# Contextual policy framework for developing a national system of innovation in Uganda

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# ABSTRACT

Uganda has gone through a period of political turbulence since it achieved its political independence in 1962. This turbulence has resulted in changes in leadership and major constitutional changes in 1965-66 and 1994-95. These changes in governance, which included a military dictatorship, have informed Uganda's economic development. Path dependence features have been characterised by an over-dependence on the agricultural sector and little processing and manufacturing in its economy.

One result of this unstable political climate has been the constant disruption of its educational institutions, including its well-known Makerere University, which has failed to emerge as an institution of higher learning providing high level manpower focused on the development of the country. Government policy in the teaching of science in the country was also affected and Uganda has moved a long a path of development that has been extremely reliant on its peasant-based agricultural sector.

This feature created a legacy of a dualistic economy between the 'modern' sector and the 'traditional/subsistence' sector, which government policy has tended to promote. This has resulted in the emergence of big gaps between the incomes of the rural peasant communities and the political and economic elites in the urban areas. This division has become a major constraint on the development of a national policy that could have moved the country towards the creation of national system of innovation. Instead, an ad hoc approach to innovation has developed with a lack of coherence in government policies, which has constituted another constraint to such an evolution in the national system of innovation.

This has led to the proposal reached in this study, while Uganda should pursue policy promoting Science, Technology and Innovation-STI, while at the same time enhancing Doing, Using and Interacting-DUI in a combined way that leads to an integration of the two modes of learning. This approach will enhance its path of development as it builds on the most positive experiences in its 'path dependence', which is anchored in its agricultural economy, while moving towards a manufacturing sector that draws on modern scientific methods.



**Keywords:** Agricultural sector, modern sector, Uganda, innovation policy, higher education, developmental university, learning economy.

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ***ARIS*** | Agricultural Research Information Services |
| **CBD** | Convention on Biological Diversity |
| **CGIAR** | Consultative Group on International Agricultural Research |
| **CPB** | Cartagena Protocol on Biosafety |
| **DAAPCB** | Deported Asians' Abandoned Properties Custodian Board |
| **DEC** | District Environment Committee |
| **DP** | Democratic Party |
| **DRC** | Democratic Republic of Congo |
| **FIRI** | Fisheries Research Institute |
| **FORI** | Forestry Research Institute |
| **FRTRI** | Fisheries Resource Training Research Institute |
| **GD** | Game Department |
| **GDP** | Gross Domestic Product |
| **GMOs** | Genetically Modified Organisms |
| **IARC** | International Agricultural Centres |
| **IITA** | International Institute of Tropical Agriculture |
| **IMF** | International Monetary Fund |
| **IPM** | Integrated Pest Management |
| **IPRs** | International Property Rights |
| **IUCN** | The World Conservation Union |
| **KARI** | Kenya Agricultural Research Institute |
| **KFRS** | Kajjansi Fisheries Research Services |
| **KY** | Kabaka Yekka |
| **LRA** | Lords Resistance Army |
| **MAAIF** | Ministry of Agriculture, Animal Husbandry and Fisheries |
| **MOES** | Ministry of Education and Sports |
| **MoFFED** | Ministry of Finance Planning and Economic Development |
| **MTTI** | Ministry of Tourism, Trade and Industry |
| **MUIENR** | Makerere University in the Faculty of Agriculture and Forestry and the Institute of Environment and Natural Resources |
| **NAADS** | National Agricultural Advisory Services |
| **NAARI** | Namulonge Agricultural and Animal Research Institute |
| **NARO** | National Agricultural Research Organisation |
| **NBF** | National Biosafety Framework |
| **NEMA** | National Environment Management Agency |
| **NFRD** | National Foundation for Research and Development |
| **NGO** | Non Governmental Organisation |
| **NRM** | National Resistance Movement |
| **NSI** | National Systems of Innovation |
| **NWSC** | National Water and Sewage Corporation |
| **PAMSU** | Protected Areas Management and Sustainable Utilisation |
| **PBS** | Programme for Biosafety Systems |
| **PEAP** | Poverty Eradication Plan of Action |
| **PMA** | Plan for the Modernisation of Agriculture |
| **R&D** | Research and Development |
| **S&T** | Science and Technology |
| **STI** | Science, Technology and Innovation |
| **TPDF** | Tanzania Peoples Defence Force |

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|---|---|
| **UIRI** | Uganda Industrial Research Institute |
| **UPDF** | Uganda Peoples Defence Force |
| **UPE** | Universal Primary Education |
| **UNEP/GEF** | United Nations Environmental Programme/Global Environment Facility |
| **UNLF** | Uganda National Liberation Front |
| **UNCST** | Uganda National Council of Science and Technology |
| **UNP** | Uganda National Parks |
| **UPC** | Uganda People's Congress |
| **USAID** | United States Agency for International Development |
| **USE** | Universal Secondary Education |
| **UWA** | Uganda Wildlife Authority |
| **WTO** | World Trade Organisation |
| **WWF** | World Wildlife Fund |

# INTRODUCTION

This research, a joint effort by three research partners in Africa, aims to investigate the promise that technology and the knowledge economy holds for growth and development in the 'catch-up' countries hinges centrally on university-industry linkages. This premise is based on the assumption that the pursuit of these relationships poses challenges for universities in the 'catch-up' economies of the South, particularly in Africa. It is further assumed that this is because of the widening knowledge divide of the global economy that tends to 'undersupply' the solutions that would be necessary to address the demands for transforming resource-intensive activities into knowledge-intensive assets to enable such countries to compete in global markets and that it is necessary for the productive role of universities in economic development to be harnessed. It is the objective of this study to investigate these assumptions.

The research focuses on three African countries at different levels of development: South Africa, Nigeria and Uganda. This creates the basis for investigating how and why university industry linkages differ according to level of development. The research focuses on incentives and constraints, as well as the extent, intensity and performance of university industry linkages. This is expected to provide a basis for considering the contributions universities can make to local and national development goals. Each country focused on a specific sector, which would enable the researchers to analyse policy mechanisms, current research efforts and technological activity, case studies of university practices, and firm surveys.

The research results will firstly, inform a series of national round-tables with key stakeholders; secondly, inform a comparative analysis across the three African countries and finally, across sectors and regions with selected countries in Latin America and Asia through cooperation with peer teams. To establish a basis for these collaborative activities to be concretised, a regional workshop was organised in Vietnam to agree on the frameworks that would enable such comparisons to be made. In addition, a workshop of the three African countries was held in Cape Town to develop common methodologies, research design and a time table for carrying out the research.

