

# **Curriculum for Masters Degree in Soil Science**

**Department of Plant Science**

**College of Agriculture and Natural Resources Sciences**



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## **1. Introduction**

### **1.1. Background and Justification**

The Ethiopian agriculture is transforming rapidly to boost the agricultural productivity. Soil serves media for plant growth. Plants obtain physical support, water, air, temperature, protection and nutrients from soil. Plants need certain *essential nutrient elements* to complete their life cycle. At least 16 elements are currently considered essential for the growth of most vascular plants. Carbon, hydrogen, and oxygen are combined in photosynthetic reactions and are obtained from air and water. The remaining 13 elements are obtained largely from the soil. Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) are required in relatively large amounts and are referred to as the *macronutrients*. Elements required in considerably smaller amount are called the *micronutrients*. They include boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn). Cobalt (Co) is a micronutrient that is needed by only some plants. Billions of micro and macro fauna live in soils, which have the capacity of turning large quantities of organic wastes into beneficial hums and increase available plant nutrients. Hence, we need educated professionals to understand the nature and properties and design management strategies to improve the fertility status of our soils.

### **1.2. Rational**

Ethiopia needs to train more researchers who have the ability to identify the agricultural production challenges for crop production through years and carry out different researches to alleviate the identified problems through different technologies. This could be achieved training more professionals in the newly established Universities such as Debre Behan University all year round, through regular, extension, and summer and even online teaching programs. Expansion of post-graduate program for Debre Berhan University could accommodate the private sector and NGOs for better science and technology transfer. With all highly qualified and educated personnel Ethiopian can full fill its millennium goal set by the Government of Ethiopia and International Community. For fast development, our expertise should be equipped with new technologies and frequent training at least to the master's degree level to improve the rampant poverty level in our country. Hence, the objective of this program is to comprehend the science and its management.

### **1.3. Objectives of MSc Program in Soil Science**

**General Objectives of MSc Program:** to help the national agricultural transformation program through understanding the most relevant nature of soil fertility and plant nutrition, soil health and environmental healthy fertilizer application geared to the high crop production.

#### **Specific Objectives**

1. To understand the nature and properties of the Ethiopian soils by improving the soil qualities for maximum crop production
2. To upgrade the qualification of the agricultural professionals in soil science who engaged at government, private, and NGO institutions which can serve as policy makers, researchers and future academicians for our nation

### **1.4. Why the MSc in Soil Science at Debre Berhan University?**

Our University is supposed to be an ideal place to train students in the field of Soil Science. This is attributed to different factors.

- The Ministry of Education has vested a power in the university to diversify its undergraduate and post graduate programs and also our university has already designed and begun training of students in various fields of studies, which is of paramount importance toward implementing the newly proposed Soil Science program,
- The area is suitable for the practical teaching learning process and potential researchable ideas/problems in the field of soil science. Specifically, there are acidity, salinity, water lodging, degradation, land variability's (lowlands, highlands etc)
- The students will acquire the untouched indigenous knowledge on farming and soil management practices. These will benefit both the society and the students,
- Motivates the farmers to use different technologies by indicating the possible advantage of the technologies in improving yield and yield component

- The existing teaching staff members, infrastructure, and reference materials in the university are additional inputs for the success of the postgraduate program in Soil Science, even though further improvements will be indispensable,
- The closeness of the university to the capital Addis Ababa will also benefit the new Soil Science program as there is a good access to invite guest instructors from various institutions, such as Addis Ababa University and others.

### **1.5. Mission of the Program**

The mission of the program is to provide trainees with advanced theoretical and practical knowledge and skills that help them to be technically fit in the Soil Science, sustainable utilization and management of natural resources resource as well as in community-based watershed management. This is achieved through provision of quality education, training, research and extension activities. This in turn will facilitate inter and intra-sectorial collaboration and development at various levels in Ethiopia.

