

Course Curricula and Syllabus for PhD Degree
Department of Soil Science
Bangladesh Agricultural University
Mymensingh

April – September Semester		
A:Compulsory Courses (9 Credits)		
Course Code	Course Title	Credit
SS 607	Advanced Soil Fertility and Plant Nutrition	3
SS 609	Advanced Soil Degradation and Conservation	3
SS 611	Advanced Research and Reporting	3
B:Elective Courses (2-4 Credits)		
Course Code	Course Title	Credit
SS 523	Soil Water	2
SS 525	Soil Resilience and Climate Change	2
SS 527	Micronutrients in Soils and Plants	2
SS 529	Soil Health and Risk Reduction	2
October – March Semester		
A:Compulsory Courses (9 Credits)		
Course Code	Course Title	Credit
SS 601	Advanced Soil Physics	3
SS 603	Advanced Soil Chemistry	3
SS 605	Advanced Soil Microbiology	3
B:Elective Course (2-4 Credits)		
Course Code	Course Title	Credit
SS 515	Waste Management and Biofertilizer	2
SS 517	Soils of Bangladesh	2
SS 519	Soil, Water and Air Pollution	2
SS 521	Soil, Water and Fertilizer Management using Nuclear Techniques	2
Others		
Seminar (Two)		4
Research Reports (End of first and third year)		4
Research		23
Dissertation evaluation		15
Dissertation defense		6
GRAND TOTAL		76

Syllabus for PhD in Soil Science
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Course Code: SS 601 Course Title: Advanced Soil Physics
Credit: 3

Soil-Water Relationships

Soil Texture, Soil Structure, Soil Water Storage, Availability and Measurement of Soil Water, Gravimetric Vs Volumetric Method, Tensiometer Method, Soil Total Pore Volume, Available Water Capacity

Gas Diffusion and Emissions in Soils

Fick's Law, Gas Diffusion and Exchanges between atmosphere and Soil, Measurement of Gas Diffusions in soils, Measurement of Gas Exchanges between Air And Soil

Heat Flow through Soil

Measurement, Impacts of Mulching on Soil Temperature Management and Crop Production

Water Balance

Application of FAO Model for Water Balance Estimation, Evaporation and Transpiration, Water Percolation, Crop Water Requirement and Water Productivity

Water Flow

Water Flow in Saturated Soils, Water Flow in Layered Soils, Steady Flow in Homogenous Soils, Darcy's Law

Soil Aggregate

Aggregate Properties, Stability and Nutrient Storage in aggregates

Pedotransfer Functions

Applications of Models: Van Genuchten Equations and Saxton Model

Books Recommended

1. Hillel, D. 1998. Environmental Soil Physics. 1st Edition, Academic Press, New York.
2. Hillel, D. 1980. Applications of Soil Physics. Acad. Press, New York, USA.
3. Hiller, D. 1980. Fundamentals of Soil Physics. Acad. Press, New York, USA.
4. James, D.W., Hanks, R. J. and Jurianak, J.J. 1982. Modern Irrigated Soils, John Wiley & Sons., NY.
5. Lambert, K.S. and Rhcroft, D.W. 1983. Land Drainage-Planning & Design of Agric. Drain. System. Batsf. Acad. &Edn. Ltd.
6. Michael, A.M. 1978. Irrigation- Theory and Practice, Vikas Publishing House Pvt. Ltd. NewDelhi.
7. Ghildyal, B.P. and Tripathi, R.P. 1987. Soil Physics. Wiley Eastern Ltd., New Delhi.

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**Course Code: SS 603 Course Title: Advanced Soil Chemistry
Credit: 3**

Nutrient availability and ion exchange

Mass flow and diffusion, interception and contact exchange, soil solution- quantity and intensity factor, Donnan equilibrium in ion exchange phenomena, cation exchange equations- Kerr and Gapon equation, Stern and Gouy- Chapman theories, zeta potential, aspects of phosphate and potash fixation in soils.

