NATIONAL INSTITUTE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH



NISIR IN BRIEF

MISSION STATEMENT

"To be a leading institution that will effectively provide solutions for sustainable socio-economic development of the nation through innovation, scientific and technological research"



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1. About Us



The National Institute for Scientific and Industrial Research (NISIR) is a Statutory Body under the Ministry of Technology and Science (MoTS). The Institute was established by the Science and Technology Act (No 26) of 1997 through Statutory Instrument No 73 of 1998, after the repeal of the National Council for Scientific Research (NCSR) Act, CAP 236 of the Laws of Zambia.The National Institute for Scientific and Industrial Research (NISIR) is a Statutory Body under the Ministry of Technology and Science (MoTS). The Institute was established by the Science and Technology Act (No 26) of 1997 through Statutory Instrument No 73 of 1998, after the repeal of the National Council for Scientific Research (NCSR) Act, CAP 236 of the Laws of Zambia.

1.2. Mission Statement

"To be a leading institution that will effectively provide solutions for sustainable socio-economic development of the nation through innovation, scientific and technological research

1.3. Vision

"To effectively undertake research and development in order to improve the quality of life of citizens"

1.4 Specific Functions

The Mandate of NISIR as stipulated in the Science and Technology Act of 1997 through Statutory Instrument No. 73 of 1998 is as follows:

1. To conduct and promote scientific, technological and industrial research in Zambia in civil engineering, mechanical engineering, electrical engineering, nuclear science, textile technology, biotechnology, energy resources, water resources, chemical engineering, electronic engineering, industrial chemistry, food science, material science and natural products, information science, cartographic and location analysis;
2. To liaise with other research bodies within and outside Zambia conducting similar research;
3. To co-operate with other organizations and institutions of higher learning in training programmes and other matters relevant to research
4. To cooperate and liaise with industry; and
5. To mobilise financial, technical and other resources for the purposes of carrying out research

Location



The Institute has three campuses: the Waterfalls campus (established in 1971) situated along the KK International Airport Road in Lusaka Province is also the Institute's headquarters; the Animal Sciences Research Centre (ASRC) campus (established in 1963) situated in Chilanga District, Lusaka Province, and the Plant Sciences Research Centre (PSRC) campus (established in 1965) situated in Riverside, Kitwe, Copperbelt Province.

Technology Services

The institute with its unique laboratory facilities and experience is a leading research and development institution in Zambia. it is in a position to make significant contributions to the growth and diversification of the Zambia economy for the benefit of all citizens

Scientific Leadership & Technological Development

The institute has proven a track record of developing of developing technologies and offering of quality analytical laboratory and other services. this is an advantage that NISIR has that can be exploited by small and Medium scale enterprises that normally have no research and development facilities of their own for mutual benefit.

The need for sustainable development requires that science and technology plays its equivocal role. it is, therefore, imperative that the institution takes the lead in providing research and development goods and services that address the need of the country.



METS – Materials Engineering and Technical Services Centre

2.0 CENTRE MANDATE

2.1 Conduct research in:

i. **Alternative energy technologies:** developing and improving technologies for renewable and sustainable energy sources.

ii. **Materials and Waste-to-Products technologies:** materials research and innovations in the circular economy by transforming waste material into valuable products.

iii. **Engineering Design:** enhancing design processes and methodologies, applicable across all NISIR Centres.

2.3 Services and Other Areas of Expertise:

i. **Glassblowing:** Providing specialized glassblowing services for industrial and scientific applications.

ii. **Mechanical services:** offering a wide range of mechanical engineering services, including maintenance, repair and fabrication.

2.4 Consultancy in Engineering:

i. **Electrical and electronics engineering:** Expert advice in electrical and electronic systems

ii. **Briquetting:** Production of briquettes from coal dust or other combustible biomass material for fuel.

iii. **Ceramics:** Specialized knowledge in ceramic materials production and their applications.

iv. **Quality refractory bricks:** Production and application of high–grade refractory bricks for industrial and domestic applications.

v. Alternative energy: Implementing alternative and sustainable energy solutions.

2.5 CURRENT PROJECTS

2.6. Potential Adoption of Biogas as an Alternative to Electrical Energy at Household Level.

2.6.1 **Rationale**

The rationale for developing a biogas purification membrane using cellulose extracted from corn stalks and activated carbon derived from maize cobs is multifaceted:

i. Abundant and Renewable Raw Materials: Corn stalks and maize cobs are agricultural residues that are widely available and renewable thus promoting the principles of circular economy and sustainable resource management.

ii. Cost-Effective and Scalable: Cellulose and activated carbon are relatively inexpensive materials, making the membrane fabrication process cost-effective. Additionally, the electrospinning technique is a scalable manufacturing method that can produce large quantities of membranes.

iii. Tailorable Membrane Properties: The composition and structure of the membrane can be tailored by adjusting the ratio of cellulose to activated carbon and electrospinning parameters. This allows for optimization of membrane properties including porosity, pore size distribution, and surface chemistry, to achieve efficient biogas purification.

iv. Enhanced Biogas Quality: The membrane is designed to selectively remove impurities, such as hydrogen sulfide (H_2S), carbon dioxide (CO_2), and moisture, from biogas resulting in purified biogas that meets quality standards for various application in heating, lighting and transportation.

v. Environmental Benefits: Biogas purification using the developed membrane can reduce greenhouse gas emissions by capturing and converting biogas a highly potent gas into usable energy. Additionally, the use of agricultural residues for membrane fabrication promotes waste valorization and reduces the environmental impact associated with their disposal.

vi. Potential for Commercialization: The techno-economic analysis of the membrane-based biogas purification system can assess its commercial viability. If the system proves to be cost-effective and environmentally beneficial, it has the potential to be commercialized as its technology readiness level (TRL) is high.

2.6.2: **Project Objectives**

i. Develop a Novel Biogas Purification Membrane:

a. Design and fabricate a biogas purification membrane using cellulose extracted from corn stalks and activated carbon derived from maize cobs.

b. Optimize the membrane's composition, structure, and properties to achieve efficient biogas purification.

ii. Improve Biogas Quality:

a. Evaluate the membrane's performance in removing impurities, such as hydrogen sulfide (H2S), carbon dioxide (CO2), and moisture, from biogas.

b. Conduct Comprehensive Characterization

c. Evaluate the membrane's porosity, pore size distribution, surface morphology, and mechanical strength.

iii. Assess Environmental and Economic Feasibility:

a. Analyze the environmental impact of the membrane fabrication process and its potential for sustainable biogas production.

b. Conduct a techno-economic analysis to assess the membrane's cost-effectiveness and scalability for commercial applications.

The project is in line with strategy 7 of the 8NDP on Environmental sustainability. Sustainable development Goals linkages include SDG 7 (Affordable & clean energy),12 (Responsible consumption and production), 13 (Climate Action),





2.7. Mobile Biofuels Unit /Mobile Biofuel Reactor Innovation

An Intention to Patent has been submitted.

2.7.1 Rationale:

The finite nature of the fossil reserves, escalating fuel prices, and the environmental impacts brought about by anthropogenic activities have encouraged a drive towards the use of alternative renewable resources including the use of biomass to produce biofuels, bioenergy and other bio-products. Therefore, first generation (food) or second generation (non-food) biomass have the potential to converted into bio-based products, however, the food-fuel competition should also be considered especially for developing countries

Globally, starchy biomass such as cassava and other sugar-based feedstocks (cereals and root crops) have been explored and converted into chemicals and fuels specifically bio-ethanol, one of the most researched bio-based chemical, with a technology readiness level at commercial stage using conventional technologies.

The government of the Republic of Zambia has begun to create a conducive environment for a green economy where renewable energy sources contribute to the national energy mix although there is need to put measures in place concerning tax incentives and tariffs on bio-based fuels.

With this backdrop, this study aims to produce fuel grade bioethanol and other products (such as gel) from locally available feedstocks using the designed mobile unit.

