Theme VI- Basic Sciences Research Thematic Area

Sub-theme 1: Bioscience Research

Eastern part of Ethiopia is rich in plant, microbe and animal diversity. Biodiversity provides ecosystem services, and forms an integral part of the rural economy, providing subsistence, goods and medicines. However, research on biodiversity, particularly from the point of view of their ecology and conservation status; use to the local people and potentials for pharmaceuticals and industrial purposes; responses to abiotic and biotic stresses are lacking. As a result, biodiversity is being lost together with indigenous knowledge of people around them. The biosciences research sub-theme, therefore, set out a research priority to study 'Plant, Microbial and Animal Biodiversity' from the following specific project components stand point.

1.1 Plant and animal species diversity, ecology, distribution and conservation for sustainable development

- Documenting plant and animal species and their distribution pattern (under-utilized)
- The interaction of plants and animals with natural environment and their responses to abiotic and biotic stresses
- Conservation status and development of conservation mechanisms for biodiversity

2.2 Biological method of waste management

- Solid waste management by using biological components
- Reducing liquid waste using bacteria
- Production of biofuels from different solid and liquid wastes.
- Application of enzymes to manage wastes

2.3 Aquatic ecosystems and biodiversity conservation

- Assessing the status of aquatic ecosystem biodiversity
- Plantation /growing of best aquatic ecosystem conserving plants
- Evaluation of aquatic ecosystem salinity/toxicity and control the toxicity by using microbe
- Production of aqua-feed from locally sourced raw materials for aquaculture application

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2.4 Economic botany

- Processes as well as the products involved in plant cultivation.
- Enhancing marketability of traditional medicinal plant species and products
- Bioprospecting from aromatic plant species for food product additives
- The use of plants and plant products for entrepreneurships, Value addition of plant products

Sub-theme 2. Chemical Science Research

Synthetic materials have many applications in medicine, pharmaceuticals, food, construction, manufacturing industries, etc. Ethiopia is rich in resources (biological and non-biological) that can be used as input in material science and synthesis. The rich biological resources we have are opportunities to use natural products in an array of applications provided that efficient scientific methods of extraction, screening and isolation are put in place. With this great potential, a great deal of researches are required to advance knowledge in areas of material science using local resources that would inevitably be used to generate technologies for various applications. The Chemical research sub-theme, therefore, set out a research priority to study 'Material Synthesis and Method Optimization for Natural Product Extraction and Trace Chemical Analysis' from thefollowing specific project components stand point.

2.1 Method development:

- Extraction methods for the analysis of heavy metals, pesticides, polycyclic aromatic compounds, mycotoxins, and emerging contaminants (e.g. nanomaterials, drugs, etc.);
- Develop sensing techniques such as colorimetric and electrochemical methods.
- Method development for real-time tracking and analysis of nanomaterials their transformation products in the environment and the biota, and mechanisms of nanomaterials toxicity.
- Development of biosorbents, and other materials for the treatment of various wastes such as sewages, and industrial discharges (influents, and effluents).

- Synthesis of green solvents (e.g. ionic liquids, supercritical fluids, etc) and adsorbents (e.g. nanomaterials, biosorbents, composites, etc.).

2.2 Effects of microplastics on the environment and the biota,

- Microplastics transformation products and processes
- Effects of microplastics in freshwater, lake water, and soil compartments

2.3 Extraction, isolation and activities of bioactive compounds from natural sources;

- Extraction and isolation of bioactive natural products, and structural elucidation in plant and in vitro activities of newly identified bioactive natural products;
- Studies that elucidate bioactive natural products and their role and mode of action in pharmacological, medical or therapeutic use;

2.4 Drug design, development and novel synthetic method from medicinally important organic molecules

- Development of new drug agents with potential beneficial to human health;
- Study structure-activity and enzymatic inhibition mechanisms relationships;
- Mechanisms of drug action and the molecular basis of disease prevention;

Sub-theme 3. Mathematical Research

Mathematics provides the framework for understanding almost any complicated phenomenon. Advanced mathematical techniques are used to model and test products on computers, optimize production techniques and have interplay with various systems. Advancing mathematical research helps to build strong scientific community capable of technology generations and new innovations. Despite its immense role, research in mathematics is not being conducted to its best level. Thus, recognizing the importance of mathematical researches to the building of strong scientific bases for technology generations and innovations, the Mathematical Research Sub-theme set out a research priority to study 'Modern Techniques in Optimization, Mathematical Models in Stochastic Differential equations and Queuing Theory' from the following specific project components' stand point.

3.1 Modern Optimization Techniques:

- Investigations of heuristic approaches like genetic algorithms; simulated annealing; particle swarm optimization; ant colony optimization; fuzzy optimization; and neural-network-based methods, etc. and their application in solving real life optimization problems.

3.2 Stochastic Differential Equations and Queuing Models:

- Includes mathematical models dealing with congestion problems in manufacturing (production) systems, computer and communication networks, health care systems, banks, inventory systems, transportation systems, etc.

3.3 Infectious diseases modelling (including chikungunya and Dengue)

3.4 Developing computational algorithms for analyzing high-dimensional data for prediction of future possible outcomes.

3.5 Developing numerical methods for solving differential and integral equations dealing with different real-life phenomena (such as flooding, earthquakes) modeled by differential and integral equations.

Sub-theme 4: Biophysics and Computational Physics

Computational physics develops algorithms that are of immense use in industries and medical issues. Research output on material computation can serve as an input to any nanoscale related research to improve the efficiency of the material for energy generation, waste treatment, sensors and so on. Biophysics looks for mathematical laws of nature and makes detailed predictions about the forces that drive idealized systems in living things. In spite of immense industrial and environmental applications research works are scanty so far in Ethiopia. Cognizant of enormous use of Biophysics and Computational physics research in industries, environment and medicine, the Biophysics and Computational Physics Sub-theme prioritized research areas from the following specific project components' stand point.

4.1 Computational physics

- Algorithm development, simulation and evaluation of its accuracy and computational speed, image processing, machine learning, disease prediction and severity determination, parallel computing

4.2 Environmental and planetary space sciences

- Predicting and Projecting of Climate Change and Variability
- Impact of climate change on water resources and agricultural production
- Environmental and Hydrological modeling
- Planetary and environmental geosciences, Space weather
- Climate Sciences, pollution (Aerosol, soil, water etc.)

4.3 Particle physics, (Radiation physics, Nuclear physics and Medical physics)

- Develop semiconductor detectors and dosimeters for clinical applications in radiation protection, radiation oncology and nuclear medicine as well as high energy physics applications.

4.4 Exploration Geophysics;

- Measuring, modeling, prediction or mitigation of natural hazards (volcanoes, earthquakes, floods, droughts, landslides, etc.)