The analysis in the three regions focused on one technology platform in each country whose use was expected to hold the highest promise for addressing specific problems faced by the developing countries and hence, the focus on bio-sectors. The Ugandan researchers decided to focus on biotechnology and its relation to indigenous knowledge systems and traditional medicines. This would draw attention to the existence of this form of knowledge, and current collaborative research activity in communities and their potential for the economic and social transformation of the country.

**Section 1** of this paper provides a general introductory overview of the situation in Uganda, examining the 'path dependence' features of the country. Four characteristics of path dependence in Uganda's political and economic development are identified.

**Section 2** reviews the general policy context and the specific bio-sector policies that informed the government's approach to economic development, and examines the development goals enshrined in the policies. The section then examines the extent to which Uganda's technological innovation policy promotes the development of a National System of Innovation-NSI. The researchers did this by looking at the current S & T situation in the country and the funding of the R & D research activity. This review

concluded that Uganda has lacked a focused educational policy that can promote scientific and technological development. The report revealed that most of the research activity being undertaken in regard to the bio-sectors is foreign funded and is directed at capacity building, which has very little relevance to the needs of the country. The research discovered that this was especially the case in regard to the needs of the rural farming community, which has an extensive knowledge system upon which a research strategy could focus but which has been ignored by donor funding. In **Section 3**, the university and higher education systems in the country are examined. Here, the general education policy for the different levels of the educational system is examined. The analysis supports the observation - made with regard to the S & T policy – that the government's educational policy has not paid adequate attention to the teaching of science subjects at all levels of the system. It also revealed that little scientific research that has any relevance to industry is carried out in the universities.

For this reason, the research then focused on the research undertaken by the public research institutes in **Section 4A** of the paper. The evidence produced here shows that the National Agricultural Research Organisation-NARO coordinates research and development activity for the whole country in relation to the bio-sectors. It also undertakes technology transfer in animal production and health, biotechnology, fisheries, aquaculture and food production and processing alongside a number of other research institutes and the Makerere University. Even with this achievement in research, the researchers found out that the focus on the universities, public research institutes and governmental departments does not represent the entire system of knowledge production for development. In **Section 4B**, the researchers, therefore, decided to produce evidence of research being undertaken by non-governmental organisations-NGOs, especially in the area of indigenous knowledge in which traditional medical practitioners are involved.

**Section 5**, presents the structure of firms and industry. It shows that Uganda's economy, as reflected in this structure, is agricultural based with a small manufacturing sub-sector that has very low capacity utilisation and a high cost production structure.

**Section 6** addresses the 'Way Forward' for Uganda. Recommendations are made to the effect that Uganda needs to adopt a two-pronged strategy based on the development of STI and DUI modes of learning and innovation for its economy to make new breakthroughs that will lead to more sustained development. In **Conclusion**, the paper goes on to suggest that in order to bring about a sharper and more elevated focus on technological change as an important driver of economic growth and development, the government should delegate powers to an upgraded and renewed UNCST. Through the development of an unambiguous policy specification and the involvement of all relevant stakeholders and actors, the UNCST should provide leadership aimed at encouraging technological upgrading in industry, including organising background research across carefully selected sectors in order to evolve standards and performance targets for technological change.

# A GENERAL INTRODUCTORY OVERVIEW

## GENERAL

Uganda is a small country in the heart of Africa, which Churchill referred to as "The Pearl of Africa". It has the following characteristics:

- **Area:** 91,135 sq miles (236,040 $km^2$)
- **Water:** 15,399 sq miles
- **Population:** 28,616,000 (July 2006)
- **Economy: GDP** (PPP) 2005 Estimate
  - **Total:** $45, 97 billion
  - **Per Capita:** $1,700
  - **Currency:** Uganda Shilling (UGX)
- **Geographical Location:** Great Lakes Region, East African Community. Neighbouring: Kenya (East), Sudan (North, Tanzania (South), Rwanda (South West).
- **Capital:** Kampala.
- **Religion:** Christian (Catholic and Protestant) 66%, Islam 15% and African religions 18%.
- **Language:** The official language is English. There are, however, numerous other languages in use, including various Niger-Congo languages or 'Bantu' family (i.e. Luganda), Nilo-Saharan languages, Swahili and Arabic.

## PATH DEPENDENCE FEATURES: A SHORT POLITICAL HISTORY

Varblane et al. [2007] have defined 'path dependence' as a "phenomenon whose outcomes can only be understood as part of a historical process," but which are not optimal. Thus applied to Uganda's historical economic transformation and the potential constraints to its development and innovation, Uganda's 'path dependence' features can be described as 'crop dependent' due to its rich soils and relatively reliable rainfall. This situation determined Uganda's later path to economic transformation, which relied heavily on its 'natural capital' and later became the basis of an agro-processing manufacturing sector, with low intensity technological investment [Nabudere, 1980:37-66].

Uganda was a British Protectorate since 1893 and gained independent in October 1962, with a government based on an alliance between the **Uganda Peoples' Congress-UPC** and the **Kabaka Yekka Party**. This government collapsed within three years in an internal 'Palace *Coup d'etat*.' The prime minister removed the president and himself became the president under a new constitution. The traditional kingdoms, which had been recognised under that constitution, were abolished in the 'revolution.' This *coup* ended Uganda's Independence Constitution that had been negotiated by all the parties, including the kingdoms, in London at the Lancaster Constitutional Conference in 1961 and 1962.

The new Republican Constitution adopted a hybrid system of government, which adopted some elements of the presidential system in line with the Lancaster House parliamentary system in 1967. This approach led to the increasing concentration of

power under the presidency, which has continued up to now. The second change came with a military *coup d'etat* in 1971 when the president, Milton Obote, was overthrown by Idd Amin Dada.

In1978-79 Amin invaded Tanzania and a war between the two countries followed resulting in the removal of the Amin military government. His government was replaced by a unity Interim Government led by the **Uganda National Liberation Front-UNLF**, which took over in April 1979: This interim government only served for one year and was in turn removed in May 1980, by a military coup led by a group of politicians and military officers sympathetic to Milton Obote's UPC. The group called itself UNLF Military Council.