Surface reaction in soil colloids

Adsorption of cations and anions, mechanism of ion sorption at mineral/water interface, selectivity in ion adsorption, diffuse double layer models of ion adsorption, adsorption isotherm including Freundlich and Langmuir equations.

Oxidation and reduction in wetland soils

Nernst equation, quantification of soil redox potential, intensity and capacity of soil reduction, mechanism of reduction in paddy soil, soil reduction and wetland plant functioning.

Soil Clay Mineralogy

Structural units of soil clay minerals, classification of silicate and non-silicate structures, Genesis and crystal chemistry of silicates, surface chemistry of soil clays, important clay minerals found in Bangladesh, radionuclide-contaminated soils and mineralogical perspectives for their remediation, reactions of pesticides with soil minerals, interactions of enzymes with clays and applications in bioremediation.

Books Recommended

1. Tan K.H. 1982. Principles of Soil Chemistry, CRC Press, Taylor & Francis, Boca Raton.
2. Bear, F.E. 1967. Chemistry of the Soil. Reinhold Pub. Corp., USA.
3. Bohn, H.L., Mc Neal, B.L. and O'Connor, G.A. 1974. Soil Chemistry, John Wiley & Sons, New York.
4. Greenland, D.J. and Hayes, M.H.B. 1981. The Chemistry of Soil Processes. John Wiley & Sons Ltd., New York.
5. Grim, R.E. 1953. Clay Mineralogy. McGraw Hill Book Co., Inc., New York.
6. Mengel, K. and Kirkby, E.A. 1987. Principles of Plant Nutrition. Int. Potash Inst. Pub., Switzerland.
7. Ponnampuruma, F.N. 1972. Advances in Agronomy, Vol. 24. Amer. Soc. Agron., Inc. Pub., Wis., USA.
8. Dixon, J.B. and Schulze, D.G. 2002. Soil Mineralogy with Environmental Applications. Vol. Soil Sci. Soc. America, Inc. Madison, Wis., USA.

**Syllabus for PhD in Soil Science
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**Course Code: SS 605 Course Title: Advanced Soil Microbiology
Credit: 3**

Soil as a Microbial Habitat

Soil microbes and their nutrition; diversity and distribution of soil microbes; environmental and management effects on soil microbes, microbial interactions; microbial biomass; rhizosphere - its biology and impact on crop productivity

Biological Nitrogen Fixation

Symbiotic, non-symbiotic and associated nitrogen fixation systems; biochemistry of nitrogen fixation; nitrogenase enzyme, oxygen protection mechanisms and regulation; Nif genes; methods for measuring nitrogen fixation

Plant Growth Promoting Rhizobacteria (PGPR)

Concept of PGPR; biological control of phytopathogens; mechanism of control – *Trichoderma* sp. and *Pseudomonas fluorescens* biocontrol agents; disease suppressive soils; biopesticides and their importance; biodegradation of pesticides

Microbial Genomics

Structure and diversity of soil microbial community; molecular techniques used in soil microbial community studies – soil DNA extraction, PCR, qPCR, gel electrophoresis, DNA sequencing

Books Recommended

1. Alexander, M. 1977. Introduction to Soil Microbiology. John Wiley & Sons Inc., New York.
2. Brady, N.C. and Weil, R.C. 2012. The Nature and Properties of Soils. Pearson Education Pvt. Ltd. New Delhi, India.
3. Coyne, M.S. 1999. Soil Microbiology: An Exploratory Approach. Delmar Publishers.
4. Keister, D.L. and Cregan, P.B. 1991. The Rhizosphere and Plant Growth. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M. and Stahl, D.A. 2017. Brock Biology of Microorganisms, 15thEdn. Pearson Education.
6. Paul E.A. (Ed.). 2015. Soil Microbiology, Ecology and Biochemistry. 4thEdn. Academic Press.
7. Rangaswami, G. and Bagyaraj, D.J. 2004. Agricultural Microbiology, Prentice Hall of India (Pvt) New Delhi.
8. Roger, L.J. and Gallon, J.R. 1988. Biochemistry of algae and cyanobacteria. Oxford University Press, London.
9. Subba Rao, N.S. 2001. Soil Microorganisms and Plant Growth. Oxford and IBH Publishing Co. Pvt. Ltd.

