that lack of self-confidence and existence of low expectations for girls to study sciences and mathematics make them avoid such fields at any cost. It has also been noted that higher education institution faculty members' unsubstantiated beliefs about women's lack of ability in STEM fields has also made women not to be confident enough to study these subjects (Hafkin, 2016).

- **Lack of female role model scientists**

Most often, in Ethiopia, men are those who are known for their expertise in the fields of science and technology. The low number of female professors in the country's higher education institutions can be an indicator of such phenomenon. Due to this, female students do not usually have the opportunity to see successful women scientists who motivate to develop female's interest and self-confidence to join STEM at various levels. Women in academic institutions serve as a role model and their presence is crucial to recruit more women in science fields (Kvach et al, 2017) and they can help mitigate the negative stereotypes about women's ability in STEM subjects (UNESCO, 2018). In spite of this fact, lack of women role model instructors and scientists who could inspire and inform female students has been a challenge (Mamo et al, 2017, Samulewicz et al, 2012). Hafkin (2016) also argues that scarcity of women instructors/role models has been a bottleneck for females not to opt for STEM in Ethiopia.

- **Lack of adequate support from higher education institutions**

If students are to make wise field of study choices in higher education institutions, there is a need for orientation and guidance before as well as during the choice process (Egne, 2014). Universities are also expected to give adequate support in all aspects the students need assistance, and implement the government policies and strategies in relation to higher education. To this end, higher education institutions are trying their best to assist their students, and increase the number of females and reduce their attrition in STEM. However, some of the instructors at higher education are blamed for not implementing the policies and strategies that have been in place. Wondimu (2004) argue that some of the measures such as affirmative action have not been supported by some officials and teachers of higher education institutions. It was also noted that low enrolment and high attrition rate of female students in STEM had also emanated from lack of support from instructors (Hafkin, 2016). Moreover, weak gender based guidance, counselling, information and remedial learning programs have been the other challenges to bring gender equality in science and technology fields in Ethiopia (MoE 2014). The tutorial sessions intended to support female students, though it has benefits, had been given arbitrary without any guideline and needs assessment, as an informant explained.

- **Gender disparity in employment**

Ethiopia is a country with a remarkable economic growth. Despite this fact, the unemployment rate among female graduates attests the prevalence of gender inequality in getting a job in their field of study. Taking the women unemployment of 2009 to 2013, Jote (2017) indicated that on average 26.6% of female electrical engineering graduates could not get job where as the unemployment rate was 15% among male graduates of the same field. Cognizant of this fact, MoE (2018a) in its draft education development road map stated that under the current pace of the manufacturing sector development, it is less likely to employ all current graduates of engineering fields.

4.6. Opportunities and future prospects for women's participation in STI in Ethiopia

Though women have been disadvantaged in participating in STI ecosystem of the country, a number of opportunities have been in place which is primarily used to motivate them to take part in it. Since Ethiopia is a country striving to bring gender equality in all endeavors of life, in the policies and strategies designed, gender issue is among the priority areas.

The Growth and Transformation Plan II (GTP II) (2015/16-2019/20) of the country is one of the major documents that can be cited for giving emphasis for women's participation in the overall development of the country. One of the major targets of GTP II is 'ensuring gender equality at all educational levels, creating conducive environment for female students, increasing number of female teachers, increasing gender equality in employment....'(Federal Democratic Republic of Ethiopia, 2016). The Higher Education Proclamation (Proclamation No. 650/2009) also dictates to increase the proportion of women in senior positions, and as an affirmative action for students' enrolment into higher education institutions that gives special consideration of female students (Federal Negarit Gazeta, 2009). Furthermore, having considered gender issue among the problematic area of the education system of the country, the Ministry of Education Action Plan of the Education Sector Development Program (ESDP IV), incorporates females' equitable access to education at all levels as one of its objectives (MoE, 2015). The higher education road map drafted in 2018 also proposes to further strengthen the affirmative action already in place to narrow the gender gap in higher education institutions. Moreover, one of the guiding principles of the national TVET strategy of the country is to let women have equal access to TVET, and the TVET institutions are expected to develop gender sensitive policies that women will not be discriminated.