### **1.6. The Contribution of the Program**

#### **1.6.1. At the National Level**

The newly proposed graduate program provides advanced training opportunities to those professionals who are interested to extend their knowledge and skills in the area of Science at the country level. The program contributes much to satisfy the demands of skilled human power that the country needs in the field of Soil Science. The program establishes and promotes professional links through education, research and extension with different governmental and non-governmental organizations that are found in the country. The staff members of the program will carry out relevant field researches and experiments that address the various socio-economic and environmental issues and help solve the prevailing problems in the area of Soil Science throughout the country. The program advocates proper management and sustainable utilization of land resources. This

in turn helps Ethiopia to achieve its millennium development goals through promoting a climate-resilient green economy.

### **1.6.2. The Contribution the Program at the Local Level**

When the newly proposed graduate program is implemented on the ground, it provides job opportunities to the local people, for example, in the form of technical assistance during the process of educational trainings and field researches in the area of Soil Science. The program discovers new technologies via researches and makes them available to the local people through community outreach and extension services. This in turn helps the local people to wisely manage and sustainably utilize the natural resources existing in the area. The program provides short-term training opportunities to the local people who are interested to extend their knowledge and skills in the field of Soil Science in particular and natural resources management and sustainable utilization in general. The program also makes the university competent and introduces it at local, national and international levels in researches, formal and informal trainings, scientific publications and extension services especially in the field of Soil Science.

## **1.7. Nature of the Masters of Science Program in Soil Science**

### **1.7.1. Course Work**

The program includes basic and supportive courses that help the students to acquire detailed basic and applied knowledge and skills in Soil Science. All the designed courses are offered in a student centred manner so that the students internalize most relevant aspects of Soil Science.

### **1.7.2. Thesis Research Work**

A central element for the MSc program is thesis research, a process of two semesters during which the students develop proposal and carry out the actual research on the ground in their chosen areas of interest. The thesis research is an essential component of



the program to train the students to develop an independent way of thinking about important problems related to in their field of specialization, to analyze them and look for the best possible solutions. Along the research process, students upgrade their capabilities for responsible, critical and rational thinking. The MSc research thesis successfully completes with the submission of a relevant and sound thesis document followed by passing the defense examination.

### **1.7.3. Admission Requirements**

The School of Graduate Studies provides an application form for admissions and admission may take place twice in a year. Students of the program must fulfill all the graduate admission requirements listed in the university's senate legislation for the MSc programs. Specifically, the candidate must fulfill the following requirements to join the program:

- The candidate should be a graduate of BSc degree from an accredited university or college in biological science, ecology, forestry, natural resources management, or other related disciplines;
- The candidate must also pass the written entrance examination administered by the program;
- The candidate must be supported by at least two letters of recommendation from his/her undergraduate instructors and, in addition, if he/she is employed and/or a member to one from his/her employer and one from professional association (if any);
- Unless he/she is self-sponsored, a graduate student shall present evidence of support from his/her respective sponsoring organization for his/her salary, travel cost and the cost for his/her thesis research project.

### **1.7.4. Class Size**

As indicated in the university's senate legislation, the minimum intake of the program shall be five students. However, the optimum (i.e. minimum and maximum) number of

students in the program may be determined by the availability of space and demand for training.

#### **1.7.5. Duration of the Study**

Building upon the bachelor program, the duration of the study for the MSc in *Soil Science* is designed for two years administered in four semesters provided that the student is registered in the regular track. Most of the first year will be allotted for course work while the second year will be dedicated for seminar presentations and research thesis work with possible minimal course work during the first semester. However, in very rare cases, six months may be added with the approval of the Program Graduate Council or the College. In the extension track, the program needs three years, but in the summer track, it requires four consecutive summers for completion.

#### **1.7.6. Mode of Delivery**

Lectures, practical sessions, individual or group works, projects, experience sharing, laboratory and field demonstrations, self-directed assignments, guided readings and student presentations on variety of topics are the main recommended mode of delivery for the program.