This Council organised presidential and parliamentary elections in December 1980, which were generally regarded as having been rigged by the pro-Obote Military Council. As a result, a rebellion erupted leading to a civil war between the Obote II Government - which had been elected in the fraudulent elections - and the rebel **National Resistance Movement-NRM**. The civil war continues for five years and resulted in internal splits within the official Uganda army, called the **Uganda National Liberation Army-UNLA**, leading to a second coup against president Obote in 1985. This weakened the government and although the army tried to form a government to include the rebel NRM, the conflict continued for a few months leading to the **NRM** winning the war and taking over the government led by the current leader, Yoweri Museveni, in January 1986.

**The NRM** has been in power since then, however, the country has continued to be plagued by civil rebellion in the North of the country with the **Lord's Resistance Army-LRA** led by Joseph Kony, which has persisted for nearly 20 years since 1986. Currently there are peace talks under way in Juba, Southern Sudan, between the Ugandan government and the rebels of the LRA, under the mediation of Government of Southern Sudan and the former Mozambican President, Joachim Chissano. Under the NRM government, Uganda has also been involved in a civil war in former Zaire in the period 1996 to 1998 and later, from 1998 to 2002. It has backed various rebel groups in the DRC, including that led by Pierre Bemba, who lost the presidential elections to President Joseph Kabila and later became the leader of the opposition but now in exile in Portugal.

Internally, Uganda continues to be saddled by political instability in the form of demands for federalism by the leading traditional Kingdom of Buganda. The three other Kingdom areas - **Bunyoro, Toro, and Ankole** - also aspire for an enhanced political role in the governance of the country. There has as a result re-emerged cultural revivalism in favour of traditional governance. At the same time, the Ugandan Government is involved in discussions with the governments of Kenya and Tanzania to fast-track the establishment of the **East African Federation**, which appears to be heading for a stalemate due to lack of consensus in the region. This development is likely to lead to the growth of federalist centrifugal forces in the country, which may yet signal a new phase of prolonged instability for the country. As we shall see below, Uganda's economic development has been influenced by these political developments.

## ECONOMIC FEATURES 1962-2007

Uganda's economy can be said to have been 'evolutionary' from the Model of the 'Moral Economy-Natural Economy' to an agricultural-based economy (based on subsistence crops and cash crop export economy) and later to an agro-processing economy. This

created the basis for an import-substituting industrial colonial economy. In the colonial and post-colonial periods, the economy has been marked by four time phases, each with specific characteristics defining the features of a 'path dependency' for Uganda. These phases are: (i) Years of Optimism (1960-1971); (ii) The 'Economic War', Decline and Informalisation (1972-1980); (iii) Reform without Stability (1981-1985); and (iv) Economic Liberalisation (1986-2007) [Bigsten & Kayizzi-Mugerwa, 1999]. These phases will be examined separately to establish their real content and 'path dependence' historical trajectories.

## Years of optimism (1962-1970)

Emerging from the colonial period at the end of the Second World War, Uganda's economy had witnessed a period of 'boom' in the early 1950s associated with the Korean War. However, it soon began to decline in the 1970s. For the first five years following political independence in 1962, Uganda's economy resumed rapid growth, with GDP, including subsistence agriculture, expanding at the rate of approximately 6.7% per year. Even with population growth estimated at 2.5% per year, net economic growth of more than 4% was registered, which suggested that people's lives were improving on the whole. By the end of the 1960s, commercial agriculture accounted for more than one-third of GDP, which indicated a dramatic change in the composition of the total economy towards monetisation away from subsistence.

Industrial output had increased to nearly 9% of GDP, primarily the result of new food processing industries, which included sugar and beverages. Other manufacturing areas included copper mining and cement, and the manufacturing of soap, beverages, and textiles based on an import-substitution strategy. Tourism, transportation, telecommunications, and wholesale and retail trade still contributed nearly one-half of total output.

This post-Independence optimism was based largely on a mutually beneficial relationship that existed between the government and smallholders. Peasants produced subsistence food crops and export crops while the government ensured adequate producer prices and provided the crucial infrastructure services, which it provided through cooperative societies and cooperative unions. In addition to coffee, which was the main cash crop, there were other important cash crops such as cotton, tobacco and tea that were also produced for export.

The economic approach adopted by the new government after independence was based on a mixed-economy strategy, with emphasis on state-ownership of the 'commanding heights' of the economy, which led to the nationalisations of the late 1960s and early 1970s. The period was also marked by an increasing 'radicalisation' of the economy and political debate about the direction of the new nation. This included a debate as to whether Uganda should pursue 'African Socialism' – as the movement came to be known - or whether it should follow a 'free-market' approach.

This debate resulted in the adoption of the *Common Man's Charter* in 1969, which was represented as a "Move to the Left" strategy and the consequent *Nakivubo Pronouncements*, which announced the nationalisation of British-owned banks and some industries, very much along the lines of the Nyerere's *Arusha Declaration* of 1967 and the subsequent nationalisations in that country between 1965-1969. However, the *coup d'etat* that brought Major-General Idd Amin's rise to power put an end to the

economic experimentation of this period, and the new period ushered in a decade of political and economic chaos and *ad hoc* solutions.

The science and technology policy was dependent on the colonial policy of using Uganda as a source of agricultural products with minimal technological content. In the emerging manufacturing industry, the strategy was mainly import substitution, which was based on a technological policy of the transfer of technology replicating the technology from which the imports had been received before. There was no educational policy tailored to developing a technological base for the country and no funding was available for this purpose.

## The 'Economic War:' Decline and Informalisation 1971-1979

This period was characterised by erratic policies associated with the military regime led by 'Field Marshall' Idd Amin Dada. GDP declined each year from 1972 to 1976 and registered only slight improvement in 1977 when world coffee prices increased dramatically. Negative growth was recorded largely because the government disrupted the economy by expelling the Asian commercial class. The government expropriated their business assets and either nationalised them or gave them to favoured individuals who did not have experience in business to adequately run them. The resultant 'economic war' resulted in an increase of the public sector by creating several parastatal companies to run about 250 business enterprises that were taken over from the Asians. The government also created a Departed Asians' Abandoned Properties Custodian Board (DAAPCB) to administer the smaller ventures and interests, which were not otherwise allocated to individuals or to the parastatals.