This project can potentially bring socio-economic and environmental benefits in Zambia thus support strategy 7 of the 8NDP's drive (Environmental sustainability) to achieving a self-sustaining middle income industrialised country, thus realising its Vision 2030 aspirations. Other Linkages include SDG 7 (Affordable & clean energy),12 (Responsible consumption and production) and 13 (Climate Action).

2.7.2: **Objectives**

a. To produce fuel–grade bioethanol and bio–gel using locally available feedstocks in a mobile biofuel reactor.

b. To build capacity in artisanal skills among young people for the production of biofuel.

c. To empower women through an out – grower scheme model to produce and supply fuel grade ethanol to larger scale industries.

2.8: **Production of Plaster of Paris (POP) and Pavers**

2.8.1: **Rationale**

Zambia is endowed with many natural resources and as such the NISIR's ceramic's department and Zambia as a whole, if well-supported has potential to manufacture a plethora of cost-effective products (e.g. POP, pavers/tiles). One use for pavers could be for paving purposes in residential road networks to curb the challenge of unmaintained roads, thus creating jobs and skills development for the youth. It also has potential to contribute to the health and educational sectors by producing locally made cost-effective Plaster of Paris (POP) and training of interested persons in this skill.

The brickyard at NISIR has potential to offer training programmes and offer a conducive environment for innovators to thrive, potentially leading to spin-off/startup companies.

This project intends to aid the health and education sectors by creating quality locally produced Plaster of Paris (POP), dental molds and chalk starting materials etc. for use around the country.

2.8.2: **Objectives**

A. To produce quality, locally made Plaster of Paris (POP) and pavers.

B. To create job opportunities and develop skills among the youth.

C. To support the health and education sectors with affordable POP and related products

D. To revitalize the NISIR brickyard and make it self-sustainable



2.9 INNOVATIONS

The Centre supports innovations and ideas from individuals or without any scientific or engineering background. The following prototypes are some of the innovations currently being supported:

A. Mobile biofuels unit

This is a portable or transportable system that can produce biofuels (such as biodiesel or bioethanol) from organic materials. These reactors can be used in various applications, including decentralized energy production, waste management, and sustainable fuel production.



Figure of the Mobile Biofuels Unit

B. Mechanical lawnmower prototype

A mechanical lawn mower, also known as a reel mower, is a push mower that does not rely on fuel, electricity, or oil. Instead, it's powered by the person pushing it.



Mechanical lawnmower prototype

C. Light aircraft

This is a work in process and is being developed by a NISIR security personnel with no scientific knowledge. This is a cost-effective light aircraft with potential to be used for deliveries/transportation, aerial photography and surveys etc. An opportunity for technical support from external experts is readily available.





A Light Aircraft Innovation

D. CONVERTIBLE CONCRETE MIXER – WHEELBARROW

A convertible Concrete Mixer – wheel barrow is a portable solution designed for construction sites or refurbishment work. It is designed to simplify construction manual work by providing useful tools to local artisans in one component (concrete mixer and wheelbarrow). The design of this unit was initiated in order to encourage production of tools and equipment locally at

small scale as well as to diversify income generation initiatives by adding more locally made tools to the market.





Convertible Concrete Mixer - wheel barrow

A NISIR designed Concrete Mixer – Wheelbarrow Prototype

Our COLLABORATIONS

i. EIZ- Mobilised young innovators to showcase their prototypes at the EIZ 2024 Annual General Meeting Symposium, Livingstone.





ii. NSTC – Supervise and offer technical support/laboratory infrastructure to researchers funded by NSTC.

iii. ZENGO – On the fabrication of improved cook stoves.







iv. Youth and Innovators on briquetting technologies.



CAPACITY BUILDING

2. 10 CAPACITY BUILDING

The Centre offers:

i. Internships and student attachments,

ii. School tours and opens its facilities for demonstrations to learners from primary to tertiary level.









2.11 GLASS BLOWING SECTION

- The Scientific glassblowing workshop at the National Institute for Scientific and Industrial Research (NISIR) was established in 1975. It is situated at NISIR Headquarters along Kenneth Kaunda International Airport Road. It was established to ensure that the institute is self-reliant in the production and repair of scientific glass apparatus for NISIR laboratories and offer the same service to the public.

- The workshop fabricates, repairs and modifies non-graduated laboratory glass including test-tubes, boiling tubes, Liebig condensers' laboratory spirit lamps, stirring rods, beakers and supplies them to research Institutions, universities, colleges and schools in Zambia.



2.12 CERAMICS SECTION

- This section produces ceramic flower pots, vases, mugs, tandoori ovens, pots and shells. (Creative ceramic products have also been produced on demand), porcelain reel and shackle insulators.
- Additionally, it produces pavers and Plaster of Paris (POP).
- It also offers technical support to innovators and consultancy services.





3. Energy Development Research Centre

The mandate of the Center is the use of Renewable and non Renewable energy to create a competitive future through sustainable clean energy and environmentally friendly innovations/research.

3.1 Radiometric and Nuclear Analytical Techniques

The Centre promotes peaceful application of Nuclear Science and Radiation Technology through research using nuclear analytical techniques and radiation processing technology. such as Gamma Spectrometry, Liquid Scintillation Counter, Alpha-Beta Counting, Alpha Spectrometry and Radon Gas monitoring).

3.1.1 Gamma Radiation spectrometer

The spectrometer uses a High Purity Germanium Detector (HpGe) to measure low level radioactivity in a wider range of materials including: environmental samples (Water, soils and sediments), biological samples, food stuffs (grains and cereals, milk), vegetation and geological samples (mineral ore)



FIGURE 1 : GAMMA RADIATION SPECTROMETER

3.1.2 Radon Gas Monitoring Equipment

Radon gas is a naturally occurring radionuclide that can cause cancer. Radon is an inert gas, colorless and odorless gas found everywhere in the earth's atmosphere. It is mostly found in high concentration in confined areas with poor ventilation such as underground mines, curves, and tunnels. The Center is able to measure radon gas in air in underground mines, curves and tunnels using the AB-5, Working Levels Meter and PARC radon gas monitors



FIGURE 2 : RADON GAS MONITORING EQUIPMENT

3.1.3 Alpha Radiation Spectrometer

Used in identification and quantification of radionuclides based on alpha particles emitted in the decay process

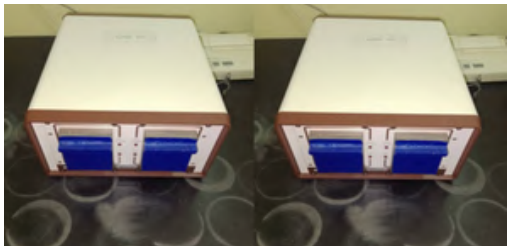


FIGURE 3 : ALPHA RADIATION SPECTROMETER

3.2 Analytical/ Consultancy services

The Center also has a Centralized analytical laboratory that houses the Varian (Agilent) AA280FS, Analytik Jena ContrAA800 atomic absorption spectrometers, Shimadzu UV/Vis Spectrophotometer to support its research activities Measurement of Radioactivity in environmental Samples

- Radon Gas monitoring in dwelling places and underground mines
- Analysis of heavy metals in water, geological samples, food and other environmental sample.
- Analysis of nonmetals such as nitrates, sulphates, phosphates, chlorides and other salts in various environment constituent.
- Constancy in Radiological Risk Assessment
- Expert advice / training on safety and radiation protection
- Training of students, interns in nuclear analytical techniques

3.3 Nuclear energy

Nuclear energy is generated through nuclear fission, where the nucleus of heavy atoms like uranium is split, releasing a substantial amount of heat. This heat is used to produce steam, which, in turn, powers steam turbines connected to generators, ultimately generating electricity.

