PATHOGEN
ECONOMY

Goal:

A developed Pathogen Economy Ecosystem Contributing **USD 48.3Bn to Uganda's GDP by 2040.**

Focus:

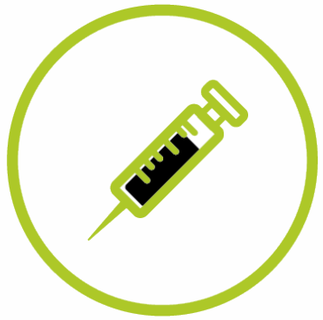
Research, development, technology transfer, and commercialization of inputs for human, plant, and animal health, including Vaccines, Therapeutics, Diagnostics, Medical Equipment, and Devices.

Background

The Global Pharmaceutical Industry was valued at more than 1.48 trillion USD in 2021 and is expected to rise to 1.7 trillion USD by 2026. The vaccine market, which was USD 40 billion in 2020, spiked to USD 141 billion in 2021 due to the COVID-19 pandemic. The United States owns 49.1% of this market. Africa is the only market where genuine growth is still achievable. For example, the continent's pharmaceutical industry is worth USD 20 billion and is predicted to reach USD 70 billion by 2030. To tap into this lucrative opportunity, the Pathogen Economy Bureau has prioritised the following:

- Establish starter utilities, construct and equip PCR and Rapid Diagnostics Pilot plant in Biosciences Park;
- Support clinical trials for Natural Therapeutics
- Support operations of central facilities for the Pathogen Economy ecosystem (in vitro studies, animal laboratory facilities, Biobanks)
- Support the R&D in emerging and priority areas of the Pathogen Economy
- Human Capital Development for the Pathogen Economy;

Key Highlights



Vaccines

3 human vaccines for acute respiratory infections completed animal trials.

Adenovector Vaccine Backbone patented at WIPO, attracting:

£2 million in funding for CCHF vaccine.
£3 million in funding for RVF vaccine.

£5 million grant secured for Marburg vaccine development, monoclonal antibodies, and biomarkers.

Dual vaccine for LSD/FMD completed in-vitro studies.

Anti-tick vaccine progressed to Phase **2** clinical trials.

20 specialized jobs created in vaccine R&D.

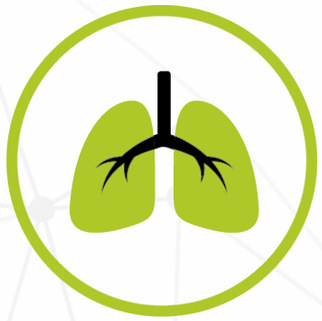
Diagnostics

Developed diagnostic tools and kits for COVID-19, acute respiratory infections, and plant diseases.

Generated **USD 2 million** from Proficiency Test panel sales to 15 African countries.

Internal diagnostic testing for respiratory infections saved
UGX 135.8 billion.

12 diagnostic tools ready for industrial production.



Therapeutics

UGX 11.4 billion generated from sales of natural therapeutics like Jena Herbals.

Uganda's Natural Therapeutics have already reduced medicine importation into Uganda by **3.9%** of the total import value.

50,020 direct jobs created.

Preclinical testing in animals initiated for multiple therapeutic products.

Clinical trials completed for **3** natural therapeutics for management of acute respiratory infections.

Central Facilities

Support for vaccines, therapeutics, and diagnostics development, with over **50,000** archived samples for research.

2000 cancer samples archived for R&D.
3 Human Vaccines for acute respiratory infections, 1 vaccine for Rift Valley Fever and 7 Therapeutics ready for animal trials.

Incubation and Acceleration of **15** startups leveraging AI for Health innovations.

50,316 samples for archived for acute respiratory infections.

External validation done for **30** diagnostic tests of different technologies (RDTs, RT-PCR, serological and molecular techniques.)

Achievements

Infrastructure

Vaccines:

- Fully equipped vaccine manufacturing line for humans and animals at Alfasan (U) Ltd.
- Flexible vaccine R&D platforms at:
- Uganda Virus Research Institute (UVRI)

Diagnostics:

- Centre for Cancer Biomarkers at Uganda Cancer Institute.

R&D laboratories at:

- Gulu University (Plant Diagnostics)
- Makerere Biomedical Research Center (PCR)
- Makerere University MAPRONANO (Nanotechnology)
- Makerere University College of Veterinary Medicine, Animal Resources, and Biosecurity (MakCOVAB)
- National Agricultural Research Organization (NARO)
- Fully equipped Clinical Trial Farm in Ngoma

Therapeutics:

- Facilities established for biotech, GLP, and GMP at:
  - Dei BioPharma
  - Busitema University
  - Natural Chemotherapeutics Research Institute
  - Soroti GMP Facility

Biomedical Equipment and Inputs	• R&D platform for medical textiles development at UIRI
Central Facilities	• Central Laboratory Animal Research Facility equipped for animal experimentation at Makerere University; • Pan-Cancer Tissue Biorepository at Uganda Cancer Institute Biobank, • A biobank at the Makerere Biomedical Research Center (MAKBRC), • Pathogen Labs - anR&D facility for ICT for Pathogen Economy at Makerere University.

