INNOVATIONS AND COMMERCIALIZATION OF RESEARCH OUTPUTS BY UNIVERSITIES FOR DEVELOPMENT

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State Department for University Education and Research

Ministry of Education

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• Constitution of Kenya - Article 33 (1) (c) on freedom of expression acknowledges academic freedom and freedom of scientific research

• Disclaimer: Views expressed here are mine and do not imply endorsement by the Kenyan Ministry of Education
Presentation Overview

• Knowledge based economy
• Role of University
• ‘Triple Helix’ Model
• Legal Frameworks
• Some observations/Kenyan situation
• Kenyan university success stories
• Discussions
• Way Forward
Government’s View of Technology

Technology to drive my Big Four promises, says Uhuru

President expresses confidence that digital revolution will help him deliver on agenda

BY PATRICK LANG’AT
palangat@ke.nationmedia.com
AND PSCU

President Uhuru Kenyatta yesterday said that the government will focus on technology to deliver on his Big Four second term promises of affordable housing, universal healthcare, food security, and manufacturing.

He said technology would support affordable healthcare by driving access to information, better financing, stronger training for health workers, and, ultimately, broader access to services.

Digital technology would also support efforts to increase food security by playing a key role in agricultural value chains through better access to inputs, more reliable weather and crop information, tracking of counterfeit inputs, more transparent access to markets and fair pricing.

"M-Pesa, M-Kopa, GroIntelligence, Andela and others show that we can lead the world with innovations that drive financial inclusion, access to energy and better data to drive our agriculture,”

President Uhuru Kenyatta addressing delegates attending the Digital Economy Symposium at Strathmore University Law School, Nairobi.

He said Kenya was also positioning itself to reap the most out of the global digital revolution. The government, he added, would set up a committee on Blockchain and Internet of Things technologies to study the benefits and challenges from the latest digital innovation trends.

Blockchain is the technology that will transform the world,”

He said the country had been a leader in digital innovation and would not be left behind in the latest trends. The potential for digital dividends was enormous.

"As a matter of fact, the internet and associated digital trade of goods and services have led up to 10 per cent rise in employment in Africa.”
ST&I and Economic Development

• Robert Solow (1957) using economic theory and mathematical analysis to data in USA from 1909-1949:
  – Demonstrated that 7/8 of growth in GDP was attributed to technological development
  – re-analyzed same data later and showed that GDP growth was explained by 30% education and 64% technology
  – In 1987, he was awarded Nobel prize for this finding
  – investments in research thus benefit society (Jones and Williams, 1998)
Figure 1.5. Knowledge as a Factor in Income Differences between Brazil and the Republic of Korea, 1956–90

Source: Calculations based on World Bank internal data. Knowledge for Development (K4D) Program, World Bank Institute.
Innovation Increases people’s Income

Technological achievement

per capita income by region

East Asia & Pacific
Middle East & North Africa
High income OECD
Europe & Central Asia
South Asia
High income Other
Sub-Saharan Africa
Latin America & Caribbean

Europe & Central Asia
Latin America & Caribbean
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<th>Stage 1: Factor-driven (35 economies)</th>
<th>Transition from stage 1 to stage 2 (16 economies)</th>
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<th>Stage 3: Innovation-driven (38 economies)</th>
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Knowledge-based economy

- **Based on Vision 2030**, Kenya is to transit from “factor driven” model of economic development to one that is knowledge-based and “innovation driven”

- **Effective ST&I policies:**
  - high investment in education and training at ALL levels (creative/critical thinking i.e., Centres of Excellence)
  - high-quality scientific research institutions
  - extensive relationships between governments, academia, and industry (Triple-Helix), and;
  - protection of the intellectual property
  - **Nationhood** (invoke article 10(2) (Chapter Two) on national values and principles of governance, article 73 of (Chapter Six) on leadership and integrity and article 232 (Chapter Thirteen) on values and principles of public service in educational curriculum at all levels of the education system)

- ✓ Key factors of strong economies and robust societies in the 21st century

____________________________

(Lowe, 2005; World Economic Forum, 2010/2011)
Role/Functions of a University

Universities hold **three** core, overlapping and integrated functions:

– provide highest standard/quality **teaching**,  
– engage in scholarly quality scientific **research and innovation**, and;  
– undertake a ‘**third stream’ role** of **dissemination** of outputs of research to ‘community/industry engagement/outreach’ or ‘knowledge/technology transfer’ – **commercialization** (ideas to products/services)

*(University Act, 2012)*
University-Industry Linkages

- Because of **commercialization role (still new)**, Universities have more potential to contribute to R&D – **knowledge-based economy**

- the topic of university-industry linkages (commercialization) is increasingly coming to the fore in higher education policy dialogue in Africa*

- many governments establishing universities and taking action to foster university-industry linkages