#### **1.7.7. Evaluation Methods**

As indicated in the university's senate legislation, students' evaluation is not a one-step phenomenon, but it is a continuous process. In addition to final written examinations, there is also a continuous monitoring of the level of understanding of the students through individual and group assignments, presentations, watershed field reports and oral examinations. Doing individual and group assignments, laboratory and field practical works, presentations, written projects, developing teaching and research skills and discussing scientific papers in the area of the program can be used as a means of continuous assessment method. Thus, the implementation of this curriculum emphasizes on creating ample job opportunities for the trainees in governmental and non-

governmental organizations. However, no student shall be allowed to sit for an examination at the end of each course if he/she fails to attend lectures, seminars or undertake assignments for the course.

### **1.7.8. Grading System**

The grading system will be done according to the university senate legislation for the post graduate program.

### **1.7.9. Graduation Requirements**

When all the required courses, a total of 28 credit hours, of the program are taken as indicated in this document, with no “F”, no “D” and/or no more than one “C” grade in all the courses taken, with a cumulative grade point average (CGPA) of not less than 3.00 or as stipulated in the university senate legislation, and upon the successful completion of the research thesis (i.e. 6 Credit Hours thesis research submission plus successful defense) or as stipulated in the university senate legislation, a student is said to fulfill the requirements of graduation for the MSc degree in *Soil Science*.

### **1.7.10. Thesis Research Grading Ranges and Successful Completion**

The thesis research accounts for 6 Credit Hours. However, it should be declared by the Senate that the thesis research has not been submitted for a degree in any other university. It is examined by external examiner and the thesis advisor. Both of them evaluate the thesis research out of 100% and an average weight will be taken for rating. Accordingly, average weight:

- Greater than or equal to 85 will be rated **Excellent**;
- Greater than or equal to 75 will be rated **Very Good**;
- Greater than or equal to 60 will be rated **Good**;
- Greater than or equal to 50 will be rated **Satisfactory**;
- Less than 50 will be rated **Fail**.

For successful graduation with thesis research work in this program:

- A student should score at least a “**Satisfactory**” rating in the thesis research or as stipulated in the university senate legislation, and
- A student course work performance of CGPA (Cumulative Grade Point Average) greater than or equal to 3.00 with no more than one “C” or as stipulated in the university senate legislation.

#### **1.7.11. Degree Nomenclature and Award Upon Graduation**

After fulfilling all the requirements for graduation, a student will be awarded a degree of “**Masters of Science (MSc) in Soil Science.**”

#### **1.7.12. Course Types and Naming**

The major course types given in the program are basic and supportive courses. The candidate must register and take all the courses in order to qualify for the MSc degree in **SOIL SCIENCE**.

#### **1.7.13. Course Coding**

A code of courses whose home base is the program begins with SoSc and followed by a three-digit numbers. The first digit of the three-digit numbers indicates the year of the study (i.e. “5” for year I and “6” for year II); the second represents the sequence of the course in the program for that semester, and the third digit denotes the semester in which the course is offered. For example, “ODD” last digit courses are offered during the first semester, whereas “EVEN” last digit courses are offered during the second semester. Exception to this last notion is for elective courses and MSc thesis research.

### **1.8. How to Maintain the Quality of the Program?**

Various approaches will be implemented to improve and assure the quality of the program. As the MSc program in **SOIL SCIENCE** is mainly an outdoor-training

discipline, the learning-teaching process will be accompanied by visiting different soil types in field of North Shewa Zone. Moreover, the closeness of the university to some national laboratories, factories, research intuitions enable us to do research without any hindrances and this provides good opportunities to regularly demonstrate students with practical trainings that help maintain the educational quality of the program. As the university is located close to Addis Ababa, we will establish joint venture and invite guest instructors from various institutions, such as Addis Ababa University. In addition, we will invite senior professionals to provide seminars, workshops, and short talks in their discipline to the students. Thus, the research and practical experiences shared by different professionals will improve the quality of the program. Our diverse climate and agroecology another asset, and we have highland (> 2000 masl), midland (1500-2000 masl), and low land (below 1500 masl)

### **1.9. Stake Holders**

In addition to this Debre Berhan University is situated in ideal place, and this makes the Agriculture and Natural Resources College to move head very rapidly to launch its program.