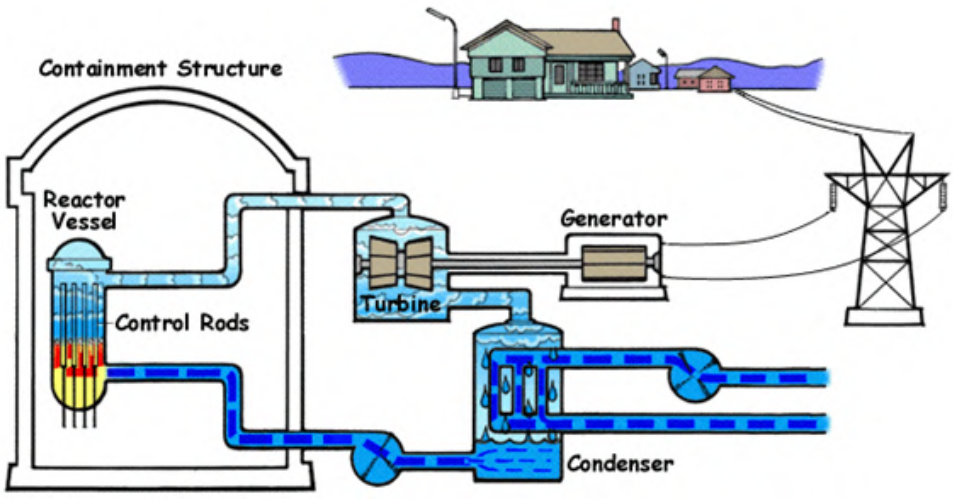


Figure 1.2 BWR-based nuclear power plant

The nuclear fuel cycle is a collective name given to the series of industrial processes involved in the production of electricity from nuclear power reactors using uranium. It starts with the mining of uranium ore from the earth and ends with the safe disposal of nuclear waste in geological disposal facilities. An artistic view of the nuclear fuel cycle is shown in Figure 4.1



Figure 1.4 Nuclear fuel cycle

3.4.. Renewable energy

Renewable energy is energy that is generated from natural processes that are continuously replenished. This includes sources such as sunlight, wind, rain, tides, waves, and geothermal heat. Unlike fossil fuels (coal, oil, and natural gas), which are finite and contribute to environmental pollution, renewable energy sources are generally sustainable and have a lower environmental impact.

3.4.1 Solar energy

Solar energy is derived from sunlight by converting it to electricity or heat. Photovoltaic (PV) systems can convert incident solar radiation to electricity using photocells. This clean and abundant energy source offers numerous benefits, including reducing greenhouse gas emissions, promoting energy independence, and contributing to a transition toward cleaner and more sustainable energy solutions for both residential and large-scale applications.



3.4.2.Wind energy

Wind energy is a renewable power source that harnesses the kinetic energy of the wind using wind turbines. These turbines consist of blades that capture the energy from the wind, causing them to rotate and generate mechanical energy, which is then converted into electricity by a generator within the turbine's nacelle. Wind energy is clean, emitting no greenhouse gases or air pollutants, and is a key part of the transition to cleaner energy sources.



3.4.3 BIODIESEL

Biodiesel is a renewable, environmentally friendly alternative to conventional diesel fuel. It is produced through a chemical process called transesterification, where organic materials such as vegetable oils, animal fats, or recycled cooking oils are converted into biodiesel and glycerol using alcohol and a catalyst. Its advantages include reduced greenhouse gas emissions, lower pollution levels, and improved energy security. However, challenges like feedstock competition, energy balance concerns, and land-use changes need to be addressed for its widespread adoption. Advances in production processes and exploration of alternative feedstocks are ongoing to enhance its viability at NISIR.

3.5 Energy

Energy storage systems (ESS) are technologies designed to store energy for later use. They play a critical role in balancing supply and demand, integrating renewable energy sources, and enhancing the reliability and efficiency of the power grid. Example is the battery (Lithium battery)



Current projects

- The potential and adoption of biogas usage in homes as an alternative source of energy
- Estimation of committed effective dose due Po210 and Pb210 through consumption of freshwater fish and sardines from rivers around Kansanshi mines, Solwezi
- Valorization of mine tailing in Kansanshi mine, Solwezi.
- Reverse Engineering of Lithium-ion Battery

Previous projects

- Assessment of drinkingwater safety in areas of Zambia with naturally occurringradioactive materials (NORMS) and development of a baseline for prospective uranium mines.
- Capacity building in environmental radioactivity characterization of contamination in the environment.
- Occupational health and radiological risk assessment due to NORM and heavy metals at Collum Coal Mine and surrounding communities, Sinazeze, Southern Province, Zambia

Collaborations and contracts

RPA

- Baseline assessment study for limits of radioactivity in food
- Zambia mining environment remediation and improvement project (ZMERIP) activity on radionuclide characterization of Chambishi, Mufurila, Kitwe, Chingola and Luanshya towns

INTERNATIONAL ATOMIC ENERGY AGENCY(IAEA)

- Capacity building

UNITED STATES OFFICE OF RADIOLOGICAL SECURITY(ORS)

- Capacity building.

ZESCO

- National Geothermal Project for exploration of alternative sources of energy.

USAID

- Scaling up Nutrition Technical Assistance (SUNTA)Water Quality analysis and capacity building services

GALLERY
PROJECTS


Collum mine (Sinazeze)


Collum mine (Sinazeze)


ZMRERIP Project


ZMRERIP Project


Kitwe (Black MT)


Solwezi samples

Digital Transformation and Strategic Information



4. Digital Transformation and Strategic Information Centre

The programme focuses on strengthening its information management and dissemination systems and developing the institutional ICT infrastructure.

It focuses on acquiring relevant scientific and technological information to support research activities and repackaging information generated through these activities for dissemination. In addition, it has a printing facility which is leased out, and hosts a TEVETA registered National Training Tele-Centre.

The centre has also 3 Libraries located in Lusaka, Kitwe, and Chilanga Research Centers.



4.1 Centres Mandate

- To develop and maintain an effective and efficient electronic communication and information system (CIS) to enhance information delivery, sharing, and decision making at NISIR.

PROJECTS UNDER THE CENTRE

4.2 Development of an Industrial Cluster Database for Enhanced Research Collaboration

4.2.1 Purpose: To identify areas within the industry that would benefit from linkages to academic and research institutions, fostering industrial research collaboration.

4.2.2 Objective: To develop a comprehensive Industrial Cluster Database.

4.2.3 Specific Objectives:

1. To identify scientific, technological, and institutional resources and constraints within various companies.
2. To facilitate the establishment of linkages between industry and research institutions.
3. Expected Outputs:
4. Identification of companies across various industries.
5. Creation of an Industrial Cluster Database.
6. Enhanced collaborations between industry and research institutions.

4.2.4 Project Description:

1. Identification of Companies in Various Industries:
   - Conduct a thorough survey to map out companies across different sectors.
   - Document key details such as company size, focus area, technological capabilities, and existing research collaborations.
   - Identify both resource-rich companies and those facing significant constraints.
2. Identification of Scientific, Technological, and Institutional Resources and Constraints:
   - Evaluate the scientific and technological assets of companies.
   - Identify gaps and constraints that hinder research and development.
   - Assess institutional strengths and weaknesses to understand collaboration potential.
3. Creation of an Industrial Cluster Database:
   - Develop a user-friendly, searchable database to store collected data.
   - Include detailed profiles of companies, highlighting their resources, constraints, and potential for collaboration.
   - Ensure the database is regularly updated and accessible to relevant stakeholders.
4. Facilitating Collaborations:
   - Use the database to identify potential partners for research projects.
   - Organize networking events, workshops, and seminars to foster relationships between companies and research institutions.
   - Develop mechanisms for continuous feedback and improvement of collaborative efforts.

4.2.5 Implementation Plan

Phase 1

Planning and Preparation

- Assemble a project team with expertise in industrial research and database management.
- Develop a detailed project plan and timeline.
- Secure funding and resources.

Phase 2

Data Collection and Analysis

- Conduct surveys and interviews with companies to gather necessary data.
- Analyze data to identify key resources and constraints.

Phase 3

Database Development

- Design and develop the Industrial Cluster Database.
- Populate the database with analyzed data.

Phase 4

Collaboration Facilitation

- Promote the database to industry and research institutions.
- Organize events to encourage networking and collaboration.

Phase 5

Monitoring and Evaluation

- Continuously update the database with new information.
- Monitor the success of collaborations and make necessary adjustments.