- Kenyan Universities have increased from 1 in 1983 to >70 in 2019 (www.cue.or.ke)

- **Huge investment** in higher education underlines importance of trained manpower in national development

*(African Higher Education Summit, Dakar, Senegal, March, 2013)*
University and Knowledge-based economy

- In knowledge economy - (It’s the educated people and their ideas) are key resource

- the creation, dissemination and application of knowledge – a factor of strong economies and robust societies in the 21st century

- research and development (R&D) is key to economic growth and global competitiveness

- the universities, as major centres of learning and research – becoming important as the sources of ideas, knowledge, skills, innovation and technological advances – Universities at Centre of National Innovation Systems

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(Rooney et al., 2005; Khademi et al., 2015)
Proposed Kenya’s National Innovation System

**ST&I DEMAND**
- CONSUMERS (final demand)
- PRODUCERS (intermediate demand)

**BUSINESS SYSTEM**
- Large & multinational companies
- Micro, small & medium enterprises
- Start-up companies

**INTERMEDIARIES**
- Professional associations
- Academies of Sciences
- Special interest groups

**EDUCATION & RESEARCH SYSTEM**
- Universities
- Research institutes & centres
- Schools
- National Research and Education Networks

**FRAMEWORK CONDITIONS**
- Financial Environment
- Taxation and Incentives
- Collaboration
- Commercialization
- Levels of education and literacy

**FINANCE**
- Government
- Private sector financiers (Banks, Venture capitalists, Angel investors & Angel investor networks)

**IPR & INFORMATION**
- KIPI
- KNBS, Among others

**STANDARDS & NORMS**
- KEBS
- ICTA
- NEMA
- KENAS, Among others

**GOVERNANCE SYSTEM**
- Coordinative Ministry in charge of ST&I
- National Commission for ST&I (NACOSTI)
- National Research Fund (NRF)
- Kenya National Innovation Agency (KENIA)

**ST&I INFRASTRUCTURE**

**INNOVATION & BUSINESS SUPPORT**
- Incubation & commercialization
- Science & technology parks
- Special economic zones

(Draft, ST&I Policy, 2008)
What an Effective NIS does

• strengthening networks between:

  – higher education, technological institutions, academic entrepreneurs, and local industries in support of R&D projects and technology transfer,

  – the provision of risk capital for new innovative companies and micro-financing for start-ups,

  – seed coaching and stipends for academic entrepreneurs
Triple Helix model

• Studies show universities with closer ties to industry – are more entrepreneurial

• Three key players in NIS are **industry, government, and universities** in a ‘**triple helix**’ who need to be brought together and be collectively **energized**

• recently, **there is the inclusion of civic society** to the triple helix, leading to a ‘**Quadruple’** model

• addition to producing **work-ready** graduates, **synergies** between universities and industry **promotes innovation and technology transfer** – **commercialization**

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Etzkowitz and Leydesdorff, (1997); Carayannis and Campbell (2012)
Etzkowitz and Leydesdorff, (1997)

Triple Helix model

Cont’d
Statist Triple Helix

Government

Industry

Academia
Statist Configuration:

- Government plays the lead role

- Drives university and industry, but

- Curtails their ability to undertake transformative and innovative transformations;

- Civil society is often actively suppressed
Laissez-faire Triple Helix

State

Industry

Academia
Laisser-faire configuration

- Industry plays the lead role;
- Limited state intervention;
- Government and university plays support roles
  - University: skilled human capital
  - Government: regulator of social and economic mechanisms
- Civil society is relatively inactive
Balanced Configuration: Civil Society is the Foundation Stone of the Triple Helix
Balanced configuration:

- Government, industry and university act in partnership;

- Each can take the lead role: substitution/complementary modes of interaction;

- Innovation takes place at the intersections of the 3 spheres

- Civil society is actively involved and constitutes the backbone of the system
Legal environment for Commercialization

- **commercialization** require not only increased investment in R&D, but also in the **legal frameworks, skills and infrastructure**

- In 1960s and 1970s, due to lack of clear policy on technology transfer, commercialization involved long periods – frustrations

- Congress to enact the **Bayh-Dole Act of 1980**

- universities were given the obligation to commercialize innovations resulting from public funding

- United States has become very advanced in technology transfer and commercialization of research due to this Act

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(Mowery et al., 2004)
Optimal environment for Commercialization Cont’d

• Many OECD enacted similar legislation to Bayh-Dole Act, with universities being given the responsibility for managing and exploiting IP.

• This gave universities the ‘Third Stream’ role, in addition to teaching and research.

• This also gave universities the ability to contribute to the commercialization of innovation.