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Course Code: SS 607 Course Title: Advanced Soil Fertility and Plant Nutrition
Credit: 3

Soil Fertility

Soil fertility research in Bangladesh-past and present; Relationship between nutrient supply and crop growth; Models for fertilizer requirements for crops; IRR model, BARC model, Queft model, missing element model; site specific nutrient management for precision agriculture. Fertilizer use in Bangladesh, economics of fertilizer use. Soil fertility management– manures and fertilizers, soil management. Integrated Plant Nutrition System; Conservation agriculture; Climate smart agriculture; Fertilizer management - compound & slow-release fertilizers, nanofertilizers; Soil amendment-liming and biochar; nutrient use efficiency, residual and cumulative effect of fertilizer use; nutrient balance.

Plant Nutrition

Nutrient movement in soils- mass flow & diffusion, contact exchange & soil solution theories; nutrient transporters in plants; nutrient mobility; nutrient interactions; nutritional disorders - deficiency & toxicity symptoms; Nutrient sensitive agriculture- methods of biofortification& micronutrients biofortification (Fe, Zn, I and Se) in crops.

Books Recommended

1. BARC, 2018. Fertilizer Recommendation Guide. Soils Publication no. 41. Bangladesh Agricultural Research Council, Farm-gate, Dhaka.
2. Brady, N.C. and Weil, R.R. 2002. The Nature and Properties of Soils. Pearson Education Pte. Ltd. New Delhi, India.
3. Bennelt, W.F. 1996. Nutrient Deficiencies and Toxicities in Crop Plants. Amer. Phytopath. Soc., St. Paul, Minnesota, USA.
4. Havlin, J.L, Tisdale, S.L. Nelson, W.L. and Beaton, J.D., 2013. Soil Fertility and Fertilizers. 8th Edition, Potash and Phosphate Institute, Canada.
5. Mengel, K. and Kirkby, E.A. 2001. Principles of Plant Nutrition.5th Edition Dordrecht: Kluwer Academic Publishers
6. Miller, R.W. and Donahue, R.L. 1990. Soils An Introduction to Soils and Plant Growth. Prentice Hall Inc., USA.
7. Mortvedt, J.J., Cox, F.R., Shuman, L.M. and Welch, R.M. 1991. Micronutrients in Agriculture. 2nd ed. Soil Sci. Soc. Amer. Inc., Madison, Wis., USA.
8. Stevenson, F.J. 1985. Cycles of Soils-Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients. John Wiley & Sons Inc., New York.
9. Troeh, F.R. 2005. Soils and Soil Fertility. 6thEdn. Wiley-Blackwell.

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Course Code: SS 609 Course Title: Advanced Soil Degradation and Conservation
Credit: 3

Soil Degradation

History, distribution, and description of soil degradation problems in Bangladesh; types, classes and processes of soil degradation

Soil Erosion

Water and wind erosion, Mechanics of water erosion, Models to predict the extent of water induced erosion, Factors affecting Inter-rill and Rill erosion, Control of Gully erosion and mass wasting, harmful effects of soil erosion; losses due to degradation- soil, nutrients, vegetation; properties of degraded soils - degraded rice soils, saline soils, acid soils, hill soils, charlands, soils polluted with heavy metals; wetland degradation. Land degradation indicators and assessment: WOCAT-BANCAT approach

Soil Conservation

Concept of soil conservation; principles of erosion control; erosion control measures - agronomical and engineering; erosion control structures - their design and layout; soil conservation planning; land capability classification as a guide to conservation; soil conservation in special problem areas - hilly, drought prone, saline, riverbank, charlands, saline regions, waterlogged and wet lands; modification of soil properties - soil structure, infiltration and drainage; socio economic aspects of soil conservation, Progress in soil conservation

Books Recommended

1. BARC. 2018. Fertilizer Recommendation Guide. BARC, Dhaka.
2. Brady, N.C. and Weil, R.R. 2015 (15thEds). The Nature and Properties of Soils. Pearson Education Pvt. Ltd. New Delhi, India.
3. FAO. 2013. Land Degradation in The Philippines. Food and Agriculture Organization of the United Nations.
4. FAO 2001. The economics of conservation agriculture. FAO Y2781/E.
5. Khuda, Z.R.M.M. 2001. Environmental Degradation: Challenges of the 21st Century. Environmental Survey and Research Unit, Dhaka.
6. Lal, R. and Sanchez, P.A. 1992. Myths and of Soils of the Tropics. SSA Special Publication No.29. Soil Science Society of America, Madison.