Since 2018/19 academic year, the Ethiopian government, in its higher education road map, changed the duration of all programs offered in higher education institutions. For example: programs that were taking three years to earn bachelor degree have been changed to four years. All the first year students take general courses so that females can have enough time to be familiar with the environment including the nature of the programs. If they are offered with sufficient guidance and mentor, they go for science and technology fields of study.

Additionally, the national STI ecosystem of the country takes human resource development as one of the policy issues. Among the strategies to implement the human resource development is increasing the proportion of female students who enroll in science and engineering fields in higher education institutions. The increasing numbers of universities in the country that offer STEM are also a good opportunity for those who are interested to study these fields.

5. Case study: Haramaya University

Haramaya University was founded in 1954. There are 9 colleges (College of Agriculture and Environmental Science, College of Business and Economics, College of Computing and Informatics, College of Medical and Health Sciences, College of Social Sciences and Humanities, College of Law, College of Veterinary Medicine, College of Natural and Computational Sciences, College of Education and Behavioral Sciences), 1 institute (Haramaya Institute of Technology), 1 academy (Sport Science Academy) and 1 directorate (Directorate of Continuing and Distance Education in the university). The University offers a total of 224 programs of which 106, 104, 14 are undergraduate, masters and PhD levels respectively. Haramaya is among the ten top public universities of the country that offers engineering and technology programs (Salmi et al, 2017)

Like other higher education institutions in the country, gender disparity exists in engineering, technology, health and other natural science fields at Haramaya University. To show the participation of female students and staff members, all the science and technology fields of study have been considered. Accordingly, Haramaya Institute of Technology (HIT), College Computing and Informatics (CCI), College of Natural and Computational Sciences (CNCS), Sport Science Academy, College of Health and Medical Sciences (CHMS), College of Agriculture and Environmental Sciences (CAES) and College of Veterinary Medicine are selected.

Academic Staff

In Ethiopian higher education system, the status of academic staff is ranked as professor, associate professor, assistant professor, lecturer, assistant lecturer, graduate assistant 2 and graduate assistant 1. Professors, associate professors, assistant professors and lecturers have been used to show the gender disparity in STEM related fields of study as shown in Table 3.

Table 3: Academic staff of colleges/institutes/academy in STEM related fields of study at Haramaya University, by gender and academic rank, 2019/20

Band	College/Institute	Lecturer			Assistant Professor			Associate Professor			Professor		
		M	F	% of F	M	F	% of F	M	F	% of F	M	F	% of F
1	Haramaya Institute of Technology	93	7	7%	8	0	0	3	0	0	0	0	0
	College Computing and Informatics	47	7	13%	4	0	0	1	0	0	0	0	0
2	College of Natural and Computational Sciences	49	1	2%	16	0	0	7	0	0	0	0	0
	Sport Science Academy	9	1	10%	3	0	0	0	0	0	0	0	0
3	College of Health and Medical Sciences	144	27	15.8%	71	5	6.6%	8	0	0	0	0	0
4	College of Agriculture and Environmental Sciences	61	15	19.7%	40	2	4.8%	13	0	0	9	0	0
	College of Veterinary Medicine	8	0	0	41	0	0	7	0	0	0	0	0
	Total	411	58	12.4	183	7	3.7	44	0		9	0	

F- Female M- Male

Source: Haramaya University, 3rd Quarter (2019/20) Performance Report (2020); HRMDD (2020), Haramaya University

As Table 3 shows, among the colleges/institute selected, there was no full professor except in College of Agriculture and Environmental Sciences and all the professors (n=9) were men. Though there were a total of 44 associate professors in the colleges/institute/ academy, none of them was woman and the percentage of assistant professors and lecturer women were 3.7% and 12.4%, respectively. Women assistant professors were found only in the College of Health and Medical Sciences (6.6%) and College of Agriculture and Environmental Sciences (4.8%). College of Natural and Computational Sciences and Haramaya Institute of Technology are the ones with the

lowest percentage of women lecturers (MSc/MA degree holders) that constituted 2% and 7%, respectively.