Foreign investments, too, declined sharply, as the regime's erratic policies almost destroyed the formal sector. The economic and political destruction of these years contributed to a record decline (14.8%) in national earnings between 1978 and 1980. By 1978, the share of (official) exports in GDP was a meagre four per cent – down from over 20% in the 1960s – which could not possibly sustain the import-intensive investment programme. When Amin was overthrown by the joint forces of the Tanzanian Peoples' Defence Forces-TPDF and the Uganda rebel groups in 1979, Uganda's GDP had dropped to only 80% of the level it had reached in 1970. Industrial output declined sharply, as equipment, spare parts, and raw materials became scarce as technological transfers came to a stand still.

It is because Ugandans, even urban residents, reverted to subsistence cultivation in order to survive that Uganda had escaped widespread famine. Both commercial and small rural peasant producers begun to operate in both the monetary and non-monetary (barter) sector, and later presented the government with formidable problems of organisation and taxation. By the late 1980s, government reports estimated that approximately 44% of GDP originated outside of the monetary economy. Most (over 90%) of the non-monetary economic activity was agricultural, and it was the resilience of this sector that ensured survival for most Ugandans. As we shall see below in the analysis of the 'learning economy', these attempts by small producers both in the agricultural sector as well as in the remaining manufacturing sector, produced some positive experiences from which the country could have developed in the subsequent periods. However, this was not done due the lack of focus of government created by the instability in the country that followed.

There was no science and technology policy in this period and the expulsion of the Indian commercial class undermined the technological strength that the industrial sector had attained through import-substitution. The education system was disrupted and there was no consistent government policy aimed at training students in science and technology that could have addressed the country's economic development. This is why, with the collapse of those manufacturing industries that were run by the Asian commercial class, there was instead a reversion to different kinds of innovations aimed at surviving the economic crisis.

## Reform without stability (1980-85)

At the start of his second period in power, Dr Milton Obote saw his government's priorities as raising efficiency in the goods producing sectors as well as in the prudent use of funds, and the creation of incentives for both domestic and foreign investors. A Commonwealth team that visited Uganda in 1979 to survey its rehabilitation needs had made similar suggestions. A key issue in the early 1980s was how to arrive at an exchange rate that would enable more efficient resource allocation and restore the formal sector. In order to meet the terms of the initial IMF-supported 13-month stabilisation programme (initiated in June 1981), Obote's II government undertook a number of measures, including floating the Ugandan shilling, increasing producer-prices for export crops, removal of price controls, rationalisation of tax structures and putting in place a better mechanism for the control of government expenditure, accompanied by increased accountability in the public sector.

To satisfy non-official needs and reduce parallel market dealings in foreign currency, while at the same time preserving a favourable rate for 'strategic' imports, a dual exchange rate system was adopted in August 1982. The dual exchange rate system and control at the Bank of Uganda indicated that the government had not given up its traditional protection of import-substituting industries. Thus, although the international terms of trade improved by about 27% from 1981 to 1982, the domestic price ratio between exportable and importable goods was negligible. This showed that the protection of domestic producers of importable goods actually increased during the dual exchange rate experiment.

There was a fairly rapid recovery in 1982 and 1983, but in 1984, despite improvement in the international terms of trade, recovery came to a halt. From 1981 to 1983, the country experienced a welcomed 17.3% growth rate, but most of this success occurred in the agricultural sector. Little progress was made in the manufacturing and other productive sectors. The renewed political crisis led to negative growth rates of 4.2% in 1984, 1.5% in 1985, and 2.3% in 1986.

The period beginning with the collapse of the IMF's stand-by arrangements in mid-1984 saw steep deterioration in economic performance. The earlier opening up of the economy had, ironically, made it more vulnerable to trade-related disturbances when the controls returned. The tightening of the foreign exchange system in 1985, as arms purchases competed with consumer imports, made it difficult to produce inputs and industrial spare parts, reversing the earlier revival of the import-substituting sector. The rural economy was devastated by civil strife and the collapse of the local administration in key producer areas. The agricultural work force was displaced and rural property was destroyed on an unprecedented scale. The country had begun to return to some aspects of the 'economic war' period [Nabudere, 1990].

## Economic liberalisation 1986-2007

Throughout these years of political uncertainty, coffee production by smallholders continued to dominate the economy, providing the best hope for national recovery and economic development. As international coffee prices fluctuated, however, Uganda's overall GDP suffered despite consistent production.

Foreign funding has been crucial in returning Uganda to stability and growth. It is also true that recent rapid progress in Uganda came from a very low base, but this was due to a level of political chaos hardly known in, for instance, Tanzania or Kenya. Uganda embarked on economic adjustment even as it struggled to bring about political stability. The elimination of economic shortages was an essential first step towards stabilisation and recovery of the economy, and in this regard Uganda's adjustment efforts were successful. By the mid-1990s, most consumer goods were available, with no price controls. The government managed to bring down inflation, while keeping growth reasonably high. However, a central aim of adjustment was also to create a stable environment for long-term growth.

In order to rebuild the economy in the late 1980s, Uganda needed foreign goods, technology and services, but its chronic shortage of foreign currency and uncertain political climate weakened the nation's standing as a trading partner. The government sought to strengthen Uganda's standing in the world economy, but to meet short-term needs officials turned to foreign donors. Acquiring foreign assistance through direct aid, loans or grants became an important focus of the government's economic efforts. Uganda continued to receive significant foreign aid and many bilateral donors worked within Uganda. With the success of the country in many areas, through economic and institutional reform, implementation of a poverty reduction strategy, reduction of the HIV/AIDS rate, and recent political changes towards multi-party democracy, Uganda has been portrayed as an African success story and has been viewed by donors with relative confidence.

However, although the economy attained higher rates of GDP growth to around 6% per annum by 2002, population growth also increased to an average of 3.8%. Uganda's low and falling life expectancy figure reflects the effect of the HIV/AIDS epidemic, whereas high infant and child mortality and low immunisation rates reflect the GoU's limited expenditure on health services. GoU expenditure on health stood at US$14 per person per year between 1990 and 1998, compared to an average of US$33 for Sub-Saharan Africa. In 1998, child mortality (under five years) in Uganda stood at 170 per 1000 live births, one of the highest in the world. The averages for all low-income countries and for Sub-Saharan Africa were 92 and 151 per 1000 live births, respectively.