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Course Code: SS 611 Course Title: Advanced Research and Reporting
Credit: 3

Basic Statistics

Basic descriptive and inferential statistics. A few measures of central tendency. An overview of univariate and multivariate analyses and test of significance. Step-by-step procedure of conducting these statistical analyses using Minitab/SPSS, reading the output, and summarizing the results

Data Processing

Collection and analysis of data, Spreadsheet handling in Excel, normalization methods, Transformation of data - square root and logarithmic transformation, Tabular and graphical forms of data presentation, Step-by-step demonstration of producing graphs and tables using Excel/Sigma plot, reading the output, and summarizing the results

Simple & Multiple Regression

Fundamental concepts underlying regression analysis, including regression equation, regression coefficients, and other indices. Multicollinearity and a means of testing interaction effects in regression analysis. Step-by-step demonstration of conducting a multiple regression analysis using Minitab/SPSS, reading the output, and summarizing the results

Field Experimentation

Basic principles of experimental designs-layout, plot size and shape, number of replications, sampling, data collection; Selection of experiment site, experimental designs -Completely Randomized Design, Randomized completely Block Design, Latin Square Design and Split-Plot Design. Different utilities of and variables used in one-way vs. two-way ANOVA, between-group vs. within-group ANOVA, and ANCOVA. Mean separation test- Duncan's multiple range test; least significant difference. Step-by-step demonstration of conducting these statistical analyses using Minitab/SPSS, reading the output, and summarizing the results

Scientific Paper Writing

Writing a scientific paper, Plagiarism testing, Procedure to submit a paper, Peer reviewing an actual example on responses to reviewers

PhD Thesis Writing

Literature reviewing, Choosing and breaking down a research topic, Developing research questions and claims/hypotheses, Developing critical reading skills and managing reading/note-taking, Structuring a doctoral thesis, Developing oral presentation skills

Writing Project &Management

Development of research/problem question, project description, specification of target group, possible financiers, time plan, and budget. Distribution of responsibilities and roles within a project group, as well as methods for follow-up and evaluation.

Books Recommended

1. Anonymous, 2004. A Handbook of Scientific Report Writing. Graduate Training Institute (GTI), Bangladesh Agricultural University (BAU), Mymensingh.
2. Cargill, M. and O'Connor, P. 2009. Writing Scientific Research Articles: Strategy and Steps. Blackwell Publishing, West Sussex, UK.
3. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. Second Ed. John Wiley & Sons, New York.
4. Mertler, C. A. and Vannatta, R. A. (2010). Advanced and multivariate statistical methods (5th edn.). Glendale, CA.
5. Pallant, J. (2011) SPSS survival manual: A step by step guide to data analysis using the SPSS program. 4th Edition, Allen & Unwin, Berkshire.
6. Winner, L. 2004. Introduction to Biostatistics, Department of Statistics, University of Florida.
7. Zaman, S.M.H., Rahman, K. and Howlader, M.1982. Simple Lessons from Biometry. Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Dhaka.

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**Course Code: SS515 Course Title: Waste Management and Biofertilizer
Credit: 2**

Waste

Concept, types and availability of wastes, scope and importance of waste utilization in Bangladesh

Waste management

Municipal solid waste management: process and practice, incineration of waste, land filling, implication in agriculture

Organic recycling of waste

Composting of waste, methods of composting, maturity of compost, enrichment of compost, composing scenario in Bangladesh, challenges and opportunity of composting
Quick composting, vermicompost, Trichocompost

Biofertilizers

Definition, scopes, types, quality control and use of Biofertilizers

Rhizobium: Classification, characterization, mass production of inoculums and use.