4.2.6 Expected Impact:

- Improved identification and understanding of industrial resources and constraints.
- Enhanced collaboration between industry and research institutions.
- Accelerated industrial innovation and research output.
- Strengthened linkages between industry and academia, leading to mutual benefits and growth.









4.3 Systematic Identification and Knowledge System of Indigenous Plants/Trees for Microbial and Medicinal Research

4.3.1 Purpose: To develop an Indigenous Knowledge System (IKS) of indigenous plants and their end product benefits, facilitating further study of micro-organisms and microbial processes associated with these plants/trees. This will also aid in determining optimal methods based on the use of substrates.

4.3.2 Specific Objectives:

1. To systematically identify indigenous plants/trees and document their characteristics.
2. To disseminate data to scientists for the examination and scientific quantification of the use and management of indigenous plants/trees for medicinal purposes.

4.3.3 Project Description:

1. Systematic Identification of Indigenous Plants/Trees:
   - Conduct field studies to identify and catalog indigenous plants and trees.
   - Document botanical characteristics, habitat information, and traditional uses.
   - Collect specimens and create a herbarium for reference.
2. Creation of an Indigenous Knowledge System (IKS):
   - Compile traditional knowledge on the uses of indigenous plants and trees.
   - Develop a digital database to store and organize this information.
   - Include details on the medicinal, nutritional, and other benefits of these plants.
3. Dissemination of Data to Scientists:
   - Share the database with research institutions and scientists.
   - Facilitate collaborative studies to validate traditional uses scientifically.
   - Organize workshops and seminars to promote knowledge exchange.
4. Study of Micro-organisms and Microbial Processes:
   - Investigate microbial processes associated with indigenous plants/trees.
   - Identify beneficial microorganisms and their applications in medicine and agriculture.
   - Optimize processes based on substrate use for maximum efficiency and benefit.
5. Reporting and Knowledge Transfer:
   - Publish findings in scientific journals and reports.
   - Create informational materials for local communities and stakeholders.
   - Develop educational programs to promote the sustainable use and management of indigenous plants.

4.3.4 Implementation Plan

Phase 1

Planning and Preparation

- Form a project team and establish partnerships with local communities and research institutions.
- Develop a detailed project plan and timeline.
- Secure funding and resources.

Phase 2

Field Research and Data Collection

- Conduct systematic surveys and collect plant specimens.
- Document traditional knowledge and uses of plants.

Phase 3

Data Analysis and Database Development

- Analyze collected data and identify key plants and their benefits.
- Develop and populate the Indigenous Knowledge System (IKS) database.

Phase 4

Dissemination and Collaboration

- Share the database with scientists and research institutions.
- Facilitate collaborative research and validation studies.

Phase 5

Reporting and Knowledge Transfer

- Compile research findings and publish reports.
- Develop educational materials and conduct outreach programs.

4.3.5 Expected Impact:

- Enhanced understanding and documentation of indigenous plants and their uses.
- Strengthened collaboration between traditional knowledge holders and scientists.
- Promotion of sustainable use and conservation of indigenous plants.
- Increased awareness and utilization of indigenous plants for medicinal and other benefits in Zambia.



















4.4 Project Title: Digital Transformation at NISIR

4.4. Purpose:

The Digital Transformation Initiative aims to integrate digital solutions within the National Institute for Scientific Research (NISIR) to streamline information organization, enhance day-to-day operations and decision-making processes, and deliver content directly to users without human intervention.

4.4.1 Objective:

To integrate digital technology into research and development at NISIR.

4.4.2 Specific Objectives:

1. To improve efficiency, increase competitiveness, and drive innovation within NISIR.
2. To optimize the digital transformation processes at NISIR.

4.4.3 Expected Outputs:

1. Expansion and improvement of NISIR's Enterprise Resource Planning (ERP) systems.
2. Development of a comprehensive knowledge management system.

4.4.4 Project Description:

1. Integration of Digital Technology:

- Assess the current technological infrastructure and identify areas for improvement.
- Implement advanced digital tools and platforms to support research and development.
- Ensure seamless integration of new technologies with existing systems.

2. Improving Efficiency and Competitiveness:

- Automate routine tasks to reduce manual intervention and increase operational efficiency.
- Use data analytics to inform decision-making and strategic planning.
- Enhance communication and collaboration through digital platforms.

3. Driving Innovation:

- Foster a culture of innovation by providing researchers with access to cutting-edge digital tools.
- Support the development and implementation of innovative projects.
- Encourage the use of digital technologies to solve complex research problems.

4. Optimizing Digital Transformation:

- Develop a comprehensive digital transformation strategy aligned with NISIR’s goals.
- Provide training and support to staff to ensure effective use of new technologies.

Continuously monitor and evaluate the impact of digital initiatives.

4.4.5 Implementation Plan

Phase 1

Planning and Assessment

- Form a digital transformation team and establish partnerships with technology providers.
- Conduct a thorough assessment of current systems and processes.
- Develop a detailed project plan and timeline.

Phase 2

Technology Implementation

- Identify and procure necessary digital tools and platforms.
- Implement and integrate new technologies with existing systems.
- Ensure data security and compliance with relevant regulations.

Phase 3

Development of ERP and Knowledge Management Systems

- Expand and improve the ERP system to cover all aspects of NISIR's operations.
- Develop a comprehensive knowledge management system to organize and store research data.
- Provide training for staff on the use of the new systems.

Phase 4

Monitoring and Optimization

- Monitor the performance of the new systems and gather feedback from users.
- Optimize processes based on feedback and performance data.
- Continuously update and improve digital tools and systems.
-







4.4.6 Expected Impact:

- Enhanced efficiency and productivity in research and administrative operations.
- Increased competitiveness of NISIR through the adoption of advanced digital technologies.
- Improved management and accessibility of information and research data.
- A culture of innovation driven by the effective use of digital solutions.





4.5 Youth Mentorship and innovation



Youth Mentorship is one of many initiatives the institute has adopted in order to support the promotion of Science, Technology, Engineering and Mathematics (STEM) fields. Through a systematic identification of mentors in various industries and of a youth mentees



4.5.1 Objective:

- Creating a research and mentorship hub enabling environment for the mentees and employees

4.5.2Specific objective:

- Initiate Science graduates into the world of work
- Provide space where Science graduates can be trained /mentored and nurtured over varied periods of time
- Incubate the next generation of researchers and innovators





4.5.3 Expected outputs

- Creation of youth innovation hub
- Transfer skills that are relevant to the young population



5. ANIMAL SCIENCE RESEARCH CENTER





Animal Science Research is Located in Chilanga, and houses the following Laboratories:

5.1 Biotechnology Lab

A number of countries have established National Biosafety Frameworks that regulate the use of modern biotechnology products. Zambia developed a National Biotechnology and Biosafety Policy in 2003 and enacted a Biosafety Act in 2007. Additionally, a National Biotechnology Laboratory with the capacity to detect and monitor genetically modified organisms (GMOs), was established in 2007).

5.2 The core objective

The Biotechnology Lab core objective is to;

- Aid in the monitoring of the prevalence of genetically modified maize and soybean ingredients in different products such as whole grain and processed foods on the Zambian market thereby ensuring compliance with the Biosafety Act and;
- Providing GMO screening services to the general public such as the export and import community of agricultural products.

Modern biotechnology has been recognized and regarded as one powerful tool with potential to promote human well-being by meeting critical needs for food and health care. Through modern biotechnology, a number of herbicide and insect tolerant crops have been commercialized in some parts of the globe. However, concerns have arisen about the safety and long-term effects of the products of modern biotechnology. Currently, the Zambia Biosafety Act prohibits research, development application, import, export, transit, release or placing on the market of GMOs or products thereof without authorization from the National Biosafety Authority (NBA).