Students' enrolment

The enrolment statistics of second year and above students have been used to show the gender disparity in STEM related fields (i.e band 1 to 4) at the university.

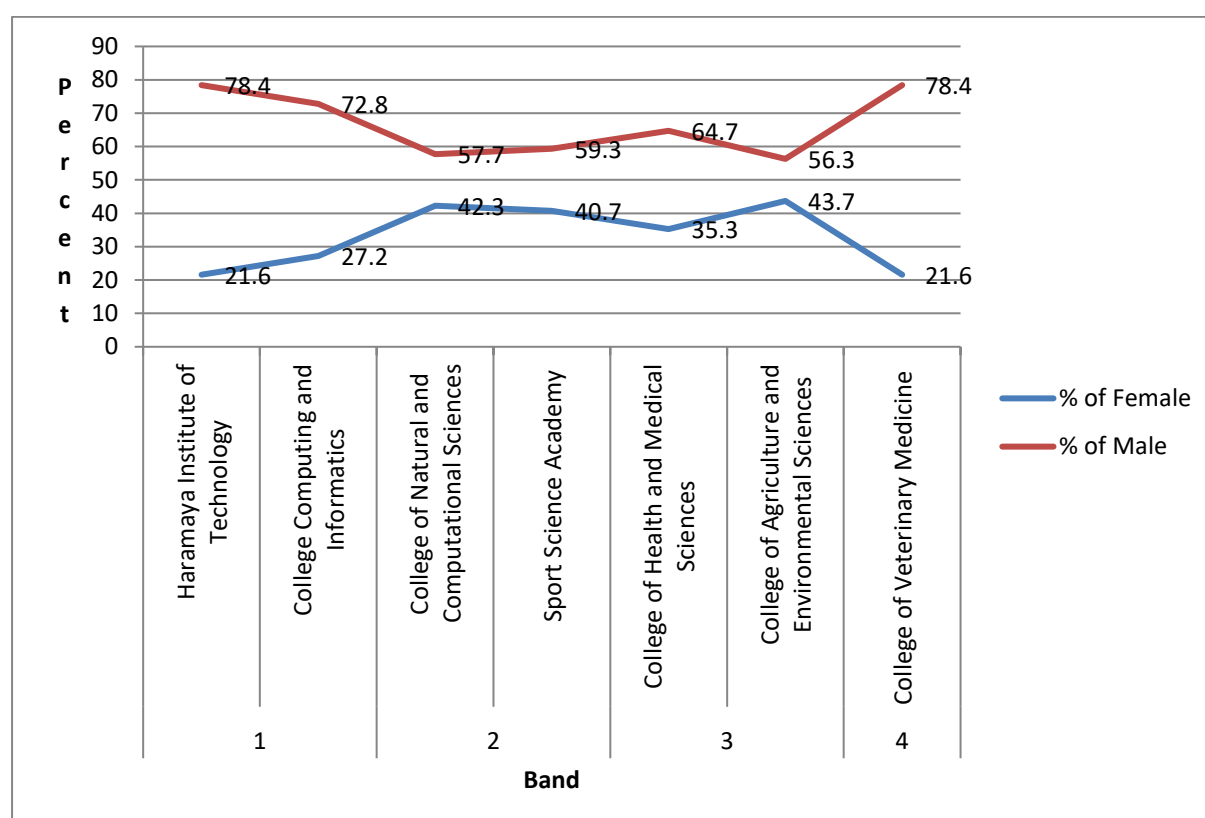


Figure 9: Regular undergraduate students at Haramaya University, by field of study (band) and gender, 2019/2020

Source: Haramaya University, 3rd Quarter (2019/20) Performance Report (2020)

As shown in Figure 7, the gender disparity is the highest among students at Haramaya Institute of Technology and College of Veterinary Medicine. The percentage of female students in all the four bands was 33.2%.