Azotobacter: Classification, physiology, amount of N fixation and use as biofertilizer

Cyanobacteria: Classification, nitrogen fixation, fate of fixed N in rice field ecosystem,

Azolla: Species, biomass production and N fixation; benefits and limitations of Azolla culture in rice field

Mycorrhiza: Types, physiology, inocula maintenance; use in seedling nursery beds for vegetable crops and fruit trees

Plant Growth Promoting Rhizobacteria (PGPR): Types and effects on plant growth

Books Recommended

1. Diaz, L.F., Savage, G.M., Eggerth, L.L. and Goluke, C.G. 1993. Composting and Recycling Municipal Solid wastes. Lewis Publishers, Boca raton.
2. Hamdi, Y.A. 1982. Application of Nitrogen Fixing Systems in Soil Improvement and Management. FAO Soils Bulletin 49. Rome, Italy.
3. Krishna Murthi, R. 1978. A Manual on Compost and Other Organic Manures. Today and Tomorrows Printers and Publishers, New Delhi-110005
4. Malik, K.A. Naqvi, S.H.M. and Aleem, M.I.H. 1985. Nitrogen and the Environment, NIAB, Faisalabad, Pakistan.
5. Subba Rao, N.S. 1984. Biofertilizers in Agriculture. Oxford and IBH Pub. Co. Pvt. New Delhi.
6. Subba Rao, N.S. 1987. Advances in Agricultural Microbiology. Oxford and IBH Pub. Co., New Delhi.
7. Vincent, J.M. 1982. Nitrogen Fixation in Legumes. Academic Press, Paris, San Diego, Tokyo, Toronto.
8. Xinthian. D.1993. Current Development in Soybean Rhizobium Symbiotic Nitrogen Fixation. Heilongjiang Sci. & Tech. Pub. House.

**Syllabus for PhD in Soil Science
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**Course Code: SS517 Course Title: Soils of Bangladesh
Credit: 2**

Environment of soil formation in Bangladesh

Location and climate; Geology; Geomorphology; Hydrology; Biological agents; Physiography

Soil Forming Processes

Soil formation on seasonally flooded and non-flooded land. The Soil Forming Processes in Bangladesh: Ripening, Homogenization, Reduction, Ferrollysis, Decalcification, Formation of gleyans, Clay Eluviation and illuviation, Acidification, Formation of mottles, Formation of lime nodules, Alkalization, Formation of peat

Soil Classification

Classification of Bangladesh Soils based on USDA Soil taxonomy and FAO-UNESCO Soil Map of the World/Legends

Agroecological Zones of Bangladesh (AEZ): concept and a brief description of different AEZs for potential crop production suitability. Description of soils: Morphological description of representative soil series of Bangladesh viz. Baliadangi, Gangachara, Sonatala, Shilmondi, Sara, Ajmiriganj, Tejgaon, Nijhuri, Pirojpur, and Rangamati series

Books Recommended

1. FAO report. 1971. Soil Survey, Project, Bangladesh Soil Resources. Rome. Tech. Rep..
2. FAO report. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development, Agroecological Regions of Bangladesh. Report-2.
3. H. Brammer, 1996. The Geography of the Soils of Bangladesh. University Press Ltd., Dhaka, Bangladesh.
4. Huq, S. M. I. and Shoaib, J. U. M. 2013. The Soils of Bangladesh, World Soils Book Series 1, Springer Science+Business Media Dordrecht, Germany.
5. Hussain, M.S. 1992. Soil Classification with Special Reference to the Soils of Bangladesh. Univ. Dhaka.