Two international instruments have been established to deal with the safety of biotechnology products.
The Convention of Biodiversity (CBD) has articles for the development of appropriate procedures to enhance the safety of biotechnology at national and international levels while the Cartagena Protocol aims at ensuring adequate levels of protection in the safe transfer, handling, and use of living modified organisms resulting from modern biotechnology with more emphasis on transboundary movements

The biotechnology laboratory is sufficiently equipped and committed to ensuring accurate, quality, timely and efficient GMO testing services to the public


FIGURE 1: PCR MACHINE


FIGURE 2: GEL ELECTROPHORESIS


FIGURE 3: WATER BATH



FIGURE 4: CENTRIFUGE (L), VORTEX(R)

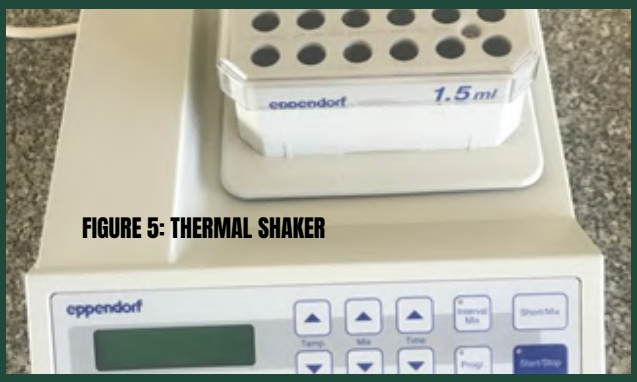


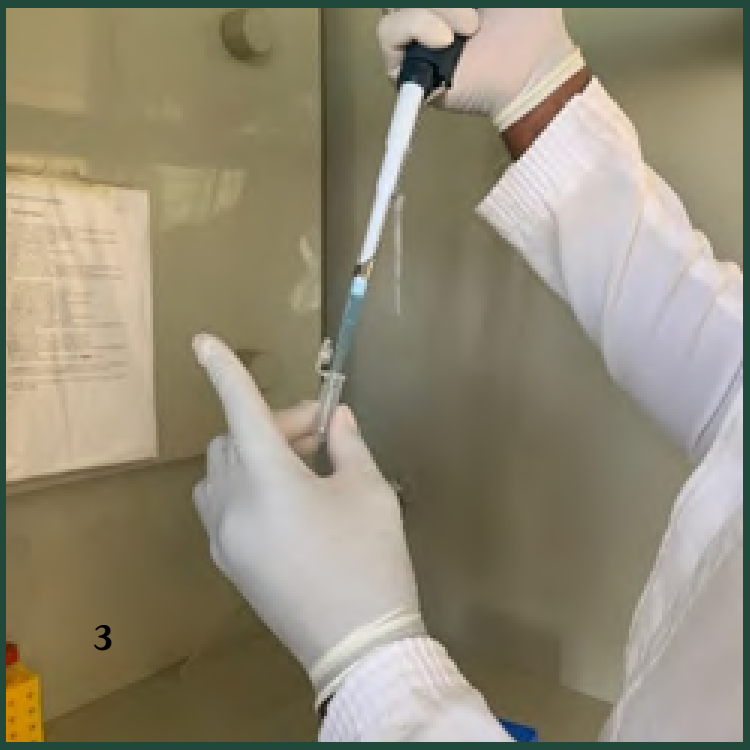
FIGURE 5: THERMAL SHAKER


INSIDE NISR LABORATORIES

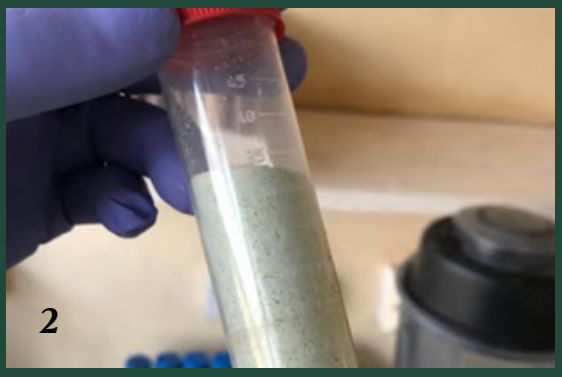
5.3 Sample Preparation, Extraction and GM analysis



1



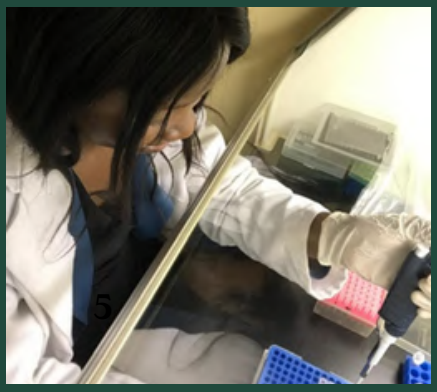
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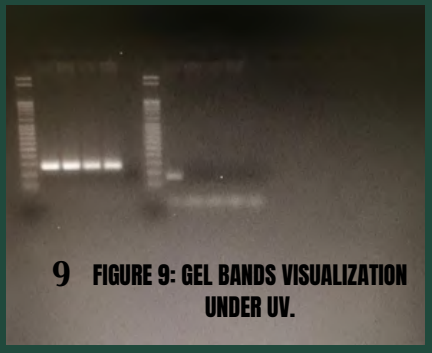
6 FIGURE 6: PCR AMPLIFICATION



7 FIGURE 7: GEL ELECTROPHORESIS



8 FIGURE 8: GEL IMAGING SYSTEM



9 FIGURE 9: GEL BANDS VISUALIZATION UNDER UV.

5.4. The Livestock Productivity and Disease Control Laboratory

The Livestock Productivity and Disease Control Laboratory can identify elucidation and make suggestion of solutions to problems that adversely affect livestock health and reproduction especially in the traditional/peasant sector.

- The Laboratory can provide consultancy on broad areas of reproductive patterns of local breeds of cattle, management practices, nutrition and pasture, distribution and seasonal activity of ticks, and ecology, biology and population dynamics of tsetse.
- The Laboratory through its extension services can help improve livestock productivity through integrated appropriate technologies and provide quality and effective research and development services to the livestock sector for improved agricultural production and food security.


