

# POSTGRADUATE INSTITUTE OF SCIENCE

## UNIVERSITY OF PERADENIYA



### **M.Sc. Programme in Plant Sciences**

#### **2013/2014**

#### **1. INTRODUCTION/JUSTIFICATION**

Plant Science like any other science is expanding rapidly while the undergraduate courses are becoming interdisciplinary and more and more broad-based. Consequently, during the undergraduate courses it has become impossible to provide a truly comprehensive course in Plant Biology. The proposed M.Sc. programme is designed to provide an in-depth knowledge of both theoretical and practical aspects of Plant Sciences to prepare graduates for advanced plant sciences study and research and/or suitable employment. This would also broaden student knowledge and understanding of current topics and also develop skills in some of these topics.

With the commencement of the Course Unit System in most Sri Lankan Universities, the students have the option of selecting courses of their interest and this could hinder a student from acquiring a complete and sound knowledge of all essential components of the Plant Sciences. This proposed M.Sc. programme in Plant Sciences aims to provide graduate students (especially those who have followed a General Degree Course) a good opportunity to gain an advanced and comprehensive theoretical and practical knowledge in certain areas of Plant Sciences.

Most applicants quite rightly are concerned about their employment prospects after completing a Masters. This M.Sc. programme would definitely provide a sound training in a range of skills in the field of plant Sciences. We also have a well-qualified teaching panel from various universities and research institutes, which is an asset for the success of a Masters programme in this category. The course content of this M.Sc. programme was specially designed by the resource persons aiming employment opportunities in the government as well as in the private sector by providing the students with an in-depth knowledge in certain important areas in Plant Sciences. This would also provide students with an opportunity to select certain modules of their choice to match their educational background and career aspirations and would definitely make the graduates more attractive in the employment market. The M.Sc. programme in Plant Sciences aims not only to provide students with hands-on practical, laboratory and field experience, but also a solid grounding for those anticipating to embark on a research career.

#### **2. OBJECTIVES OF THE PROGRAMME**

The main objectives of this programme are:

- to impart advanced theoretical knowledge of the Plant Sciences;
- to train graduates in the more demanding areas of the Plant Sciences and make them more competitive, employable and able to meet the demands of the century,
- to bridge the gap between the knowledge and skills acquired at B.Sc. level and that required to embark on research-based postgraduate programmes.

### 3. PROGRAMME ELIGIBILITY

Candidates having a bachelors' degree in Natural or Agricultural Sciences (with Biology or Botany as a subject) from a recognized University or equivalent qualifications are eligible to enrol in the programme. The final selection will be made according to the selection procedure stipulated by the Postgraduate Institute of Science. However, if the student does not have a strong Biology/Botany background, he/she will be asked to sit for a subject paper in addition to the General Aptitude Test. Employed candidates who are eligible for admission should produce evidence of leave granted to follow the programme and a letter of release from the Head of the relevant Department/Institution.

### 4. PROGRAMME FEE

*(N.B. The programme fees given below may be revised.)*

	M.Sc. programme fee
Local Candidates	Rs. 130,000/-
SAARC countries	US \$ 3,100/-
Other countries	US \$ 6,100/-

Programme fees shall be paid in two installments (*50% at registration and the balance 50% within six months from registration*). Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS.

### 5. THE PROGRAMME STRUCTURE AND DURATION

This programme consists of course work and a research project, having a total credit value of 30 (course work, 24 and research project, 6). The programme will be conducted at the Department of Botany, University of Peradeniya and at the Postgraduate Institute of Science by resource persons specialized in the respective fields in Plant Sciences from the University of Peradeniya and also from other national institutions. The programme will be conducted on a course unit basis, as stipulated by the PGIS for all M.Sc. programmes. As such, the rules and regulations governing this programme will be as in the PGIS Hand Book 2002.