The World Bank assessment released in September 2007 showed that growth in Uganda had been strong for two decades and continued to be strong, but cautioned that global experience shows that growth spurts inevitably slow down because the economy runs up against key constraints, mainly in the financial sector. The Bank also drew attention to the poor infrastructure, financial intermediation and agricultural sector development, and high population growth and a lack of commitment to results and accountability. These may be binding constraints to the necessary economic transformation after the recovery phase.
As in the previous phases, efforts to improve the technical skills of the labour force were not achieved. This was especially in the area of scientific education, technical training,

technological competence and entrepreneurial development. Bigsten and Kayizzi-Mugerwa have remarked:

> Uganda still has an inadequate capacity to adopt and absorb imported technologies, resulting in sub-optimal utilisation of available capacities. There is thus need, via training, to create an environment, which is conducive to technological absorption and innovation. It is important, therefore, to assess the impact of the current education system on the output of skills required for industrial development [Bigsten and Kayizzi-Mugerwa, *op. cit.* p.139].

As we shall see below, the current preoccupation of the government is to develop a science, technology and innovation policy, and institutions that can play this role. This effort should not be seen as a linear one where education in science leads to technological change, and sequentially to industrial and agricultural development. Rather, the policy will have to take into account the evolutionary features described above, and reinforce those heuristic and interactive learning processes that Ugandans have undergone through trial and error, leading to the strengthening of the national innovation system [Oyeleran-Oyeyinka, Gehl and Sampath, 2007: 13].

## GOVERNMENT SYSTEM

In this section, we examine the system of governance in order to comprehend the mechanisms of its policy contexts and the development of policy goals. We also examine the present research priorities, which tend to explain why Uganda has not succeeded to establish the basis for a NSI. This is due to a lack of focus and failure of some national policies.

### THE POLICY CONTEXT

Uganda's key developmental context for science, technology and innovation, is the National Science and Technology Policy objectives, which was drafted in 1993 by the Uganda National Council of Science and Technology-UNCST. This is the institution responsible for framing policy for the biosectors. Prior to this, Uganda's planning and budgeting process gave only very limited consideration to aspects of science and technology (S&T), let alone innovation policy. Having established the framework for a S&T policy in 1993, the UNCST proceeded to revise the policy in 1997 to include a broad framework and strategies for building science and technology for development. This framework was further upgraded in September 2001. The framework did not, however, indicate or elaborate specific actions that were required to nurture the linkages between various institutions, the private sector and all the actors that would have otherwise constituted a coordinated National System of Innovation-NSI. At this stage, therefore, the 2001 revised document still required a considerable articulation of what was meant by 'innovation' and how to facilitate linkages between the different actors.

In April 2005, the UNCST produced a paper entitled, *Status of Science and Technology in Uganda: Training, Application and Future Implications*, in which it reviewed the state of S&T training and application in Uganda. The report followed the broad UNESCO definition of S&T, the "systematic activities, which are closely concerned with the generation, dissemination and application of scientific and technological knowledge of all fields of science and technology". Proceeding from this definition, the paper went on to review the status of scientific education in primary, secondary and tertiary education institutions, giving details of enrolments, curriculum development, teacher training,

vocational training, assessments and an examination of the quality of teaching and instructional materials at each level. The section on the status in the tertiary institutions focused on the cost and quality of training in universities and came to the conclusion that the quality of undergraduate education in science was 'not so good', but noted that enrolment was increasing at a faster rate and thereby compromising the quality of teaching (the tertiary education sector is described in greater detail later). The paper also dealt with the status of research in the public sector (universities and independent institutes). It looked at Sectoral Based Research in areas such as, agriculture, health, tourism, trade and industry. It examined the funding of research and development by government, and came to the conclusion that not much was being allocated to S&T training.

In June 2006, the UNCST completed a final draft of the National Science, Technology and Innovation Policy, which is yet to be approved by Cabinet. The draft points out the kinds of constraints Uganda had encountered in undertaking scientific research for development, noting that only "a small number of areas" had been 'touched'. It pointed out that the constraints arose out of the fact that there was little coordination among stakeholders, "leading to duplication of efforts", a low capital base, inadequate infrastructure, and the lack of a coherent and overarching National Science, Technology and Innovation (STI) Policy, which the draft was supposed to fill. The draft policy therefore set out the vision for the STI sector and highlighted strategic frameworks - again without much content - for their attainment. It provided the mechanism for increased capacity in STI that would "result in significant improvements in national productivity that would lead to competitiveness and better standards of living for the people of Uganda" [UNCST, 2006: iv]. We shall examine this policy in depth later.

## GOVERNMENT POLICIES - BIOSECTORS

This section focuses on government policy in the biotechnology sector, where government attitude is ambivalent and the position of the foreign donors is focused. This can be illustrated by the Ugandan government's attitude when it announced the operationalisation of the *Plan for the Modernisation of Agriculture* (PMA). The mission of the PMA, as contained in the plan, is to eradicate "poverty by transforming subsistence agriculture to commercial agriculture", but the only specific mention of the role of biotechnology within the PMA is a statement to the effect that:

> The current developments in biotechnology and the globalisation of world markets put a lot of pressure on research in developing countries. A developing country like Uganda can only afford to develop minimal capacity to be able to engage in dialogue with developed countries in such areas of research. It will be necessary to establish (possibly from existing institutions within the central region) a research capacity on strategic research to include genetic resources conservation and biotechnology to ensure the country's capacity to cope with global scientific trends so as to be able to take advantage of the technological advances for the benefit of farmers.

Thus, from this statement it can be seen that the government is reacting defensively to the role of biotechnology in the country's development. The policy does not consider the experiences of farmers in this area, in their traditional practices. Despite such a policy platform identifying a potential role for biotechnology, and subsequent approval of GMOs for food in 2003, government support for biotechnology has been measured and

cautious. In 2002, the President, at the United Nation World Food Summit, made his position on the issue of biotechnology clear when he stated:

> Let us stop beating about the bush. The most fundamental problems are not the weather; are not lack of improved seeds. The main causes of food shortages in the world are really three: wars, protectionism in agricultural products in Europe, the USA, China and Japan, protectionism in value-added products on the parts of the same countries."

Following a 2003 decision of the President, GMOs are not permitted into Uganda unless they have been processed before importation. Nevertheless, Uganda continues to receive food aid that may contain GMOs, without requiring that it be milled before it is brought to Uganda, although the requirement is that it must be specified to be for consumption only. As a result, Uganda has not issued approvals for any applications for import and research on GMOs. Although applications for Bt cotton and maize were made by NARO to the UNCST in 2000, approval was not granted. Hence, relevant work in research and development (R&D) in these products was being done in other countries in expectation of approvals. In spite of such ambivalence, Uganda has taken certain steps in developing a framework for biotechnological application to local crops and production. Some of its institutions, such as, NARO and UNCST, have understood the crucial importance of biotechnology transfer for development, but this has not been central to government policy.