INSIDE NISR LABORATORIES

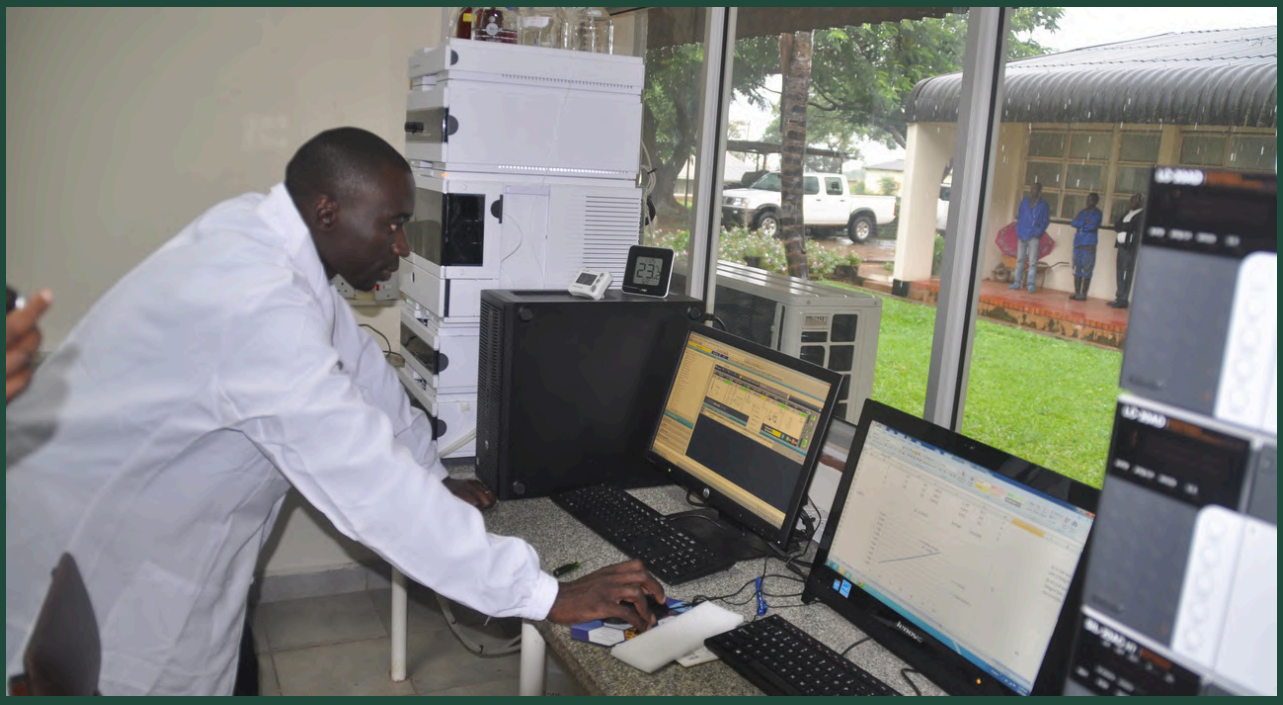

INSIDE NISR LABORATORIES


INSIDE NISR LABORATORIES

5.6 Mycotoxicology Laboratory

- Mycotoxicology Laboratory Carries out research in mycotoxins and also offers analytical testing services to the Zambian industry. Among them mycotoxins investigated are; Aflatoxin and fumonisin . Others include; deoxynivalenol, zearalenone and ochratoxin. The food matrices analyzed include groundnuts, maize, livestock feed and soya beans. The laboratory uses both screening and confirmatory methods for analyses. For screening, the lab uses standard fluorometric analytical methods to quantify with ease levels of toxins in foods/feeds to meet current technological trends in mycotoxin detection. For confirmatory test, the laboratory uses High Performance Liquid Chromatography (HPLC) method to quantify with ease the different mycotoxins. It has recently procured a Liquid Chromatography Mass Spectrometry (LCMS) through the International Atomic Energy Agency (IAEA) to expand its scope of residue testing.

- The laboratory is able to detect presence of such toxins in foods/feeds under research as well as service to industry. Due to their harmfulness many countries have put regulations on mycotoxins in foods. This may entail failure by Zambia to export certain products if not tested or if such tests indicate toxin concentration levels above set permissible limits may get affected and subsequently an economy. As part of the 8NDP, strategy 3 on enhancement of the export capability of produce as well as strategy 3 on the improvement of health through safer foods, it is envisaged that the laboratory will continue providing the critical platform to ensure conformity to the required standard.



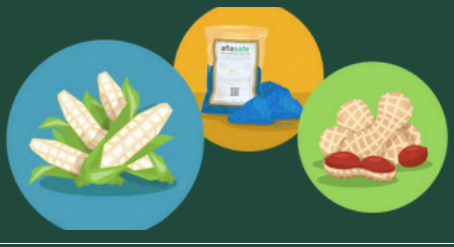
5.7 PROJECTS UNDER THE CENTRE

CREATING A COMPETITIVE FUTURE THROUGH AFLATOXIN-FREE MARKET-COMPETITIVE GROUNDNUTS AND MAIZE

Maize and groundnuts are susceptible to contamination with pathogenes including *Aspergillus* fungi. Some species of *Aspergillus* are known to produce harmful poisons called 'Aflatoxin.' The warming climate is increasing the risk of *Aspergillus* contaminating of susceptible crops.

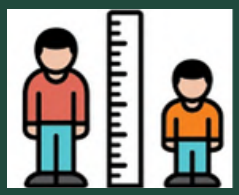
Aflatoxin Biocontrol Technology

A collaboration between NISIR, ZARI, IITA and USDA-ARS has developed two aflatoxin mitigation biocontrol agents, Aflasafe ZM01 and Aflasafe ZM02. NISIR Applied to ZEMA for manufacturing license. The product reduces aflatoxin contamination of groundnuts and maize in the field. The technology will increase the export income, promote industrial output and its subsequent growth.



Negative effects of Aflatoxins

- Causes liver cancer, abortion, stunts child growth and suppresses immunity.



Stunting



Liver Cancer

- Rejection of African food on international trade leading to loss of revenue e.g. US$670 million in the EU market (Otsuki et. et, 2001).
- Low livestock productivity and profits.

Industrial and Economical Benefits of

- Cost-effective solution to aflatoxins for farmers, industries and government by opening up to premium markets.
- Boosts productivity and profits for livestock and poultry farmers.
- Ensures food safe and saleability for processors and manufacturers of quality and safe products.
- Provides traders and governments with aflatoxin-safe products to supply to lucrative foreign export markets.

Development and Application of Aflasafe



Identifying and collecting the anti-aflatoxin fungi



Packaging the anti-aflatoxin fungus as aflasafe



How aflasafe is applied to field groundnuts



Checking for aflatoxin in the groundnuts in the laboratory



Conclusion

- Aflasafe ZM01 and Aflasafe ZM02 reduce contamination levels of aflatoxin in groundnuts by 80 – 95%.
- This translates into economic gain of about US$400 per tonne in exported groundnuts due to reduced potential rejections.

5.7.2 SUPPLEMENTATION WITH LOW- COST FEED FORMULATED WITH PROTEIN FROM MUSCA DOMESTICA LARVAE ON LIVE WEIGHT GAIN OF GRAZING MEAT GOATS



Introduction

Goats are the second popularly owned livestock by most smallholder farmers in Zambia after cattle. The most important sourcesof feed to these small ruminants are the natural pasture and the fibrous crop residues. These materials are of low nutritive value in the dry season, therefore, there is need to supplement the animals using climate friendly and affordable alternatives so they can maintain a good weight and health.

Goal

To produceand scientifically test a goat feed that will use fly larvae as its main source of protein. This will help farmers to have access to low-cost nutritious goat feed as a result, their animals will reach full production potential weight in the shortest possible time.



fig 1: Fly larvae sustrate

Methods

The formulation of the goat feed will use common housefly larvae as the main protein source.

- A substrate formulation with No.3 meal as the main constituent will be used.
- Another ingredient, Azolla, will be used in the production of the feed.
- Legumes i.e., Velvet Beans will also be used to supplement Maggots as well as to add to the bulk of the manufactured feed.



fig 2:Azolla

Results

The project is a flag ship and production of ingredients and optimization of nutritional content is being undertaken.



fig 3: Preserved Maggots



fig 4: Harvested Azolla



fig 5: Trial Goat feed

5.7.3 ˝LOW-COST TILAPIA FEED SUPPLEMENT USING FLY LARVAE AS MAIN PROTEIN SOURCE FOR SMALL-SCALE AQUACULTURE˜



Introduction

Fish production among smallholders has lagged and remains mostly stagnant, despite significant efforts from development organizations and government. Meanwhile, the large-scale sector has made significant upgrades in products and processes and is responsible for Zambia now being one the largest producers of farmed tilapia in Africa.

In spite of this, the country still experiences a large deficit in the quantity of fish produced and this difference is made up for by importing fresh fish from other countries. Smallholder farmers face many challenges like; climate change, lack of access to financial services, inadequate knowledge in pond management and limited extension services.

For this reason, this project is working to scientifically test out on-site and in situ a low-cost feed made with a protein source that aligns with climate change mitigation and adaptation strategies. These larvae can be produced anywhere in Zambia in scalable quantities and has potential to reduce feed costs.

Goal

To formulate, produce and scientifically test, on-site and in situ a tilapia feed supplement that uses fly larvae as its main source of protein.



fig 1: Fly larvaesustrate

Methods

The formulation of the fish feed will use common housefly larvae as the main protein Source

- A substrate formulation with No.3 meal as the main constituent will be used
- Legumes i.e., Velvet Beans will also be used to supplement Maggots as well as to add to the bulk of the manufactured feed.

Results

The project is a flagship. The production of ingredients, optimization of nutritional content and trial feed formulation is currently underway.



fig 2: Preserved Maggots



fig 3: Trial fish feed

5.7.4 LOW-COST GOAT AND FISH FEED SUPPLEMENT USING FLYLARVAE AS MAIN PROTEIN SOURCE FOR SMALL SCALE FARMERS



The Animal Science Research Centre (ASRC) is conducting a research project under the Livestock unit to produce feed that uses easy to source ingredients.