The course work will be conducted over a period of two semesters of 15 weeks each. The M.Sc. programme will be conducted over a period of 18 months inclusive of the time allocated for the research project. The research project will take a minimum of 6 months, which could overlap the course work. Satisfactory completion of a minimum of 24 credits of course work (with a GPA of not less than 3.00) is required for the programme in addition to the six credits allocated for the full-time research project. Continuous attendance is compulsory during the period of the programme. *(The student who does not satisfy the above criteria but obtains a GPA in the range 2.75 to 2.99 course work is eligible for the Diploma in Plant Sciences but not the M.Sc. Degree)*. After successfully completing the research project, the student is eligible for the award of the M.Sc. Degree.

An academic advisor will be appointed to each candidate enrolling for the programme. The advisor and the candidate must keep in touch with the programme coordinator for the smooth conduct of the programme. English will be the medium of conducting lectures and examinations. IT facilities are available for the programme.

The M.Sc. programme comprises the following:

- I. **Preliminary courses** – The students are strongly advised to follow the preliminary courses even though they are not considered in the computation of the final GPA. However, students should pass all preliminary courses by obtaining at least a C grade. The preliminary courses will not necessarily be conducted at the beginning of the programme.
- II. **Compulsory courses** – Should be offered in the first semester.
- III. Two modules of **optional courses** (A **module** consists of a number of courses). Students will be given the opportunity to select courses within a module. From each module students are advised to select at least 2 courses. An optional course will only be conducted if a minimum number of students enrol for any particular course. The minimum number will be decided depending on the total number of students enrolled for the programme for that particular year.
- IV. **Research project** with a dissertation and a seminar based on the project.
- V. A **seminar** on a given topic.

### Programme Summary

Course Code	Course Title	Lecture hrs.	Practical hrs.	No. of Credits
Preliminary Courses				
PLS 401	Bioinformatics	-	60	-
PLS 402	Basic Statistics <sup>1</sup>	10	15	-
PLS 403	Analytical Techniques and Bio-instrumentation	30	30	-
Semester I				
PLS 501	Genetics and Molecular Biology	15	30	2
PLS 502	Sri Lankan Flora	15	30	2
PLS 503	Plant Systematics and Biogeography	15	30	2
PLS 504	Plant Ecology	15	30	2
PLS 505	Basic Microbiology	15	30	2
PLS 506	Advanced Plant Physiology and Biochemistry	15	30	2
Semester II				
Module 1				
PLS 516	Industrial Microbiology*	15	30	2
PLS 517	Plant Pathology*	15	30	2
PLS 519	Toxins of Plant and Microbial Origin and their effects*	15	30	2
PLS 520	Environmental Pollution and its Control*	15	30	2
PLS 521	Biodiversity Conservation and Management*	15	30	2
PLS 522	Advanced Systematics*	15	30	2
PLS 526	Remote Sensing and Geographic Information Systems*	15	30	2
PLS 533	Soil Fertility and Management*	15	30	2
Module II				

PLS 523	Ecotourism*	15	30	2
PLS 528	Landscape Horticulture*	15	30	2
PLS 529	Plant Tissue Culture and Embryogenesis*	15	30	2
PLS 530	Commercial Floriculture*	15	30	2
PLS 531	Commercial Nursery Management*	15	30	2
PLS 539	Processing of Plant Material and Quality Assurance*	15	30	2
PLS 540	Phytochemistry of Medicinal Plants*	15	30	2
Seminar and Research Project				
PLS 597	Seminar <sup>+</sup>	-	-	1
PLS 598	Biostatistics <sup>+2</sup>	15	30	2
PLS 599	Research Project <sup>+</sup>	-	-	6

<sup>1</sup> This is an equivalent course to SC 403 offered by the Board of Studies in Statistics and Computer Science. This course is only for those who have no background in basic statistics.

Preliminary courses and the courses marked by (+) are not considered in the computation of the final GPA.

<sup>2</sup> Pre-requisite for the PLS 599

\* Optional Courses

## 6. COURSE CONTENTS

### PRELIMINARY COURSES

#### **PLS 401: Bioinformatics**

##### ***(2 Credits: Laboratory)***

Introduction to bioinformatics; Gene sequencing and Analysis; Computational Biology Software's; Searching sequence database and analysis, editing and application; Functional Genomics and Proteomics; Current research trends in the field of more demanding areas of Plant Science; Nutrigenomics (Nutritional Genomics).