- In and outside the compass, we have different agricultural experimental sites located at different agro-ecological zones,
- There are several factories and companies suited for our research work around our university,
- National, Regional and Zonal Agricultural, Natural resources and Environmental Management and Protection Offices,
- The are Several Federal and Regional Agriculture Research Centers equipped with adequate laboratory equipment and facilities, experimental plots (national Soil Lab in Addis Ababa, Holeta Agricultural Research Center, Ambo Agricultural Research Centers, Mekasa in Adama etc.),
- In addition to this we have several International Research Institutions (ILRI, IWMI, ICRISAT, CIP, ICARDA, ICRAF etc.),

- For Agricultural and Natural Resources it is to build permanent and seasonal greenhouse and lighthouses very quickly for the required types of experiments,
- Agricultural and Natural Resources College has adequate laboratory spaces and equipping them with laboratory equipment and tools (agronomy, horticulture, soil, plant protection, plant physiology, plant breeding laboratories etc.),
- The nature of some programs and research may need only agricultural land and community participation in the outreach, and
- The Agricultural and Natural Resources College has established linkages and agreement with several agricultural institutions (Debre Beran Agricultural Research Center, Alage agricultural training center, Worer Agricultural Research Center, Hotelea Agricultural Center and others)

#### **1.10. Resource**

##### **➤ Infrastructure**

The existing infrastructure such as classrooms, libraries, and laboratories at Debre Berhan University are important inputs to launch the MSc program in *Soil Science*, even though further improvements are indispensable. Moreover, the available materials, such as reference books, computers, and vehicles, research facilities (e.g. laboratory and field tools and equipment) in the university are supplemental inputs to commence the graduate program, though the success of the program may need additional elements.

##### **➤ Human Power**

The existing teaching staff members in the university are relevant inputs for the success of the graduate program in *Soil Science* even though further professional staff recruitments are crucial. List of instructors and their academic qualification and staff profile of the Plant Science and Natural Resources Management Department is depicted at the end of this document.

## 2. List of Courses

No.	Course Title	Course code	Credit hours
1	Soil Genesis and Classification	SoSc511	3 (2 + 3)
2	Soil Chemistry	SoSc521	3 (2 +3)
3	Soil Physics	SoSc531	3 (2 + 3)
4	Soil Microbiology	SoSc541	3 (2 + 3)
5	Biometry	SoSc551	3 (2 + 3)
6	Soil and Water Conservation	SoSc512	3 (2 + 3)
7	Advanced Soil Fertility and Plant Nutrition	SoSc522	3 (2 + 3)
8	Nature and Management of Problematic Soils	SoSc542	1(1 + 0)
9	Soil, Water and Plant Analysis	SoSc532	2 (1 + 3)
10	Graduate Seminar and Proposal Writing	SoSc572	1 (1 + 0)
11	GIS and Remote Sensing	SoSc562	2 (1 + 3)
12	Soil Survey and Land Evaluation	SoSc552	2 (1 +3)
13	Thesis	SoSc611	6

### Summary

- Course work = 29
- Thesis work = 6
- Total cr. hrs = 35

### 2.1. Distribution of Courses

#### I. Regular

##### First Year First Semester

No.	Courses Title	Credit hours
1	Soil Genesis and Classification	3
2	Soil Chemistry	3
3	Soil Physics	3
4	Soil Microbiology	3
5	Biometry	3
Total credit hours		<b>15</b>

##### First Year Second Semester

No.	Courses Title	Credit hours
1	Soil and Water Conservation	3
2	Advanced Soil Fertility and Plant Nutrition	3
3	Nature and Management of Problematic Soils	1
4	Soil, Water and Plant Analysis	2
5	Graduate Seminar and Proposal Writing	1
6	GIS and Remote Sensing	2
7	Soil Survey and Land Evaluation	2
Thesis proposal Compiling and Write up		
Total credit hours		<b>14</b>

## Second year

No.	Courses to be delivered	Credit hours
1	Thesis	6
	✓ Thesis proposal completion and submission	
	✓ Thesis proposal presentation	
	✓ Thesis proposal correction and re-submission	
	✓ Thesis final draft submission	
	✓ Thesis defence	
	✓ Thesis correction and final submission	
Total credit hours		<b>6</b>