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Course Code: SS519 Course Title: Soil, Water and Air Pollution
Credit: 2

Introduction of Pollution

Pollutants in the environment, source and consequences; organic, inorganic & biological pollutants; transport of pollutants; Phytoremediation/bioremediation: concept and application

Soil Pollution

Pesticides and fertilizer as soil pollutant: residues, degradation, hazards, and their impacts on soil properties; Heavy metals (As, Cd, Pb & Cr) as soil pollutants: sources; hazards and their impacts on soil properties and potential remediation measures

Water Pollution

Sources-heavy metals, fertilizers, pesticides, sewage sludge, industrial effluents; eutrophication of natural bodies of water; biochemical aspects of water pollution

Air Pollution

Emission of CH₄, NO_x, CO₂; Ozone depletion; acid rain; global warming; urban air pollution and impacts on environment

Health Risk &Control Measures

Risk assessment and pricing measures to control pollution; safe limits of heavy metals; water and air quality index; control of pollution; remediation measure

Books Recommended

1. Agrawal, S.B. and Agrawal, M. 2000. Environmental Pollution and Plant Responses. Cat. No. L. 1341, CRC Press, UK.
2. ASA. 1993. Agricultural Ecosystem Effects on Traces Gases and Global Climate Change. ASA Special Pub. No. 55, USA.
3. deHaan, F.A. and Visser-Reyneveld, M.I. 1996. Soil pollution and soil protection. International Training Centre (PHLO), Wageningen Agricultural University.
4. Minkina, T.M., Motuzova, G.V., Nazarenko, O.G. and Mandzhieva, S.S. 2010. Heavy metal compounds in soils: transformation upon soil pollution and ecological significance. Nova Science Publishers, Inc.
5. Mirsal, I.A. 2008. Soil pollution. New York, NY: Springer.
6. Rodríguez-Eugenio, N., McLaughlin, M. and Pennock, D., 2018. Soil pollution: a hidden reality. FAO.
7. Saha, J.K., Selladurai, R., Coumar, M.V., Dotaniya, M.L., Kundu, S. and Patra, A.K., 2017. Soil pollution-an emerging threat to agriculture (Vol. 10). Springer.
8. Yaron, B., Calvet, R., Prost, R. and Prost, R. 1996. Soil pollution: processes and dynamics. Springer Science & Business Media.
9. Yunus, I.S., Harwin, Kurniawan, A., Adityawarman, D. and Indarto, A. 2012. Nanotechnologies in water and air pollution treatment. Environmental Technology Reviews, 1(1):136-148.

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**Course Code: SS521 Course Title: Soil, Water and Fertilizer Management using Nuclear
Techniques
Credit: 2**

Stable and Radioisotopes

Stable and radioactive isotopes, Applications of stable isotopes in crop production
Principles and application of isotopes in fertilizer management and tracking soil degradation.
Predicting heavy metal contamination using isotope dilution technique

¹⁵N

Fertilizer N use efficiency, biological nitrogen fixation, N balance, Gross N transformation in soils, N availability from organic-materials, animal nutrition studies

³²P

Fertilizer P use efficiency, residual P fertilizer studies, exchangeable P in soils, root activity patterns of crops, root distribution in soils, agronomic evaluation of rock phosphates, residual P fertilizer availability

¹⁸O

Source identification of nutrients and contaminants, ecological studies, hydrology, and irrigation

¹³C

Carbon source and balance, soil organic matter dynamics in agro-ecosystems

Books Recommended

1. Zaman, M., Heng, L. and Müller, C. 2021. Measuring Emission of Agricultural Greenhouse Gases and Developing Mitigation Options using Nuclear and Related Techniques. Springer Nature Switzerland AG.
2. Singh, B., Singh, J. and Kaur, A. 2013. Applications of Radioisotopes in Agriculture. International Journal of Biotechnology and Bioengineering Research 4: 167.
3. Bhat, M. I., Rasool, F. and Bhat M.A. 2010. Applications of Stable and Radioactive Isotopes in Soil Science. Current Science, 98(11): 1458–1471.
4. IAEA (International Atomic Energy Agency) 2001. Use of isotope and radiation methods in soil and water management and crop nutrition.
5. Rakshit, A., Ghosh, S., Chakraborty, S., Philip, V. and Datta, A. 2020. Soil Analysis: Recent Trends and Applications. Springer, Singapore.
6. Zaman, M., Shahid S.A. and Heng L. 2018. The Role of Nuclear Techniques in Biosaline Agriculture. In: Guideline for Salinity Assessment, Mitigation and Adaptation Using Nuclear and Related Techniques. Springer, Cham.
7. Sood, D.D., Reddy, A.V.R. and Ramamoorthy, N. 2010. Applications of radioisotopes in agriculture and Industry. In: Fundamentals of Radiochemistry, IANCAS (4th Eds), Perfect Prints, India, pp 296-310.