In the first instance, government's attention, through these institutes, has been focused on the creation of a Biosafety Regulatory Framework, even in the absence of an overarching STI policy. Within this narrow focused policy-framework, it has produced Biosafety Guidelines and a National Biosafety Policy Framework as a first step in this direction. In this respect, Uganda can be ranked as leading the rest of the continent, except South Africa, in having an internationally accepted National Biosafety Framework. The National Biosafety Framework is already being implemented by way of introductions and testing of biotechnology research projects, including GMOs, as well as conducting research on biotechnology related subjects.

To this end, UNCST, in 2004, developed a policy aimed at implementing this framework. The policy framework it designed is multifaceted. The government, by the end of 2005, had approved the Draft National Biotechnology and Biosafety Policy. However, an Act of Parliament has yet to be legislated, but a Bill has been presented to Parliament. The Bill categorises micro-organisms on the basis of risk groups within the bacterial, fungal, parasitic, viral, rickettsial and chlamydial species. It also deals with processes of handling the introduction and testing of GMOs. The policy is aimed at the utilisation of biotechnology in sustainable national development within the context of the Poverty Eradication Action Plan and the 2005 National Vision for Development. The policy also recognises the key challenges posed by the introduction of such innovation on the environment, human health, animal welfare, values and norm systems, as well as ownership and control and access to genetic resources, intellectual property rights and welfare. The policy defines the institutional, legal, and regulatory regimes for the promotion of biotechnology development, with specific emphasis on human resource capacity development, biotechnology research, infrastructure for biotechnology, the raising of public awareness, strengthening of R&D capacity, promotion of commercial and industrial developments, addressing funding and other non-policy and cross-cutting issues.

The risks of the policy are recognised, but these are focused on transgenetic crops and foods (GM), which obscure the above benefits and the production of drugs and pharmaceuticals. The policy pays special attention to the need for *R&D,* in general, as well as the institutional framework for such R&D. The R&D seeks to strengthen existing facilities as well as the setting up of new laboratories in designated centres across the country to undertake National Biotechnology Assessment Studies to determine the research priorities in the agriculture, health, industrial, environmental, and other strategic areas. It also seeks to establish mechanisms for continuous dialogue among researchers, policy makers, industrialists and other stakeholders to elaborate on national priorities in biotechnology and biosafety.

All of the capacity-building initiatives have, to varying extents, been involved in the process of formulating regulations and policy relevant to biosafety and biotechnology. In short, the Biosafety Bill allows for applications for the introduction of GMOs to be made to the UNCST. Applications have to be reviewed by the National Biosafety Committee-NBC, which will make recommendations to the UNCST. The recommendations will be published and the public will have 30 days to present views, after which the UNCST will make a decision. If approval is given, a range of agencies will be involved in monitoring and enforcement.

With regard to the institutional framework, the competent authority to manage the implementation of the programme includes the establishment of a national Biotechnology Advisory Committee-BAC from key stakeholder institutions and organisations to oversee the implementation. A National Focal Point-NFP is also to be set up in the Ministry of the Environment to liaise with other stakeholders, including, the National Biosafety Committee-NBC and Institutional Biosafety Committees-IBC, to ensure the safe development and application of biotechnology. Most important of all, the policy aims at creating linkages with industry and commerce for the application of the technology to production. It points out that the low level of industrialisation in the country "explains" the limited application of biotechnology in food processing, vaccine manufacture, and other industrial applications. The UNCST report points out:

> This coupled with the weak industry – research linkages and the generally low levels of utilisation of research results in Uganda, has meant that biotechnology has not yet found its rightful position as a mover of industrial development...this...calls for the establishment and strengthening of inter-and intra-institutional collaboration and forging partnerships in research, development and commercialisation of biotechnology products [UNCST, 2004].

The policy therefore provided for the encouragement of private enterprise, the establishment of local and international franchises, and the fostering of collaboration between public and private enterprises in biotechnology. However, there was no indication of how these could be funded or how these objectives would be achieved. It also provides for appropriate investment incentives and to ensure that persons involved in industrial application and commercialisation comply with biosafety standards, while developing, producing, and transporting biotechnology products. It also provided for the facilitation of strategic and mutually beneficial alliances among multinational companies and local entrepreneurs in biotechnology development.

Despite these provisions, the policy acknowledges that there are weak inter- and intra-institutional linkages in the areas of biotechnology training, research, product development and commercialisation in Uganda. It points out that the existing linkages

are mainly informal and not entirely reflective of institutional collaboration beyond professional association among individual researchers. The bilateral and multilateral collaboration is mainly *ad hoc*, uncoordinated and based on the interests of the support of granting partners. This, the UNCST adds, calls for systematic development and strengthening of mutually beneficial partnerships in all aspects of biotechnology, both with the granting partners, but also internally with the relevant institutions. This is because the funding available has mainly come from foreign sources, "with a specific research agenda, which often times may not necessarily reflect national priorities for development" [UNCST, 2004].

Thus, although the institutions involved in research in biotechnology are mainly universities, such as Makerere, and a few government R&D institutions, such as the National Agricultural Research Organisation (NARO), the linkages that could lead to the realisation of an industrial and commercial potential are judged by the UNCST to be "unexploited". Thus the research and product linkages, which are *ad hoc,* are based on the interests of particular investors or donor countries in the way they have funded capacity building and other programmes [Makerere Mamdani, 2006]. These investors and donors fund and determine the direction of the biotech-sector investment and bio-product priorities. Under these circumstances the hope that university-business linkages could lead to economic growth in the country, creating a new space for the university to become a **"developmental university",** cannot not be realised. As already noted, most of the research and the promotion of capacity building in biotechnology has been donor determined, and the idea that this can be done 'neutrally' has been found to be false because this ignores the knowledge and conditions on the ground.