## II. Extension

### First year semester I

No.	Courses Title	Credit hours
1	Soil Genesis and Classification	3
2	Soil Chemistry	3
3	Soil Physics	3
Total credit hours		9

### First year semester II

1	Soil Microbiology	3
2	Biometry	3
3	Soil and Water conservation	3
Total credit hours		9

### First year semester III

No.	Courses Title	Credit hours
1	Advanced Soil Fertility and Plant Nutrition	3
2	Nature and Management of Problematic Soils	1
Thesis proposal compiling and write up		
Total credit hours		<b>4</b>

### Second year semester I

No.	Courses Title	Credit hours
1	Soil, Water and Plant Analysis	2
2	Graduate seminar and proposal writing	1
3	GIS and Remote Sensing	2
4	Soil Survey and Land Evaluation	2
Thesis proposal compiling and write up		
Total credit hours		<b>7</b>



## Second year semester II, and Third year (Semesters I and II)

No.	Courses to be delivered	Credit hours
1	Thesis	6
	✓ Thesis proposal completion and submission	
	✓ Thesis proposal presentation	
	✓ Thesis proposal correction and re-submission	
	✓ Thesis final draft submission	
	✓ Thesis defence	
	✓ Thesis correction and final submission	
Total credit hours		<b>6</b>

### III. Summer

#### Summer I

No.	Courses Title	Credit hours
1	Soil Genesis, and Classification	3
2	Soil Chemistry	3
3	Soil Physics	3
Total credit hours		9

#### Summer II

1	Soil Microbiology	3
2	Biometry	3
4	Soil and Water Conservation	3
Total credit hours		9

#### Summer III

No.	Courses Title	Credit hours
1	Advanced Soil Fertility and Plant Nutrition	3
2	Nature and Management of Problematic Soils	1
3	Soil, Water and Plant Analysis	2
4	Graduate Seminar and Proposal Writing	1
5	GIS and Remote Sensing	2
6	Soil Survey and Land Evaluation	2
Thesis proposal compiling and write up		
Total credit hours		<b>11</b>

#### Summer IV

No.	Courses to be delivered	Credit hours
1	Thesis	6
	✓ Thesis proposal completion and submission	
	✓ Thesis proposal presentation	
	✓ Thesis proposal correction and re-submission	
	✓ Thesis final draft submission	
	✓ Thesis defence	
	✓ Thesis correction and final submission	
Total credit hours		<b>6</b>

## 2.2. Course Contents

### ● Soil Genesis and Classification

Chapter	Main topic
1	Concepts and definition of soils
2	Major morphology of soils
3	Soil compositions and characteristics
4	Soil forming factors
5	Processes of soil formation
6	Classification of soils
7	Interpretation of soil characteristics

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### ● Soil Chemistry

Chapter	Main topic
1	The soil system
2	Soil chemistry, sustainable agriculture and the environment
3	Ion relationships in the soil-plant system
4	Oxidation-reduction relations in soils
5	Chemical equilibrium and thermodynamics in soil system
6	The inorganic components of soils
7	Soil organic matter: chemistry and dynamics
8	Ion adsorption and exchange in soils

## ● Soil Physics

Chapter	Main topic
1	Basic concepts of soil physics
2	General physical characteristics of soils
3	The physical and mineralogical nature of soil particles
4	Soil-water: content and potential
5	Flow of water in the soils
6	Infiltration and redistribution
7	Concepts of water availability to plants
8	Transport of salts in the soil
9	Soil air and aeration
10	Soil temperature and heat flow
11	Stress-Strain relation and soil strength
12	Soil compaction and consolidation

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## ● Soil Microbiology

Chapter	Main topic
1	Soil as a living body
2	Micro flora and fauna in the soil
3	Soil environment in relation to microbial habitat
4	Soil enzymes
5	Microbial decomposition of organic materials in the soil system
6	SOM turnover in relation to soil fertility and crop productivity
7	Nutrient cycling in soils
8	Biological and genetic aspects of nitrogen fixation
9	Microbial transformation of metals in the soil
10	Microbial interaction in rhizosphere
11	Mycorrhiza-plant relationships
12	Bio-fertilizers
13	Bio-pesticides and bioconversions and degradations
14	Organic farming and sustainable agriculture