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**Course Code: SS523 Course Title: Soil Water
Credit: 2**

Water in soil

Sources, structure and properties of water, water losses and balance, capillary rise, forces affecting free energy of soil water, percolation and groundwater, Enhancing soil drainage, Septic tank drain fields

Soil water stress

Drought tolerance of plant, ionic uptake, turgidity, osmotic adjustment, protein and hormone imbalance, growth and yield

Soil moisture and nutrient

Soil air- water interaction, nutrient uptake at different moisture levels; Water uptake by plants due to water potential gradient; components of soil water potential and plant water potential

Salty water

Salt affected soils of Bangladesh, plant response to saline and alkaline soil, reclamation and management of salt affected soil. Soil dispersion by sodium

Soil water conservation

Methods of soil water conservation: mulching, tillage, no tillage and crop varieties

Books Recommended

1. Ghildyal, B.P. and Tripathi, R.P. 1987. Soil Physics. Wiley Eastern Ltd., New Delhi.
2. Hillel, D. 1980. Fundamentals of Soil Physics. Academic Press, New York.
3. James, D.W., Hanks, R.J. and Jurinak, J.J. 1982. Modern Irrigated Soils, John Wiley & Sons. New York.
4. Kramer, P.J. 1983. Water Relations of Plants. Academic Press, New York.
5. Lambert, K.S. and Rycroft, D.W. 1983. Land Drainage-Planning and Design of Agricultural Drainage System. Cornell University Press. New York.
6. Levitt, J. 1972. Responses of Plants to Environmental Stress. Academic Press. New York.
7. Mengel, K. and Kirkby, E.A. 2001. Principles of Plant Nutrition. Kluwer Academic Publishers.
8. Michael, A.M. 1978. Irrigation - Theory and Practices. Vikas Publishing House Pvt. Ltd. New Delhi.
9. Nilsen, E.T. and Orcutt, D.M. 1996. The Physiology of Plants Under Stress: Abiotic factors. John Wiley and Sons, Inc. New York.
10. Turner, N.C and Kramer, P.J. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley and Sons, Inc., New York.

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**Course Code: SS525 Course Title: Soil Resilience and Climate Change
Credit: 2**

Balancing climate and food security through resilient cropping systems

Conservation agriculture, carbon sequestration, low input water and fertilizer, INSEFM

Nutrient balance sheet for diversified and intensive cropping systems

Holistic approach, input-output, volatilization, leaching, denitrification and crop uptake

Greenhouse gas and NH₃ emissions and mitigation

GHG and NH₃ production, transport and emissions in diversified cropping systems, Nutrient biogeochemistry in a changing climate, methods of GHG measurement, and sources/pathways of GHGs, management impacts of reducing gaseous loss of plant nutrients

GHG emissions during manure management and compost preparation

Composts, manures and urine management vs gaseous emissions

Biochar, biocompost and organic amendment for C sequestration and GHG mitigation

Production, characterization and field impacts in diversified crops and soils

Soil and climate interactions

Effects of soil properties and cropping on global warming potential and vice versa

Books Recommended

1. Prasad, M.N.V. and Pietrzykowski, M. 2020. Climate Change and Soil Interactions-1st Edition. Elsevier.
2. Lal, R. and Stewart, B.A. 2019. Soil and Climate. Published September 20, 2018 by CRC Press. Taylor and Francis.
3. Filho, W.L. 2020. Handbook of Climate Change Resilience. Springer, Cham.
4. Lipper, L., McCarthy, N., Zilberman, D., Asfaw, S. and Branca, G. 2018. Climate Smart Agriculture: Building Resilience to Climate Change. Natural Resource Management and Policy Book, Springer International Publishing.