#### **PLS 402: Basic Statistics**

##### ***(1 Credit: Lectures and Laboratory)***

Population and sample; Measures of central tendency and dispersion; Sampling distribution of mean; Introduction to probability; The Z distribution and calculation of probabilities; Principles of hypothesis testing, Type I and II errors, power of test; Two sample paired and non-paired 't' test; Simple linear regression and correlation; Analysis of 2-dimensional categorical tables (chi-square test).

#### **PLS 403: Analytical Techniques and Bio-instrumentation**

##### ***(3 Credits: Lectures and laboratory)***

Principles of the Spectrophotometer: Flame Emission Spectrophotometer (FES), Atomic Absorption spectrophotometer; application of high precision mass spectrophotometer in stable isotope studies; infrared gas analyzer; Soil and foliar analytical techniques; Kjeldhal Apparatus; Radioactive monitoring devices; Basic measuring devices in Soil Science; Isolating devices: Chromatographic techniques; Molecular Techniques: Gel Electrophoresis, Southern Blots, PCR, RFLP, AFLP, RAPDs and DNA Sequencing, 2-D gel electrophoresis, Immunoblotting, MALDI-TOF mass spectrometry, SDS-PAGE; Plant Microtechniques: sectioning and staining devices; fixing agents, fixation fluids, methods of fixation; Common fixatives for light and electron microscopy; stains and dyes.

### COMPULSORY COURSES

**PLS 501: Genetics and Molecular Biology**

*(2 credits: Lectures and Laboratory)*

Gene Expression and Regulation; Information flow from DNA to proteins - Genetic Code; Quantitative Genetics; Population Genetics; Genomics: Plant genomics; Strategies, Techniques and prospects. Human genomics - HGR and the HG maps, molecular techniques; Extra-chromosomal inheritance; Mobile Genetic elements, transposons in maize and bacteria; Recombinant DNA Technology.

**PLS 502: Sri Lankan Flora**

*(2 Credits: Lectures, Laboratory and Field work)*

Field collection, herbarium preparation, identification and characterization of Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms; Constructing keys for field identification.

**PLS 503: Plant Systematics and Biogeography**

*(2 Credits: lectures, laboratory and field work)*

Science of Plant Systematics, Methods and Principles of biological systematics; Classification systems in flowering plants, Botanical Nomenclature, Different types of taxonomic evidence: morphology, anatomy, phytochemistry, molecular etc., Phenetics, Cladistics, Phylogenetic relationships of major angiosperm groups; Important plant families; Information from Plant Geography and Ecology.

**PLS 504: Plant Ecology**

*(2 Credits – Lectures and Laboratory)*

Ecosystem Structure; Floristic and Faunistic Composition and Interactions (Competition, Mutualism, Predation, Herbivory etc); Energy and Matter Transfer; Ecosystem Dynamics - Cyclical changes: Seasonal Phenological events etc.; Non-cyclical changes: Succession (Pioneers, Colonizers, Invasives, Edge or fringe plants and secondary and primary species); Gap Dynamics, Regeneration and Restoration.

**PLS 505: Basic Microbiology**

*(2 Credits: Lectures and Laboratory)*

General Introduction to microbes; microbial physiology; general considerations and classification of microbes; Common microbiological methods: preparation of culture media, theory and practice of sterilization, preparation of pure cultures, population counts; Identification methods; Microbiology of air, soil, food and water: types, distribution, estimation, analytical techniques, diseases, preservation and purification methods.

**PLS 506: Advanced Plant Physiology and Biochemistry**

*(2 Credits: Lectures and Laboratory)*

Overview of Plant Physiology and Biochemistry, Plant form and function, energy, Structure and function of plant cell walls, Root Physiology and enzymes, water relations, plant nutrition, metabolic pathways, growth and development, Ecological Biochemistry; *allelopathy and defence against herbivory*.

