

Subtheme 3.1. Information Technology and Computing

Developments in science and technology are fundamentally altering the way people live, work, connect and communicate, with profound effects on economic advances, improvements in health systems, education and infrastructure. In this regard information and communication technology (ICT) as a key component and enabler in science and technology, is increasingly simplifying the accessibility of market information, financial service, and others to change peoples lives in unprecedented ways. ICT is also changing the way of companies do business, transform public service delivery and foster nations move toward good governance. In education sectors ICTs play an integration role with four operational missions of higher institutions (learning-teaching, research and innovation, community engagement and administrations). To address the problem of societies through well developed and managed ICT application and services; the main focus areas of research are:

- **Computational Intelligence and Machine Learning:** Artificial Intelligence for Social Good, Health intelligence, Education and Agriculture; Machine Learning; Reinforcement Learning and Natural Language Processing.
- **Natural Data Science and Analytics:** Big Data Analytics; Network analysis; Time Series Data Analysis; Adaptive Data Analytics; Data science platforms tools, models and techniques; Application of data science.
- **Indigenous Knowledge Modelling (Health, Farming and Climate) and Smart Business and Society:** Block chain Technologies; Smart Health and Health Informatics; Chatbot.
- **Internet of Things (IoT):** Smart Agriculture, Yield Prediction, Environmental Protection, Smart Cities, Right Crop to Grow Guidance and Soil Monitoring.
- **Geographic Information Processing:** Land Use Planning, Urbanization and Urban and Regional Planning.
- **Computer Systems Engineering:** Cyber security and Cryptography; Medical signal and image processing; Innovative teaching and learning technologies; Reconfigurable computing systems).
- Embedded System and Robotics (Health); Human-Centric Digital Transformation; Information Retrieval and Cloud Computing.

Subtheme 3.2. Advanced Materials Research and Development

The major challenge we face as a nation is poor productivity due to the traditional mode of agricultural systems that are being practiced hitherto. Haramaya University as one of the leading agricultural University in Ethiopia is expected to lead the research in modernizing our agriculture commensurate to its position via the involvement of emerging technologies such as nanotechnology. In this regard, research related to increased plant and animal production and productivity is important with particular emphasis on delivery, sensing, diagnosis, nutrition, fertility and quality. Energy is also scarce and the community depends mostly on firewoods and fossil fuels for cooking, heating, lighting and cottage industry. Hence, energy problem has contributed to food shortage and curtailed economic development. Environmental pollution is another formidable challenge that hampers the socio-economic development of our country. This is attributed mainly to population growth, lack of proper waste management systems and poor urban planning and other anthropogenic factors. To address these challenges, Ethiopia needs to build institutional excellence in the area of nanotechnology. Accordingly, we suggest the following topics on fabrication of advanced materials (Metal oxides/Chalcogenides, Reduced gaphenes oxides rGO, Perovskites, Polyoxometalates, Metal Organic Frame works, Conducting Polymers, Nanocomposites/Organic-Inorganic hybrids) and Nanomaterials Immobilization. The major areas of applications are the following:

- **Agricultural Applications:** Plant production and productivity (Delivery, Sensing and Diagnosis); Animal Production and Productivity (Nutrition, Diagnosis, Sensing, Fertility, Quality); Postharvest technology (Bio-insecticidal formulations); Nanobiotechnology, Food processing and packaging.
- **Application to Energy:** Renewable energy production (Solar cells; Fuel cells; Bio-energy such as bio-fuels, bio-diesel, bio-oil, bio-gas); Energy storage (improved materials for super capacitors, batteries).
- **Application to Environment and Monitoring:** Photocatalysis; Sorption/desorption; Ion exchange; Photo-disinfection; Antimicrobials; Bio/Chemo-Sensors.