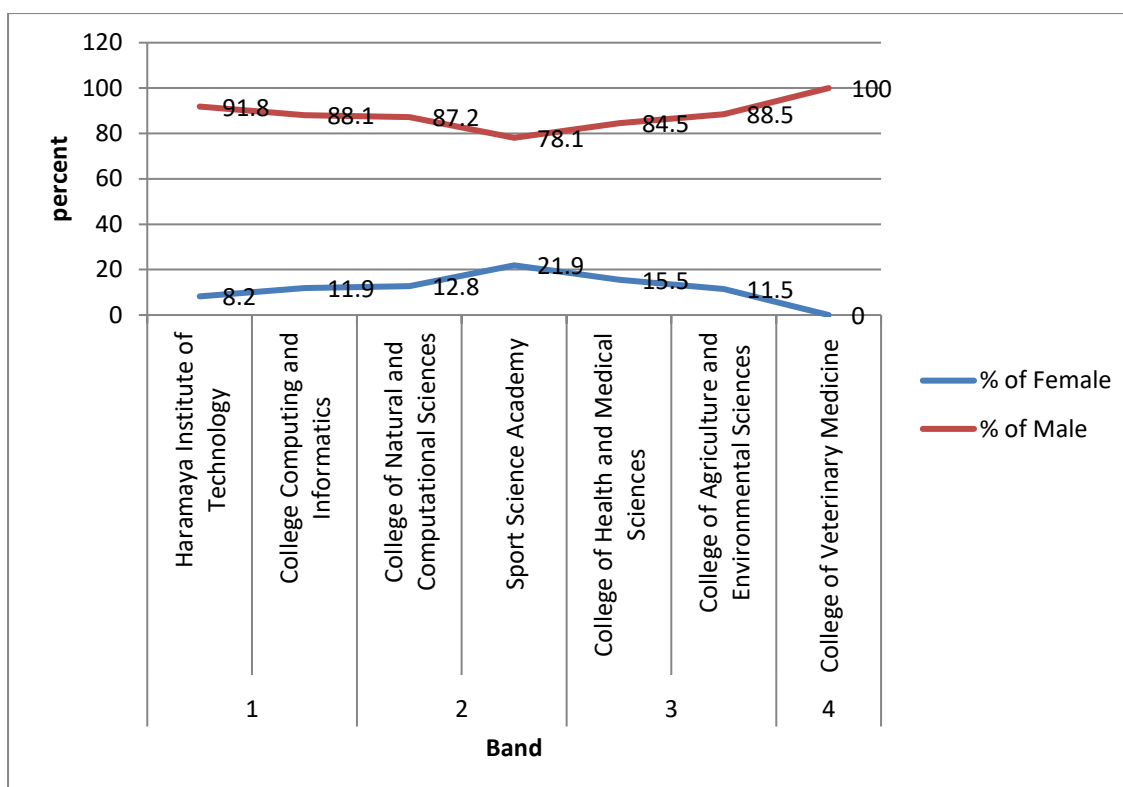


Figure 10: Regular postgraduate (masters, PhD and specialty) students at Haramaya University, by field of study (band) and gender, 2019/2020

Source: Haramaya University, 3rd Quarter (2019/20) Performance Report (2020)

The gender disparity among the postgraduate students was very high particularly in Haramaya Institute of Technology and College of Veterinary Medicine. No female postgraduate student was found in College of Veterinary Medicine. Generally, female constituted 11.7% of the postgraduate students in the four bands.

Research

As a higher education institution in Ethiopia, a number of researches have also been conducted by the academic staff and students. The studies conducted have been categorized in to six prioritized thematic areas. They are Productivity and Environmental Sustainability for Food Security and Poverty Alleviation (Theme I); Human Health, Nutrition, and Welfare (Theme II); Energy, Engineering, and Information Technologies (Theme III); Human and Social Development (Theme IV); Institutions, Innovation Systems, and Economic Development (Theme V); and Basic Science Research (Theme VI). As the third quarter (2019/20) report of the university,

154 research projects have been undertaken. Among the research projects, 109 of them have already been completed between July 2019 and March 2020.