**OPTIONAL COURSES****PLS 516: Industrial Microbiology**

*(2 Credits: Lectures and Laboratory)*

General Introduction and Methodology; Scope of Industrial Microbiology; Principal types of fermentation; Methylootrophs and their economic importance; Microbial production of food: *dairy products, alcoholic beverages, fermented vegetables etc.*; Microbial biotechnology in the Food industry: Food flavours and colours; Production of pharmaceuticals: antibiotics and their mode of action; Energy from microbial and other sources: biogas and methanogenic microbes; Utilization and biodegradation of paper, wood etc.; bio-degradation of industrial wastes; Bioremediation.

**PLS 517: Plant Pathology*****(2 Credits: Lectures and Laboratory)***

Cause of plant diseases, Techniques in Plant Pathology, Plant disease diagnosis, plant-pathogen interactions, Systemic Acquired Resistance in plants, Biotechnology in disease control, plant quarantine, chemical control, use of plant promoters etc. and Laboratory exercises based on above topics.

**PLS 519: Toxins of Plant and Microbial Origin and their effects*****(2 Credits: Lectures and Laboratory)***

Introduction to terminology used in toxicology – LD 50, bioaccumulation, biodegradability, dose-response relationships; microbial toxins of bacteria, cyanobacteria and fungi (mycotoxins), their nature and effects; factors contributing to their formation in food and methods of prevention of contamination and decontamination: case studies, toxins of higher plants, their nature and effects, analytical techniques, legislature in different countries; Uses of toxins.

**PLS 520: Environmental Pollution and its control*****(2 Credits: Lectures and Laboratory)***

Environmental Pollution as a human activity: advances in science and technology, over-population, over-consumption and depletion of resources; Air Pollution: Structure of the atmosphere and chemical reactions occurring at different levels, Air pollutants, organic air pollutants and photochemical smog formation, Bioindicators of air pollution; Acid rain: origin, monitoring and effects on ecosystems, RAINS-ASIA as a predictive tool for evaluating effects of acidic depositions; Global Warming: Greenhouse effect, global efforts at mitigating global warming, Kyoto protocol, Clean production mechanism and carbon trading; Ozone layer and its destruction; Water and Land Pollution: Land and Groundwater Remediation, Physico-Chemistry and Modeling of Water Quality.

**PLS 521: Biodiversity Conservation and Management*****(2 Credits: Lectures and field work)***

Biodiversity: *definition, levels and estimates*; Quantifying Biodiversity; Biodiversity hotspots; Criteria and indicators; Importance of Biodiversity; Conservation and Management of Biodiversity; Identifying important areas for conservation; Endemism; Sri Lankan biodiversity; On-farm biodiversity conservation; crop diversity and wild crop relatives; Intellectual property rights and the third world; case studies. Conservation of Genetic Resources: Role of IUCN, IBPGR, PGRC, Red Data Book; In-situ approach; Ex-situ approach; Role of International Organizations.

**PLS 522: Advanced Systematics*****(2 Credits: Lectures, Laboratory and field work)***

Phylogenetic systematics; Characters; Character coding of different data; Tree building; Tree statistics and confidence; Molecular systematics; Phylogenetic relationships of angiosperms; ‘Non-monocot paleoherbs’; Monocots; ‘Magnoliid complex’ and Eudicots; Taxonomic literature and writing.

**PLS 523: Ecotourism*****(2 Credits: Lectures and fieldwork)***

Ecosystem services; Non consumptive value of wildlife; public awareness; nature based tourism; Urban wildlife resources as tourist attractions; Enjoyment of wildlife by park visitors; wildlife values and cost benefit analysis; Willingness to pay, Rights and Responsibilities; Role of visitor interpretation centres.

**PLS 526: Remote Sensing and Geographic Information Systems*****(2 Credits: Lectures and Laboratory)***

Introduction to Remote Sensing: A survey of RS technologies and various uses of data; Electromagnetic radiation and energy interactions with earth surface features; Satellite sensor systems: Active and passive sensor systems; Preprocessing of imagery: Radiometric and geometric corrections; Image enhancement and image interpretation; Image classification; Principal Component Analysis of satellite data;

Introduction to GIS; Geographic information and data models; geographic and non-geographic information; Coordinate systems and transformations; Hardware and software architecture of GIS; GIS functionality; Spatial operations and Applications.