The feed will be a good source of nutrients with potential to meet the nutritional requirements equivalent to commercial feed which is rather expensive for low-income households.

The ingredients being used in the project will help mitigate the emerging challenge of climate change being experienced.
Common housefly larvae will be used as the main protein source. Other ingredients; Azolla and Velvet beans.



Figure 1: Goat



Figure 2: Fish



Figure 3: Maggot Substrate



Figure 4: Azolla pond



Figure 5: Azolla

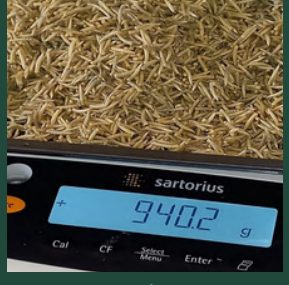


Figure 6: Harvested Maggots



Figure 7: Preserved Maggots



Figure 8: Feed production

This project will provide support to small-scale farmers through the utilization of readily available and affordable ingredients to produce high protein feed.



PLANT SCIENCE RESEARCH CENTRE

The Centre was established in 1965 as a Tree Improvement Research Unit of the Agricultural Research Council of Central Africa. Over the years, the Centre has evolved from focusing solely on tree improvement research to encompassing other programmes that support the mining industry, human health through natural products, food security and nutrition, and cosmetic industries. In the past the Centre has produced (a) a formulation for fighting Bilharzia, (b) propagated Impundu, Masuku and Mungongo trees for beverage production and nutrition and (c.) Jatropha for cosmetics and bio-fuels. The Centre also produced mini potato tubers for Zamseed, and demonstrated the potential of reclaiming mining waste lands using Jatropha plants. In addition, the Centre is mandated to liaise with other public and private institutions within and outside that are conducting similar research in order to enhance benefits from plant science.

6.1 Objective

- "Effectively and efficiently undertake research and development in order to improve the quality of life of Zambians.

6.2 Current Research Focus of the Centre

The Centre is currently focusing on:

- Developing improved root crop cultivars i.e. Irish potatoes, cassava and sweet potatoes. Root crops are preferred for their versatility and high yields, ultimately a suitable option to address food security challenge.
- Utilizing Mukula (*Pterocarpus chrysothrix*) as a climate change mitigation measure and for remediation and reclamation of mine-wastelands .
- Conserving and domesticating wild plants to address the food security challenges in drought prone areas.

- Establishing a natural products and pharmaceutical pilot plant aimed to produce affordable nutraceutical as well as pharmaceutical products from locally grown and known herbs. In this regard, the Centre is has received support from Government and hopes to work with the Private Sector to construct the herbal medicine Pilot Plant building.



Air layering of mukula for creation of plantlets for woodlots



Macro propagated pineapple seedlings ready for transplanting

Furthermore, the Centre is in the process of establishing a Pilot Plant for herbal medicines. In this regard, the Centre is has received support from Government and hopes to work with the Private Sector to construct the herbal medicine Pilot Plant building





6.3 The Centre tomorrow and Beyond

In order to continue to contribute to the improvement and quality of life of the Zambian citizenry, the Centre will continue to explore technologies in pharmaceutical and natural products and tissue culture.

In pharmaceutical and natural products as well as tissue culture. The Center will partner locally and regionally with the pharmaceutical industry and Universities conducting research in herbal medicine. A number of products have well known health benefits and are already on the market albeit mostly imported. NISIR will be involved with primary and secondary packaging on its own as an entity as well as offer packaging solutions to industry. Planned

products will include: locally grown herb resources.

In addition, as the backbone of the Centre's technology generation, the pharmaceutical and natural products as well as the tissue culture lab facility are in the process of been refurbished in order to support the production of herbal medicines, potato seedling, propagation of beneficial herbal plants, and conservation and domestication of importance wild plants.













7. FOOD SCIENCE RESEARCH CENTRE

The Food Science Research Centre is located at the NISIR Headquarters along the Kenneth Kaunda International Airport Road in Lusaka. The Centre was established to conduct scientific research and provide technical support in the area of Post-Harvest Food Technologies and Nutrition programmes. In addition the Centre provides analytical services to the food industry and the public.

Objective

- To conduct scientific research in food science and nutrition and value addition to indigenous food crops through food processing, preservation and product development, in order to improve the quality of life for the people.
- To provide technical expertise in the area of food science and technology through consultancy in food processing, safety and nutrition.
- To offer food analysis as a means of quality control and assurance in raw foods, food products, ready to eat foods. water and swabs



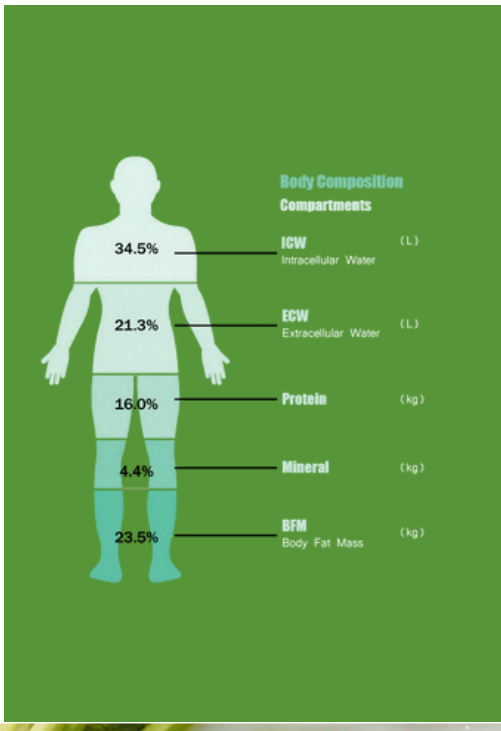


OUR LABORATORIES

7.1 NUTRITION CLINICAL LABORATORY

The Laboratory was established with the help of IAEA especially in acquisition of equipment and training of the staff. The Laboratory uses FTIR to measure breast milk intake andNutrition Clinical Laboratory body composition in two compartments i.e. Fat-free (lean) mass and fat mass by the use of isotopic technique which is a more accurate method (golden standard method) to determine the nutrition status of people.

in addition, the Laboratory is equipped with instruments such as Weight Scale, Stadiometer, Calipers, Measuring Tapes, skin fold, body circumference and Bioelectric Impedance Analysis (BIA) in the assessment of nutrition status.



Equipment used Nutrition Clinical Laboratory





7.2 FOOD CHEMISTRY LABORATORY



The Laboratory is mostly used for determination of food chemical composition at bench level. Analysis carried out includes:

1 . Proximate Composition

- Moisture
- Carbohydrate
- Fat
- Ash
- Fibre
- Energy
- Protein



2 . Minerals (Iron, Calcium, Phosphorus, Zink, Ascenic, Copper)

3 . Vitamins (Vitamin C)

4. Sugars

5. Free Fatty Acid

6. Peroxide value

7.3 FOOD MICROBIOLOGY LABORATORY

Most of the analyses carried out in this laboratory are used as

* Total Viable Count (TVC)
* Yeast and Mould Count
* Coliforms
* E.Coli
* Clostidium perfringes
* Salmonella
* Staphylococcus Aureus
* Bacillus Cereus