Subtheme 3.3. Energy Resources Development and Utilization

Energy is the main input to the technological, industrial, social and economic development of a nation, which stimulates the economic development of a country. The Ethiopian energy sector is

faced with the double challenge of limited access to modern energy and the heavy dependence on traditional biomass energy sources to meet growing demand. In this new era, renewable energy sources are an extremely attractive and desirable option in the energy sector due to the rising price of oil, natural gas and coal as well as environmental concerns in terms of greenhouse gas emissions and global warming. Besides, lack of alternative energy which has brought deforestation, land degradation and food insecurity in Ethiopia have led to the search of a new technological way of energy utilization. There is a general acceptance for the need to diversify energy supply for confronting these challenges by developing advanced, cleaner, more efficient, and cost-effective renewable energy technologies, including superior and cleaner fossil fuel technologies. Thus researches shall focus on the following areas.

- **Solar energy:** solar & wind energy system design and development, solar photovoltaic system development, solar thermal storages, adaptive technology focusing on solar photovoltaic and wind energy.
- **Bio-energy:** planning of natural resources, biomass gasification; biogas generation from agricultural wastes; biodiesel production and utilization, stability of biodiesel and its blends.
- **Small hydro development:** small hydropower planning, investigations, designs, development, optimization of generation, cost optimization.
- **Wind and geothermal energy:** wind energy explorations and power generation systems; design and generation geothermal renewable Energy.
- **Energy conservation:** conservation of energy in electrical network, energy auditing etc

Subtheme 3.4 Postharvest Technology, Processing and Food Analysis

In Ethiopia, the post-harvest management system is in dire conditions characterized by poor quality products and large losses. As a result, the local market is inundated with poor quality products. Thus, the research in the postharvest management must focus on minimization of losses, quality improvement, product development, and processing technologies of industrially and economically important crops. In addition, researches in food science and technology must focus on safeguarding quality of food from production to consumption. Besides, development of food quality standards, improvement of quality of fresh produce as well as development of new food products from wild, indigenous and traditional food resources is crucial. Furthermore,

nutritional problems in developing countries like Ethiopia must be addressed by creating awareness on benefits of diversified diet through practical training and other different approaches. Therefore, priority shall also be given to develop the rich and diverse cultural and traditional food processing techniques to increase their role in the national economy. Thus researches shall focus on the following lines.

- Postharvest technology, processing, and food analysis for plant and animal products
- Development and promotion of food products for different target groups
- Proper utilization of food sources for alleviating food and nutrition insecurity
- Adopting and introduction of wild edible and new food sources for enhancing food and nutrition security

Subtheme 3.5 Civil Infrastructure, Manufacturing and Industrial Technology

Production and quality management has been recognized as an important factor in country's economic growth. Rapid changes in technology have posed numerous opportunities and challenges, which have resulted in enhancement of manufacturing capabilities through new materials, facilities, techniques and procedures. Hence, managing a service/production system has become a major challenge in the global competitive environment. Production and quality management leads the way for organizations to achieve their goals with minimum effort. Equally, computer aided manufacturing and control system (automation) or robotics is current global trend as it is capable of reducing cost of production, waste, hazard and increase accuracy, productivity as well as process capability in different industries. Attention shall be also given for small and medium manufacturing enterprises (SMME) as they contribute a lot in job creation and support to the national economy of a country. Currently, SMME are organized and expanding in Ethiopia on the basis of agricultural-economy to industrial-economy transformation. Hence, design and renovation of modified, cost competent and demand driven technologies in areas of crop harvesting and after harvest processing as well as construction equipment are highly required in these manufacturing enterprises and markets to gear up the economy. Accordingly, the following prioritized research areas are included:

- Different aspects of quality & production management of different industries in eastern Ethiopia: logistics, total quality management, production operation management; continues improvement (KAIZEN);

- Reverse Engineering: focusing on biomedical engineering, mechatronics and/or robotics (Automation of systems & mechanisms);
- Adaptive Technology: focusing on agricultural machinery, construction equipments, and appropriate technologies to address local community problem.