**PLS 528: Landscape Horticulture**

*(2 Credits: Lectures and Laboratory)*

Introduction to Landscaping: Importance and history of landscaping in Sri Lanka and World; Materials used in landscape designing: soft landscape materials, hard landscape materials; Establishment and Management of lawns; Theories and Principles of landscape designs; Landscape for different environments; Production and maintenance of planting materials and nursery stocks.

**PLS 529: Plant Tissue Culture and Embryogenesis**

*(2 Credits: Lectures and Laboratory)*

Plant Tissue Culture: Basic plant propagation procedures and Somatic embryogenesis; Applications: meristem culture for virus elimination, embryo culture and embryo rescue, Androgenesis; Plant Transformation: Agrobacterium-mediated transformation, Direct DNA transfer and other methods; Plant Embryogenesis: Embryo and meristems, embryo pattern formation, mutant seedlings and defective body plan and long-distance signaling.

**PLS 530: Commercial Floriculture**

*(2 Credits: Lectures and Laboratory)*

An Introduction to floriculture; The cultivation, harvesting, transport and marketing of selected cut flowers to international markets; The cultivation, harvesting, handling and marketing of flowers for local sales; Cultivating foliage plants for local and international markets; Growing flowering ornamental plants for local sales; Bed plants used in gardening and cultivation techniques for selected varieties; Pests and diseases and their control; Infrastructure development for commercial nurseries with reference to greenhouses; New technologies in the cultivation of floriculture crops.

**PLS 531: Commercial Nursery Management**

*(2 Credits: Lectures and Laboratory)*

Principles of propagation: methods and cultivation techniques; General aspects and environmental factors of nurseries: Construction and maintenance of nurseries, different types of nurseries, microclimatic and edaphic factors of nurseries; Seed Propagation: seed selection, handling and germination techniques; Vegetative propagation: biology and techniques of propagation by cuttings, grafting, layering, budding and propagation by bulbs, corms, tubers, rhizomes etc.; Hormones to enhance sprouting and break dormancy; requirement of light, water and growth media for nurseries; Hydroponics and Drip Irrigation.

**PLS 533: Soil Fertility and Management**

*(2 Credits: Lectures and Laboratory)*

Basic soil physical and chemical properties; Soil fertility parameters and interpretations; Assessment of soil fertility; Nutrients and crop production; Sustainable management of soil fertility; Soil biological processes in tropical ecosystems; The importance and management of soil organic matter (SOM) in the tropics; Modeling SOM dynamics and plant productivity in the tropics; Soil Fertility and fertilizer management; Organic farming; Soil erosion and its control; Soil acidity and its amelioration; Soils and the quality of the environment.

**PLS 539: Processing of Plant Material and Quality Assurance**

*(2 Credits: Lectures and Laboratory)*

Collection, drying, packaging and storage of harvested medicinal plant material; Problems encountered during processing and storage: Mould growth, mycotoxins, spoilage, insect infestation, loss of activity etc and their prevention; Standardization and quality control of medicinal plants and their products.

**PLS 540: Phytochemistry of Medicinal Plants**

**(2 Credits: Lectures and Laboratory)**

Introduction to Phytochemistry and herbal drug development; Principles and methods of extraction and isolation of phytochemicals; Chromatographic techniques; Spectroscopic analysis of phytochemicals; Problems associated with herbal drug development; Fatty acids and polyketides; Phenylpropanoids; Flavanoids; Terpenoids and steroids; Alkaloids; Glycosides and volatile oils.

## **OTHER COURSES**

**PLS 597: Seminar**

**(1 Credit)**

Each student is required to present a literature seminar based on the current developments in an area of Plant Sciences.