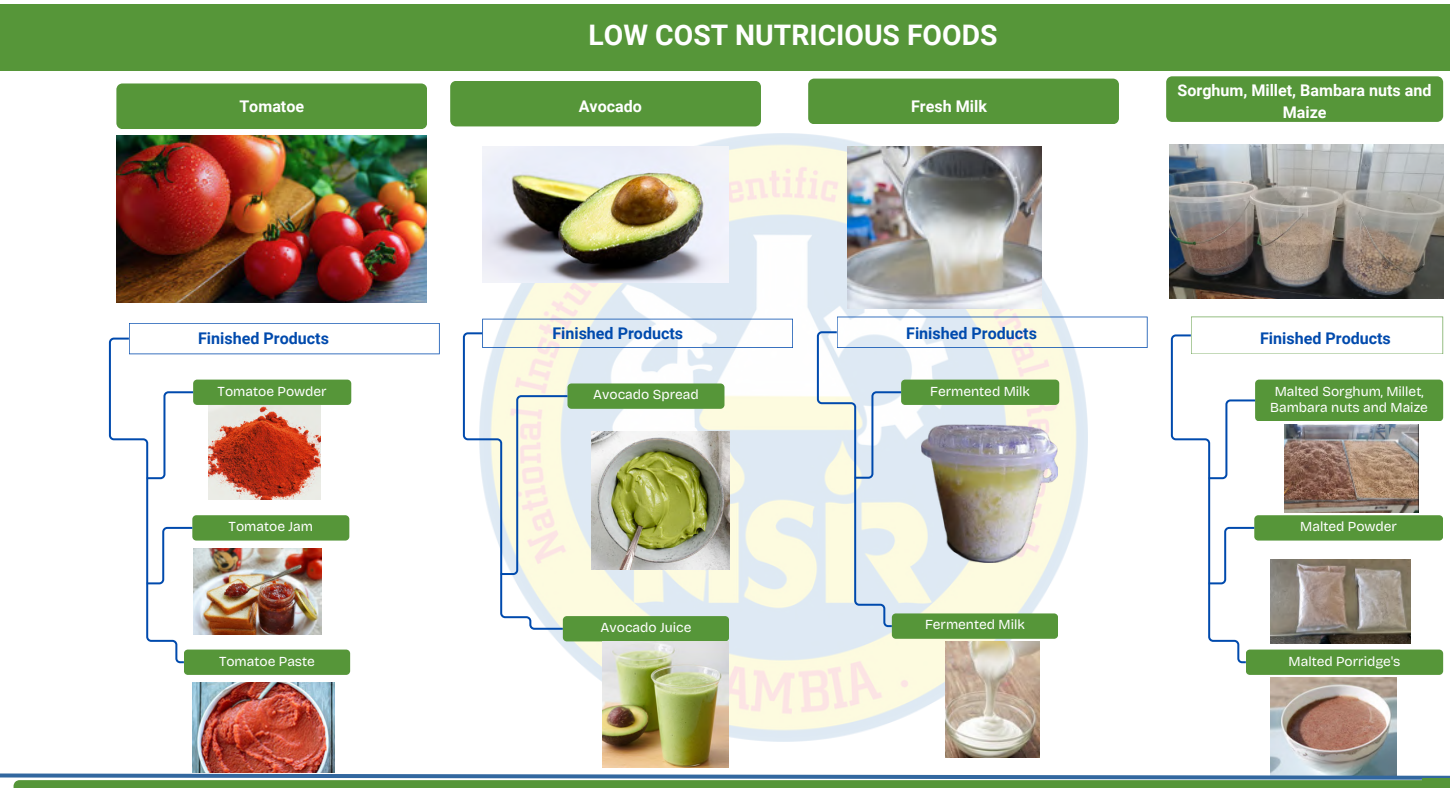


7.4 FOOD VEGETABLE PILOT PLANT

Equipped with steam boiler, steam jacketed pots, condensers, crushing machines, pulper, filter press, fruit washing machine, juice press and oil press. However, most of this equipment requires rehabilitation

7.5 LEGUMES, ROOTS, TUBERS AND ROOTS PROCESSING

This is a Pilot Plant for processing cereals, legumes, roots and tubers which is equipped with the following equipment: Ovens, stove, baking tins, mixers, mills, fermentation tank, grater and deep fryer. Products includes composite and high quality flour (cassava, bambara, cowpeas, fermented maize, millet and sorghum and starch) which have been used for various formulations such as, bread, buns, biscuits, flakes, crackers, crisps and instant porridges.



CURRENT PROJECTS

1. Low Cost Production of Avocado puree/Paste: To develop a method for processing and producing avocado puree that is nutritious and safe
2. Production Of Nutraceutical Food Products: To locally produce nutraceutical food products that will contribute to improvement in child nutrition and as part of nutrition care in cholera management
3. Value addition of tomatoes through Low cost production methods of dried tomato powder: To develop a low-cost methodology for production of dehydrated tomato powder

PAST PROJECTS

1. value addition to tomatoes through low cost production methods dried tomato powder
2. validation of the DTM protocol to measure Breast milk intake
3. Development of Nutritious blends, Cowpeas and Bambara blends.
4. Maize meal fortification with vitamin A, Iron and Zinc at hammer meal level (National Project).
5. Production of fuel Grade Ethanol from locally available raw materials. This is a joint study with the Crop Sciences Department of the University of Zambia (Sweet sorghum stocks developed by UNZA are being used for extraction of Ethanol and Mpundu fruit so as to achieve a 99.9% ethanol for blending with gasoline)
6. National Project on Evaluating Metabolic Composition of HIV-Infected People on ARVs in Zambia as a means of assessing the impact of food supplements (HEPS).
7. Retention of Pro-vitamin A in Biofortified maize (orange maize) during traditional storage and after processing and cooking. Collaboration with ZARI and Harvest Plus.
8. Commercialization of cassava through characterization of the different varieties, subjected to different treatment method and product development.
9. Assessing the suitability of Zeer Pot Technology (Clay stoves that work like fridges) in the preservation of fresh vegetables. Collaboration with Program Against Malnutrition (PAM).
10. Effect and treatment in stunted and non-stunted children assessed by the use of Isotopic Technique in measuring their body composition
11. Analysis of Zambeef products for; shelf-life and nutritional information.
12. Analysis of Delite samples for quality and nutritive composition.

8. WATER AND ENVIRONMENT RESEARCH CENTRE



Our Expertise

We have expertise in :

1. Microbiology
2. Chemistry
3. Water Engineering
4. Civil Engineering
5. Hydrology
6. Environmental Studies.

Who We Are

We are a team of qualified and competent researchers and laboratory staff with the mandate to conduct research and offer consultancy and analytical services in water and the environment.

8.1 RESEARCH

We conduct community need-based research to improve people's livelihood by promoting low-cost technologies utilizing local materials. Our work further aims to protect the environment from pollution and ensure the safety of water for water for drinking.





Laboratories

8.2 Water Chemistry Laboratory

Under the water chemistry laboratory we analyze the physical and chemical properties of water as listed below:

- pH
- Total alkalinity
- Turbidity
- Total suspended solids
- Total dissolved solids
- Chlorides
- Sulphates
- Nitrates
- Total hardness
- Sodium
- Potassium
- Phosphate
- Ammonia
- Magnesium
- Biochemical oxygen demand
- Dissolved oxygen
- Chemical oxygen demand
- Conductivity







8.3 Water Microbiology Laboratory

Under the water microbiology laboratory, we analyze water to estimate the number of bacteria present.

- Total coliform
-Fecal coliform

Ongoing research studies include:

1. Enhancing, Planning, Management and Sustainable Utilization of Water Resources
2. Developing a Cost-Effective method of water treatment using Moringa OleiferaSeed
3. Climate change mitigation – quantifying GHG emissions from landfills

Previous research studies include:

1. Water quality assessment in cholera-prone areas of Lusaka, Zambia
2. Water quality assessment in new residential areas in Lusaka.
3. Production of fuel grade Ethanol from locally available raw materials.
4. Optimization a method for Nitrate Determination in Drinking Water.
5. Characterization of Bio-solids and Evaluating the effectiveness of sun drying beds as bio-solids stabilization method in Lusaka, Zambia.

Activities

1. We provide analytical services in water quality to a range of clients, ranging from individuals to private water scheme providers and mining companies.
2. We offer consultancy, internships, and laboratory demonstrations to students.



8.4 CAPACITY BULDING



International Atomic Energy Agency (IAEA) training course on the development of detection and response equipment life cycle management program in Vienna, Austria.

International Atomic Energy Agency (IAEA) Regional Training on The use of Isotope Tracers Complementary Hydrological Tools for the Development and Validation of Conceptual Groundwater Flow Models in Palapye, Botswana.





Regional (AFRA) training course on the use of Nitrogen isotopes in water pollution studies by International Atomic Energy Agency (IAEA), Rabat - Morocco.

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