Human Capital

Vaccines:	• Specialized GMP training for 6 scientists in South Korea. • Career development, mentorship, and strategic internships for 18 scientists (Bachelors, MSc, and Ph.D.) in vaccine research.

Diagnostics:	• **15 PhDs** and **40 MSc** students trained in nanomaterials, additive manufacturing, and biomedical research
	3 scientists trained in GMP (Kenya)
	Training for:
	  • 6 junior scientists (Biomarker Technology)
	  • 5 MSc students and 1 PhD student on malaria diagnostics
	  • 3 post-doctoral researchers from East Africa

Therapeutics:

- Training for:
  200 indigenous scientists in in-vitro/in-vivo research
  - 40 health workers on herbal medicine usage
  - 5 MSc students and 5 research fellows in clinical trials
  - 3 scientists trained on In vitro Molecular Biology techniques
- A specialized Master of Pharmacy in Product Development was established at Busitema University as a direct outcome of STI-OP engagements.

Central Facilities:

- **9** scientists trained in animal handling and preclinical studies.
- **20** scientists trained in biorisk management.
- **6** scientists trained on working with IACUC

Investment

Total:

- **UGX 50,220,681,817 in vaccines**

Additional funding of

- 2 Million Pounds raised for the development of the Crimean-Congo Hemorrhagic Fever (CCHF) vaccine
- 5 Million Pounds secured for the development of the Marburg vaccine, monoclonal antibodies, and biomarkers

Total:

- **UGX 19,575,110,492** has been invested in Diagnostics
- **UGX 19,091,337,300 + UGX 723,000,000,000 (Dei BioPharma) + UGX 4,827,246,869 (Covidex).** Has been invested in therapeutics
- **UGX 31,081,090,064 invested in Central Facilities**

Path to Commercialization

1

12 diagnostic tools developed for acute respiratory infections, with all internal and external validation completed, ready for industrial production.

2

A rapid diagnostic kit for banana wilt, cassava mosaic, and sweet potato virus has been developed, with internal validation successfully completed.

3

Inputs and reagents for diagnostic R&D have been developed and successfully internally validated.

4

The Human African Trypanosomiasis test kit has been developed and is awaiting clinical trials.

5

The malaria urine strip has been developed and is currently at the prototype validation stage.

6

The rapid bovine pregnancy test kit is at the prototype stage.

7

Saliva Diagnostic Kit - ready for commercialisation

8

The PCR and anti-body diagnostic kits- ready for commercialisation

9

PCR-based diagnostic Assays- ready for commercialisation

10

Development of Antibody ELISA for COVID-19 surveillance- ready for commercialisation

11

Development of rapid low-cost point-of-care nucleic acid diagnostic tools for Banana Xanthomona wilt, cassava mosaic disease and sweet potato viruses- ready for commercialisation

12

In vitro testing for bacterial, fungal and viral sterility; as well as antibacterial, antifungal, antidiabetic, anticancer and antimalarial, antiviral and antioxidant/ anti inflammatory assays for Half Maximal Inhibitory Concentration (IC50) done for 49 natural products

13

Preclinical testing in animals done for two natural products, 9 awaiting in the pipeline for pre-clinical testing in malaria, sickle cell, cancer and diabetes.

14

Clinical trials completed for 3 natural therapeutics for management of acute respiratory infections

15

Clinical trials starting for COVIDEX and for 3 antidiabetic natural products, 3 antimalarial natural products and one analgesic natural product

16

Development and production of medical and biomedical plastic supplies at MAPRONANO ACE

17

Smart Postpartum Haemorrhage Volumetric Drape (SMART-PVD) device

18

The Baby Saver device for affordable neonatal resuscitation with intact umbilical cord at birth in Uganda

19

Telemetric shunt

20

Neonatal intensive care unit (Baby incubators)

21

Recycling of plastic waste into interlocking blocks

22

Re-usable unisex sanitary pads and protective gears for salt miners

Ecosystem

Uganda Virus Research Institute (UVRI)

National Agricultural Research Institute (NARO)

NationalLivestock Resources Research Institute (NALIRRI),

Makerere University College of Veterinary Medicine

Animal Resources and Biosecurity (COVAB)

Alfasan

Uganda Cancer Institute (UCI)

Makerere University College of Health Sciences (CHS),

Makerere University Biomedical Research Center (MakBRC)

NDIYO Biosciences

Joint Clinical Research Center (JCRC)

Gulu University

Kabale University

PIBID/BIRDC (Bushenyi)

Mbarara University of Science and Technology

Busitema University (Mbale)

WINDSOR LAB, Herbs For You SMC

Lira University

Jenna Herbals

Natural Chemotherapeutics Research Institute

Africa Center of Excellence in Materials Product Development and Nanotechnology (MAPRONANO ACE),

Africa One Health University Network (AFROHUN)

PUMZI Devices Uganda,

Sanyu Africa Research Institute

CURE Children's Hospital

Africa Space Science

Innovations Research Programme.

Work has started on the Biosciences Park, as the nation's One-stop Center for Research and Development (R&D), and pilot Industrial Manufacturing for Vaccines, Diagnostics, Therapeutics and other inputs targeting human, animal, and plant health, on 152 acres of land in the T-6 Industrial Park (Nakasongola).