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Course Code: SS527 Course Title: Micronutrients in Soils and Plants
Credit: 2

Geochemistry of Micronutrients Different Forms of Micronutrients in Soils, Micronutrient Reactions in Soils – Adsorption & Desorptions, Inorganic Equilibria Affecting Micronutrients in Soils, Geographic Distribution of Trace Element Problems

Micronutrient - Organic Matter complex in soil, Metal Chelates in Soils and Nutrient Solutions, Mechanisms of Micronutrient Uptake and Translocation in Plants, Functions of Micronutrients in Plants, Critical limits of micronutrients in soils and plants, Environmental and Soil Factors Affecting Micronutrient Deficiencies and Toxicities, Micronutrients and Disease Resistance and Tolerance in Plants

Micronutrient Fertilizer Technology, Fertilizer Applications for Correcting Micronutrient Deficiencies, Trace Elements in Animal Nutrition, Trace Elements in Human Nutrition

Books Recommended

1. Alloway, B.J. 2008. Micronutrient Deficiencies in Global Crop Production. Springer, Dordrecht, The Netherlands.
2. Barker, A.V. and Pilbeam, D.J. 2007. Handbook of Plant Nutrition, CRC Press, Taylor & Francis, Boca Raton, FL
3. Brady, N.C. and Weil, R.R. 2017. The Nature and Properties of Soils. 15th edn., Pearson Education, South Asia.
4. Fageria, N.K., Baligar, V.C. and Jones, C.A. 2010. Growth and Mineral Nutrition of Field Crops. 3rd ed., Marcel Dekker, Inc., New York.
5. Havlin, J.L., Tisdale, S.L., Nelson, W.L. and Beaton, J.D. 2013. Soil Fertility and Fertilizers, 8th ed., Prentice-Hall Inc., New Jersey, USA.
6. Marschner, H. 2012. Mineral Nutrition of Higher Plants. 3rd ed., Academic Press. Harcourt Brace & Company, Publishers.

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**Course Code: SS529 Course Title: Soil Health and Risk Reduction
Credit: 2**

Soil health

Concept of soil health and soil quality; components of soil health; characteristics and functions of a healthy soil; effects of soil health on human health; present status of soil health in Bangladesh, challenges of climate change to soil health; causes of soil health deterioration; indicators for assessing soil health - physical, chemical and biological; impact of major soil health indicators on sustainable crop production; calculation of soil health index for crop productivity; principles to improve soil health; management of soil health revitalization- strategies and practices, impacts of vastly increased ratios of people to land, intensified agriculture-the Green Revolution, Biochar: Hype or Hope for soil quality, Organic farming system, sustainable agricultural system for resource poor farmers

Disaster risk reduction

Concept of disaster and hazards; relationship among soil, disaster, and hazards; climate change and disasters - impact on soil health and land use; planning for resilience against multiple risks; soil and land use related adaptation and coping measures for disaster and climate change risk reduction; global climate change adaptation policies regarding soil health and its current status in Bangladesh

Books Recommended

1. Brady, N.C. and Weil, R.C. 2012. The Nature and Properties of Soils. Pearson Education Pvt. Ltd. New Delhi, India.
2. Shaw, R., Mallick, F. and Islam, A. 2013. Climate Change Adaptation Actions in Bangladesh. Springer, Japan
3. Shaw, R., Mallick, F. and Islam, A. 2013. Disaster Risk Reduction Approaches in Bangladesh. Springer, Japan
4. FAO. 2013. Climate-Smart Agriculture: Sourcebook. Food and Agriculture Organization of the United Nations, Rome, Italy.
5. Habiba U, Abedin, M.A., Hassan, A.W.R. and Shaw, R.2015. Food security and risk reduction in Bangladesh. Springer, Japan, p. 273.
6. Singh, V.P., Cowie, A.L. and Chan, K.Y. 2011. Soil Health and Climate Change. Springer.