(Molas-Gallart et al., 2002; Mowery and Sampat, 2005)
Kenyan Situation

- **commercialization** of university research outputs *(still new)* requires appropriate policies and management systems

- If **knowledge transfer can’t be measured**, it also **can’t be readily recognized and rewarded** *(Osborne and Gaebler, 1992)*
Some Observations

• A study in 17 universities (15 Public and 2 Private)

• 6 universities did not respond (3 public and 3 Private)
### University Commercialization Environment

<table>
<thead>
<tr>
<th>Study Variable</th>
<th>Number of respondents (N=17)</th>
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<tbody>
<tr>
<td>Geometric Mean Expenditure in KES on R&amp;D (Range)</td>
<td>21.1 (2M-3.5B)</td>
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<tr>
<td>Median (IQR) Expenditure in KES on R&amp;D</td>
<td>18.3 (9.5-33.0)M</td>
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<tr>
<td>Commercialization in University Vision and Mission Statements</td>
<td>16</td>
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<tr>
<td>Research in strategic plan</td>
<td>17</td>
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<td>Commercialization in Strategic plan</td>
<td>17</td>
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<tr>
<td>University has guidelines on Commercialization</td>
<td>13</td>
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<tr>
<td>University has innovation policy</td>
<td>14</td>
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<tr>
<td>University informs industry on their products</td>
<td>11</td>
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<tr>
<td>University has financial target on commercialization</td>
<td>10</td>
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### Commercialization Environment

Cont’d *(Commer. Office)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>% respondents</th>
<th>No. of respondents (n=17)</th>
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<tbody>
<tr>
<td>University has a dedicated entity for commercialization</td>
<td></td>
<td>6</td>
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<tr>
<td>Number of spin-off companies started since university started or last 10 years</td>
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<td></td>
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<td>● 0</td>
<td></td>
<td>12</td>
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<td>3</td>
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<td>● 3</td>
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## Intellectual Property Rights (IPR) Cont’d

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<th>Variable</th>
<th>% respondents</th>
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<tr>
<td>patents that universities have sought in last 5 years/since establishment</td>
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<td>● 20</td>
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<td>Number of patents issued locally</td>
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<td>Number issued elsewhere</td>
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Intellectual Property Rights (IPR) Cont’d

No of Universities and their Consultancies in the last Two Years (n=17)

(Parenthesis = number of Consultancies)
NATIONAL PATENTS GRANTED
(1990 – 2013)

(Bolo et al., 2015)
Kenyan University-Industry Linkages

UNIDO, 2014
### Characteristics of Generation of Universities (Wissema, 2009)

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<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt; generation</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; generation</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; generation</th>
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<tr>
<td><strong>Objective</strong></td>
<td>Education</td>
<td>Education + Research</td>
<td>Education + Research + know-how exploitation</td>
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<td><strong>Role</strong></td>
<td>Defending the truth</td>
<td>Discovering nature</td>
<td>Creating value</td>
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<tr>
<td><strong>Method</strong></td>
<td>Scholastic</td>
<td>Modern Science, mono-disciplinary</td>
<td>Modern Science, inter-disciplinary</td>
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<td><strong>Creating</strong></td>
<td>Professionals</td>
<td>Professionals + scientists</td>
<td>Professionals + scientists + entrepreneurs</td>
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<td><strong>Orientation</strong></td>
<td>Universal</td>
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<td><strong>Language</strong></td>
<td>Latin</td>
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<td><strong>Organization</strong></td>
<td>Faculties, Colleges</td>
<td>Faculties</td>
<td>University institutes</td>
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<td><strong>Management</strong></td>
<td>Chancellor</td>
<td>Part-time academics</td>
<td>Professional management</td>
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Dons in Kenyan varsities not active in research - report

Apart from funding issues, institutions lack labs and incubation centres

BY OUMA WANZALA
Partnerships, not collaboration

Industry-University interactions at different levels
Establishment of Science and Technology Parks, or Business Innovation and Incubation Centres in Universities

Technology transfer from research labs in to markets

- Company incubation
- Linking innovators with investors
This Science and Technology Park

was officially commissioned by

H.E. Hon. Mwai Kibaki, C.G.H., M.P.,

President and Commander - in - Chief

of the Armed Forces of the

Republic of Kenya

on Thursday 4th December, 2008.
SCIENCE & TECHNOLOGY PARK & INDUSTRIAL LINKAGES (STPIL)

MELIPONI CULTURE PROJECT

TITLE: HARNESING STINGLESS BEE FOR POVERTY REDUCTION, WEALTH CREATION AND CONSERVATION OF BIODIVERSITY & ENVIRONMENT

FUNDING: MMUST-URF
Production of Biodiesel From Waste Cooking Vegetable Oil

Dr. Betty Mbatia (Technical University of Kenya)

Biodiesel is being produced from Waste cooking oil collected from hotels and chips restaurants.