**PLS 598: Biostatistics**

**(2 Credits: Lectures and Laboratory)**

Principles of experimental design; Completely randomized and randomized complete block designs; Partitioning of sums of squares (Analysis of variance); Principle of Latin squares and Latin square designs; Multiple regression analysis; General linear models; Model selection procedures; Introduction to multivariate methods: Principle component and factor analysis and Cluster analysis.

**PLS 599: Research Project**

**(6 Credits)**

Each student is required to conduct and complete a research project on topic falling within the discipline of Plant Sciences. A dissertation and a seminar on the project will be evaluated for the final grades. Students are expected to present a pre-proposal at the commencement of the project. The selection and planning of the project should commence during the second academic semester.

## **7. PROGRAMME EVALUATION**

Programme evaluation will be as stipulated in the PGIS Handbook 2002.

## **8. PANEL OF TEACHERS**

Prof. N K B Adikaram, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Cey.), Ph.D. (Belf.)*

Prof. B M R Bandara, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), Ph.D. (ANU)*

Dr. N C Bandara, Postgraduate Institute of Science, Univ. of Peradeniya.  
*B.Sc. (Perad.), M.Sc. (New Orleans), Ph.D. (New Orleans)*

Prof. M D Dassanayake  
*B.Sc. (Cey.), Ph.D. (Manchester)*

Prof. I A U N Gunatilleke, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Cey.), Ph.D. (Cantab.)*

Prof. C V S Gunatilleke, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Cey.), M.Sc. (Aber.), Ph.D. (Aber.)*

Prof. O A Illeperuma, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Cey.), Ph.D. (Arizona)*

Mrs. A M Karunaratne, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), M.Sc. (Nebraska)*

Prof. S A Kulasooriya, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Cey.), Ph.D. (Lond.)*



- Prof. D Kumaragamage, Dept. of Soil Science, Faculty of Agriculture, Univ. of Peradeniya  
*B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Manitoba)*
- Dr. A Nugawela, Deputy Director/Research, Rubber Research Institute, Agalawatta  
*B.Sc. (Perad.), M.Sc. (Lond.), Ph.D. (UK)*
- Dr. G A D Perera, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), Ph.D. (Oxon.)*
- Mr. S P Prematilleke, Research officer, Department of Minor Export Crops, Matale.  
*B.Sc. (Kel.), M.Sc. (Sri Jayawardhanapura)*
- Mr. K B Ranawana, Dept. of Zoology, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), M.S. (SUNY-ESF), M.Phil. (Perad.)*
- Dr. R M S Ratnayake, Department of Botany, Faculty of Science, University of Peradeniya.  
*B.Sc. (Perad.), M.Sc. (Otago), Ph.D. (Auckland)*
- Dr. G Seneviratne, Senior Research Fellow, Institute of Fundamental Studies, Kandy  
*B.Sc. (Perad.), Ph.D. (Perad.)*
- Dr. K U Tennakoon, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), Ph.D. (West Australia)*
- Dr. H M S P Madawala Weerasinghe, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), M.Phil. (Cantab.), Ph.D. (Cantab.)*
- Dr. P Wickramagamage, Dept. of Geography, Univ. of Peradeniya  
*B.A. (Cey.), M.Sc. (Lond.), Ph.D. (Lond.)*
- Dr. A Wickramasinghe, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Perad.), Ph.D. (Munstr.)*
- Prof. P Wijekoon, Dept. of Statistics & Computer Science, Faculty of Science, Univ. of Peradeniya  
*B.Sc. (Kel.), Ph.D. (Dortmund)*
- Dr. D S A Wijesundara, Director, Royal Botanic Gardens, Peradeniya  
*B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (CUNY)*
- Dr. K M S Wimalasiri, Dept. of Food Science and Technology, Univ. of Peradeniya.  
*B.Sc. (Perad.), Ph.D. (Perad.)*
- Dr. D Yakandawala, Dept. of Botany, Faculty of Science, Univ. of Peradeniya  
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- Mr. K Yakandawala, Dept. of Horticulture and Landscaping, Wayamba Univ. of Sri Lanka,  
Makandura *B.Sc. (Perad.), M.Sc. (Reading)*

## **PROGRAMME COORDINATOR**

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