The participation of women in the research undertaking was lower than men in the University. Among all the researchers, women constituted 15.2% (Haramaya University, 2020).

Attrition rate

As to the Haramay University (2018) report, though the attrition rate of female undergraduate students at the University decreased from 3.09 in 2015/16 to 1.85 in 2017/18, the gender gap remained. Among male undergraduate students in 2017/18, the attrition rate was 0.77%.

6. Conclusion and Recommendations

6.1. Conclusion

The STI ecosystem of Ethiopia has been given attention as it is considered a way to achieve sustainable development. The country developed STI policy and the stakeholders of the eco-system are operating to realize the country's aim to be among the middle economy countries. Higher education, as a key actor of the STI ecosystem, is contributing by producing competent graduates and problem solving researches. Moreover, an extensive effort has been made to make the ecosystem inclusive that women can take part in it. It is because participation of women in STI ecosystem is not only giving equal opportunity to attend STI fields of study in higher education institutions but also let them contribute to the development of technology and innovation. However, the proportion of women is very much less than men in STI ecosystem. The gender disparity in the enrolment of both undergraduate and postgraduate programs and the employment opportunities in high-skilled positions witness the status of the country in this regard. There have also been big gaps in terms of the qualification among men and women academic staffs of higher education and TVET institutions in Ethiopia. It is hardly possible to find women with PhD degrees in

STEM in most of the higher education institutions of the country. The low participation of women is attributed to various constraints/challenges. Therefore, it is critically important to work towards redressing the challenges so as to bring more women in the STI eco-system of the country.

6.2. Recommendations

Despite the government of Ethiopia has policies to achieve gender equality in the education sector and tries to create conducive environment to redress the prevailed gender inequality in STI eco-system, the gender gap still exists. The situation calls for a continuous effort to achieve the objectives set so that the participation of women in STI will be enhanced. To do so, the following are recommended:

- Awareness creation among female students at early stages: female students have to be given orientation about STEM at school so that they develop interest and self-confidence towards the fields.
- Elementary school teachers have to contextualize science education to the real life situation of the students so that females will develop interest and positive attitude towards it.
- Affirmative action has to be given more attention in relation to admission of female students to higher education and recruitment of female faculty in STEM fields of study: higher education institutions has to aggressively work to implement the affirmative action in STEM fields of study, the outcome of the affirmative action has to be regularly monitored and the impact has to be evaluated.
- Arranging freshman advising and mentoring, and organize training to develop research skill of female students.
- Gender awareness training has to be given to school teachers as well as instructors at higher education institution to let them motivate female students develop interest in the fields of STEM.
- The success stories of female scientists (role models) in STEM have to be told to female students and school and higher education institutions must invite these figures to inspire female students and boost their confidence to attend science fields.

- Make research fund available to female academic staff in higher education and research institutions with a particular emphasis to researches in science and technology fields, and reward those who excel in their performances
- Ensure women take advantage of travel to attend national and international conferences and workshops, and motivate and support them to present their research findings, and publish in reputable journals.
- Arranging accommodation and other facilities to female academic staffs in higher education institutions so that they have sufficient time to focus on their studies and research.
- Any academic support to female students (such as tutorial programs) have to be need-based (i.e. based on specific needs and gaps of female students) and has to be given in planned and organized ways.
- Strengthening international and regional cooperation to secure fund to give scholarship and research grant for women
- Strengthening academia-industry linkage: the linkage will serve to support the industry labour needs. Moreover, through equitable participation of women in manufacturing, women unemployment will be reduced.
- Promote visibility of women in STEM careers, especially in leadership positions in public offices, industries, business enterprises, universities and research organizations.

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