Waste oil & fat from hotels and restaurants

Closed loop Biodiesel reactor

A TUK-TUK engine running on 100% Biodiesel
Revitalizing Textile Industry
Natural dye from a local weed Mexican marigold
Prof. Richard Mibey, - Moi University

- This innovation revived the textile industry by providing sustainable and cost effective dyes

- Its application is saving Rivatex East Africa a facility of Moi University the cost of importing dyes to the tune of over 20M annually.
Development of Bio-fertilizer –
Dr. Joseph Mwafaida, Pwani University

- Production Bio-fertilizer - Composted garbage after 4 months
- Price: Kshs 500
- Approx 55 bags per compost pit (3 X 4m)
- 5 bags per cubic meter ($M^3$) of raw garbage
Salsy Innovate (KU)

• Salsy Innovate ltd is a technology firm providing payment systems mainly to schools, colleges and universities.

• Have partnered with a number of strategic partners including banks and retail outlets to ensure quality and innovative products for our customers.
University of Nairobi Science & Technology Park and Fablab

• Developed Fabfi, a wireless Mesh Network, wifi solution to extend the accessibility of wifi communication internet in a cheap and affordable way. A company, Fabcom Co. Ltd was founded from the park.

Fabfi set up

Fabfi reflector on a tower in Nairobi
University-Industry Partnerships

**Example:** Jomo Kenyatta University of Agriculture & Technology: Partnership with Nissin Foods Holdings Co., Ltd to foster food security technology in Kenya

Noodles and Instant Porridge
CERTIFIED BEANS SEEDS

Chelalang  Tasha  Ciankui

For Medium to High Altitudes

- HIGH YIELDING; 7 to 10 Bags/Acre
- EARLY MATURING; 2.5 to 3 Months
- GRAIN HAS NO ACIDS, NO GAS AND COOKS FAST

PLANT 25 Kgs Per Acre pure stand

AVAILABLE AT EGERTON AGRO-SCIENCE PARK (FISH FARM) OFFICE
NEXT TO CHEMISTRY DEPARTMENT
Some funded projects with Success stories

**Improve Maize Variety Resistant to Striga weeds** - Prof. Mathew Dida (Maseno University)

Striga weed causes severe yield losses, sometimes the farmers loose 100% of their harvest.

The agricultural sector suffers close to 7 billion USD in losses as a result of this infestation of the weed.

The project developed a seed variety that withstands striga weed infestation.
Models Commercialization

Old approach = Science ▶ Capital ▶ Business ▶
Linear model

Results
slower process
increased risk

New approach = Science ∩ Capital ∩ Business
Synergistic model

Results
Demand based, outward focused innovation,
Increased speed,
Improved scope
Scalability,
Multi-dimensional innovation

Old and new approaches to innovation
Economic impact of commercialization to community

- Employment to community
- Consumptions of products of community
- Technology increasing community productivity
- Multiplier effect creating demand for other products/services
- Suppliers to university
- Spending in community by faculty
- Fees paid by students
- Enhanced quality of life.
Discussion/Conclusions

• Because of small markets and low purchasing power in Africa, global firms are unlikely to develop specialized products for Africa.

• Universities are well-placed to fill this role of increasing productivity, quality control and value addition, particularly SMEs.

• Innovation to transform of Africa from a continent dependent on natural resources to one that is innovation-based.
Discussion/Conclusions

- Structures for commercialization are in place but **poorly resourced** *(broaden RM)*
- There is need for **mainstreaming** commercialization of research in Universities *(Culture change - entrepreneurship)* – VCs/councils will be key – i.e., leadership
- Industries and universities need to talk **with** each other *(Linkages)*
- Research should be appealing to industry/users *(applied research)* i.e., fit-for-purpose
WAY FORWARD

• Universities need to be **proactive** *(ivory tower)*
• Invest in **internal capacity** *(IP, marketing and entrepreneurial training)* – **avoid early disclosures**
• Engage in high quality relevant research **even if not cutting edge**
• Broaden promotion criteria *(innovate or perish)*
• Focus on home-grown solutions for Kenya/Africa
• Build multidisciplinary through **strong collaborations**
• Go beyond **IP filing to licensing**
• Invest in **training and infrastructure** to attract best of best
Restructuring

- Universities must **ready themselves** for restructuring (i.e., a common term in private sector)
- Mergers, acquisitions and strategic alliances, downsizing and outsourcing **may become unwelcome vocabulary in Universities**. It will be either **reinvention or extinction**
- Maseno can become a **research intensive university** molded on your:
  - Unique and differentiated profile,
  - Mission and setting,
  - Characteristics of your academic community
  - Scope of your constituent colleges, schools and departments, and;
  - Your willingness to commit to public service and community engagement
- **developing your own niche (Lake??)**
“Wisdom acquisition is a moral duty. It’s not something you do just to advance in life” - Charlie Munger

(American businessman, lawyer, investor, and philanthropist)
Thank You