## DEVELOPMENT GOALS ENSHRINED IN THE POLICY

Since 1997, the government of Uganda's national economic/development planning framework has been defined under the Poverty Eradication Action Plan (PEAP). With a grand, holistic and multi-dimensional approach, PEAP addresses economic growth and development issues in various ways that in combination aim at improving productivity, incomes and standards of living for Ugandans. Supporting and directly contributing to the PEAP are strategic action plans like the *Plan for Modernization of Agriculture (PMA)* and the *Medium Term Competitive Strategy (MTCS)* for the private sector, which includes the *Strategic Export Programme (SEP)*. However, this sector remains tied to low-value crops that account for limited domestic processing into high-value products for export.

The MTCS is a strategic plan, under the PEAP framework, which was formally adopted as government policy in 2000, and later revised in 2003. The Strategy aims at reforming and empowering the private sector for greater productivity, efficiency, growth and local as well as regional/global competitiveness. Using a wide consultative process, the MTCS identifies and articulates a roadmap, which attempts to address the key aspects that impede private sector growth and competitiveness. The roadmap articulates a plan of action through broad, but well-defined interventions in thematic areas.

The policy does not articulate a deliberative university-industry linkage, but certain *ad hoc* research activities do take place in default of such a policy. As will become apparent, the overall national innovation and technology capability of Uganda is rather low compared to bigger African countries, although it has experienced significant improvement in its human development index rating over time. Even then a clear

quantitative assessment is lacking due in large part to poor data availability. Despite this, a wide array of private and other sector actors (beyond the state) are emerging as important players and so, public research organisations (including universities and research organisations) need also to reconfigure heir roles and relationships in the light of these developments.

## NATIONAL SYSTEM OF INNOVATION?

The concept, **National Systems of Innovation-NSI**, is an analytical tool to comprehend the various efforts by the government to develop a S&T strategy in enhancing the country's social and economic growth potential. At the present moment, Uganda cannot be described as having put in place policies amounting to an NSI structure, although some efforts have been made in this direction. As has been noted by a number of scholars [e.g. Lundvall, 1992, and Nelson, 1993], the national system of innovation that exists in the developed industrial economies cannot be applied to a majority of developing countries, so that even its use as an 'analytical' model can become problematic.

The Ugandan experience confirms the observation made by Lall and Pietrobelli [2003] on the economies of sub-Saharan Africa when they found that in general, S&T institutions are poorly funded, poorly resourced, delinked from industry and operating with little government support. Their argument, that we cannot therefore use the concept of national systems of innovation in these types of countries, is well founded as seen in the Ugandan experience, as we have observed already. Although Uganda had, by 1993, established the National Council of Science and Technology, and crafted a national S&T policy framework, such a framework did not elaborate the specific actions that were required to act as a trigger mechanism to effect such a policy in a majority of cases [Oyeleran-Oyeyinka & Sampath, 2007:22].

We therefore agree with Adeoti [2002], who argues that the development of local technological capability for the purposes of 'catching up', means the ability to make effective use of technological knowledge in an effort to assimilate, use, adapt and change existing technologies, whether these be foreign imported or indigenous accumulated knowledge. We will see from the Ugandan experience that while it is correct to argue that the identification of a particular development path should not inhibit a country from attempting to pursue high technology cutting edge innovation, such a prospect can only be tentatively asserted subject to the real experiences. This is especially the case where we differentiate the kinds of innovation that take place in countries such as Uganda, where incremental innovation is a more appropriate form of a learning point of view [Diyamett & Wangwe, 2004: 184]. It also depends on the way traditional forms of knowledge are given protection to enhance chances for learning through exclusive intellectual property rights (IPRs) [Maskus & Reichman, 2004: 281]. In such a case, the more cautious approach is appropriate. This is because in such a situation, the more probable approach is to look at small local innovations, especially in the areas of socio-economic development at lower levels of transformation, such as agricultural development, health and the environment as well as in metal fabrication, which creates conditions for improvement in levels of production and productivity. The reliance on innovations in such areas are likely to be productive and useful because they do not depend on licences or patents from the developed economies who have monopolised the application of S&T for their own ends through such means. Such an approach should inform national capacity for knowledge generation and for incremental

innovative activity as a critical approach to innovation in 'catch-up' economies such as, Uganda. We intend to develop this argument as we proceed.

The Uganda case shows that the debate as to whether the country should focus more strongly on importing high technology and work at the frontier in terms of innovation, is inappropriate to be one-sided. Although these issues can be made to relate to university-firm interactions and to the developmental role of the university, such a focus may also need to be interrogated and problematised, especially as they relate to situations where the role of universities is also changing. This is especially the case since other private actors, such as Non-Governmental Organisations and private consultancies and think tanks, are challenging the role of the university in knowledge production. Furthermore, the place of the university as a public research and teaching institution is under threat due to the 'commercialisation' and 'privatisation' of its functions by a few private interests, especially multinational corporations. Accordingly, its role as a public institution able to engage in public research that can benefit not only big businesses and firms, but the entire society, has been compromised since it has also been forced into the role of a competitor in the market place where it has to act as an 'entrepreneurial university' with the capacity to own patents and other forms of intellectual property [Nabudere, 2007].

Thus 'innovation' must, in the case of Uganda, be understood in a broader context in which minor innovation and adaptation, and assimilations of existing (imported technologies) are more prevalent than engagement in major innovations. Moreover, we must look to other research actors, beyond universities, to obtain a fuller picture of what is happening on the ground. This is especially the case in the transfers of technology that involves non-market interactions in addition to market interactions, which may arise from technological spill-overs to the benefit of the latecomers such as Uganda. Hence, there is a need to stress the importance of incremental innovations that enables the identification of the existing technological capacities, which can become the basis of such an incremental innovation. Such incremental learning processes may be small, but their impact can bring about significant improvements in production [Diyamett & Wangwe, 2004: 184].

## UGANDA'S PRESENT S&T SITUATION

### Science and technology

Although there is a growing recognition in Uganda that S&T are important for economic and social development and are critical determinants of the country's ability to compete in the world economy, S&T has hitherto not been considered a priority and there has been little attention paid to the generation of a minimum level of indigenous technology necessary to absorb technology from foreign sources and adapt it to its needs. This has been conditioned mainly by the historical path of Uganda's economic development, which had depended heavily on the peasant producer of 'cash crops' for export and semi-processing manufacturing, which does not demand high levels of technological investment. Consequently, Uganda currently lacks the necessary technological manpower, which can produce and absorb technological change through the process of technology transfer, adaptation and diffusion. The problem of the weak indigenous technological capacity is compounded by the shortage of scientists, engineers and technicians specifically trained for the purpose of technological adoption, adaptation and diffusion in the country. This suggests that Uganda's path dependence characteristics have, as we have seen, been consistent, in that the country has depended more on its

peasant-based agricultural production without much value-added to bring about improvements in other the other sectors.