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● **Biometry**

Chapter	Main topic
1	Basics of biometry
2	Statistical inferences
3	Principles of experimental design
4	Designs for single factor experiments
5	Factorial experiments
6	Comparison of treatment means
7	Analysis of covariance
8	Regression and correlation analysis
9	Non-parametric test
10	Data transformation

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## ● Soil and Water Conservation

Chapter	Main topic
1	Concepts and facts of soil and water conservation
2	Soil erosion factors
3	Soil erosion types, impacts and magnitude
4	Estimating of surface run off
5	Soil erosion models and modelling
6	Measurement of soil erosion
7	Control of soil erosion by water
8	Control of soil erosion by wind

## ● Advanced Soil Fertility and Plant Nutrition

Chapter	Main topic
1	Introduction
2	The soil as a medium of plant nutrition; soil fertility and productivity
3	Principles of nutrient availability and uptake
4	Essential nutrients
5	Beneficial and toxic elements
6	Organic wastes as nutrient sources
7	Soil fertility evaluations
8	Nutrient interaction in soil and plant nutrition
9	Nutrient and water use efficiency
11	Yield response functions; plant growth and crop production
12	Fertilizer and fertilizer application
13	Integrated soil fertility management

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## ● Nature and Management of Problematic Soils

Chapter	Main topic
1	Definition and principles
2	Management of acidic soils
3	Management of salt affected and alkaline soils
4	Management of water logged soils
5	Management of eroded and degraded soils
6	Management of nutrient imbalanced soils
7	Management of polluted soils

### References:

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## ● Soil, Water and Plant Analysis

Chapter	Main topic
1	Soil, water and plant samples collection and preparation
2	Soil, water and plant samples handling
3	Laboratory management and chemical and instrumental handling
4	Use of basic laboratory equipment's
5	Specialized instruments: principle, theory and operation
6	Applications: Data analysis and management
7	Laboratory analysis of soil samples (full protocol)
8	Laboratory analysis of water samples (full protocol)
9	Laboratory analysis of plant samples (full protocol)
10	On field characterization and classification of soils

### References:

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3. Smith, A.K. and M.S. Cresser. 2004. Soil and Environmental Analysis: Modern Instrumental Techniques. 3rd Ed., Marcel & Dekker, Inc., USA.
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● **GIS and Remote Sensing**

Chapter	Main topic
1	Introduction
2	Basic concepts, principles and functions of GIS
3	Components and applications of GIS
4	Coordinate systems
5	Geographic database and data modelling
6	Basic concepts, principles and functions of RS
7	Image and sensors
8	Imagery resolutions, analysis techniques and transformations
9	Cameras and aerial photography

● **Soil Survey and Land Evaluation**

Chapter	Main topic
1	Basics aspects of soil survey and mapping
2	Soil survey principles and applications
3	Techniques of soil survey and field data
4	Soil maps and mapping units
5	Interpretation of soil characteristics

**Reference:**

1. Soil Survey Staff. 2006. Keys to Soil Taxonomy. 10th Ed. USDA, Washington DC, USA.



### 3. Staff Profile

<b>No.</b>	<b>Name</b>	<b>Level of education</b>	<b>Field of Specialization</b>	<b>Year of experiences</b>
1	Dr. Girma Tadesse	PhD	Soil science & plant nutrition	>25
2	Dr Asmare Melese	PhD	Soil Science	10
3	Dr Wendosen Tena	PhD	Soil Science	
4	Haymanot Awgichew	Msc	Soil science	5
5	Fikray	PhD	Soil Science	
6	Mitiku Ashenafi Ejigu	Msc	Agronomy	6
7	Gebre Kiros Meko	Msc	Agronomy	15
8	Hailu Terefe Diressie	Msc	Agro Ecology	21
9	Fresew Belete G/tsadik	PhD candidate	Agronomy	
10	Negash Tamiru	PhD candidate	Environmental Science	