## Funding of research and development (R&D)

According to the UNCST, the level of R&D in any country can be a good indicator of technological change and innovation, and the capacity to assimilate, adapt and diffuse new technologies. Allocation of spending on R&D represents the level of national priorities and the potential to increase the rate of factor productivity and growth. During the period 1990 to 2001, Uganda's estimated gross expenditure on R&D was dramatically raised from Ushs.2,146 million in 1990 to Ushs.6,328 million in 2001. In spite of this positive trend, the allocation of resources to R&D, as a proportion of the Gross Domestic Product (GDP), was still below 1%. The highest recorded level was in 2000 when the government allocated only 0.21% of the GDP for this purpose. The dollar equivalents for these expenditures during this period was about 1 US $ to Ushs. 1,500.

There are about 600 researchers involved in R&D activities nationally. Of these, 33% work in government institutions, 36% operate in the higher education sector, 28% in business enterprises and 3% in the private non-profit sector. The majority of high quality scientific research activities is carried out in a small number of research institutes, especially in the fields of medical sciences and agriculture, and foreign donors mainly fund these research activities directly to the institutions concerned. Currently, a substantial number of PhD level scientists involved in research, are trained abroad and would have been trained by those foreign donors with a view to employing them on their own projects either in the universities, government or non-governmental organisations. This funding is made as part of the funding to the universities [Mamdani, 2006].

The UNCST has estimated that over 90% of all funding for R&D is provided by foreign donors. For instance, for the period 1990 to 2001, a big proportion of the R&D spending, equivalent to Ushs.44.088 billion (55.6%) was on medical and veterinary sciences, where 385 research projects were registered. Of this amount, donor funding accounted for 98.84%, while government and local NGOs contributed only 1.14% and 0.02%, respectively. The high allocation to medical and veterinary services was largely attributed to clinical trials for HIV/AIDS, including the construction of laboratories, staff, and the purchase of medicines and compensation of patients/research participants. The government, in its draft STI policy document, notes the following constraints in the development of an R&D strategy:

> The progress of research and development activities has been constrained by a number of challenges, which include low level of coordination among stakeholders leading to duplication of efforts, low capital base, inadequate infrastructure and most importantly the lack of a coherent and overarching National Science, Technology and Innovation (STI) policy to guide activities and distribution of resources for science, technology and innovation. The above mentioned challenges coupled with shortage of skilled manpower, over dependence on foreign technology, and inadequate social consciousnesses of the role of STI in national development have combined to keep the country underdeveloped" [MoFPED, 2006: iv].

This admission on the part of the government suggests that Uganda has not embarked on a conscious NSI policy and that a framework of such a policy needs to be further elaborated along side the creation of relevant institutions before such a coherent NSI

can emerge. To arrive at this level, Uganda will have to undergo a series of 'learning' experiences in the process of developing its policy. Short of this, Uganda will remain over-dependent on low-level foreign technology for its needs with low value-addition. It will also remain over-dependent on foreign funding and foreign inspired capacity building for most of its STI, which ultimately will reflect foreign NSI interests through funding directed at particular areas of interest. In short, Uganda will, in those circumstances, be part of the NSI of other countries and dependent on them economically, mainly used as a testing ground for those purposes, especially in the field of biotechnology, as we shall see below.

## Foreign funded research and its relevance

The earliest funding intervention in the biotechnology field by foreign donors was the UNEP-GEF Pilot Phase in 1997. At the time of the inception of international capacity building assistance for biosafety and biotechnology in Uganda, the elaboration of biosafety and biotechnology policy was at a very early stage capable of being described as a 'broker-driven' innovation policy. Uganda had already ratified the convention on Biological Diversity in 1993. The Cartagena Protocol on Biosafety-CPB was adopted in 2000. The *Plan for the Modernisation of Agriculture (PMA),* the clearest statement of the role of biotechnology in Uganda, was not proclaimed until 2000. Even then, while the PMA identified the use of biotechnology as part of a poverty eradication goal, it did not explicitly mention the use of modern biotechnology, nor did it elaborate parameters or modalities of support for biotechnology.

From the interviews conducted from with officials who were part of the PMA project, it became clear that between 2000 and 2004, various government officials made public pronouncements about biosafety and biotechnology, which illustrated uncertainty within the government about the approach to be taken. This demonstrated ongoing consideration and debate within government about the role of biotechnology vis-à-vis the root causes of poverty, the way certain approaches to biotechnology and biosafety would impact export markets. This debate also reflected the nature of the relationship between Uganda and the USA, and raised the standard risk/benefit concerns.

While the pilot phase of the National Biosafety Framework-NBF project was frequently viewed as a major factor in starting this dialogue, by the time of signing the CPB in 2000, policy makers in Uganda had yet to evaluate, in a systematic and thorough manner, the significant number of ethical, scientific, social and economic dimensions that were relevant to the regulation of biosafety and the use of biotechnology. The policy development was at an early stage in Uganda and was consistent with the preference expressed by several actors in the NBF process about the pace of policy development, and the need to act thoroughly and slowly. While there was a perception on the part of many that it was possible that biotechnology may have the potential to bring some benefits, among some policy makers across government agencies, there was also a high degree of caution with regard to GMOs, and a preference to develop policy and regulations carefully and slowly with sufficient time to understand the issues, consult stakeholders and debate broader issues with regard to poverty, ethics, science and innovation.

Information received from these quarters indicated that there was concern that there had been pressure to rush policy processes in Uganda. There was also concern that Ugandan policy makers had felt pressured in a certain direction by the content and

conduct of capacity building assistance, including the expert revision of the legal framework that had been drafted by the UNCST. While this concern was expressed, it was also feared that despite this perception, policy makers in Uganda were actively resisting perceived external pressures and continuing at a pace that they were comfortable with. A clear example of this was resistance to ideas of regional harmonisation of policy or certain legal approaches, with a preference to establish Ugandan systems first, before considering harmonised approaches regionally.

In this context, some officials viewed projects that advocated a particular approach to biosafety with suspicion; while some supported biotechnology applications defensively. In the event, some projects' support of biotechnology was viewed with less suspicion than others. It is important to examine the reasons for this. An initial reflection would suggest that the projects, which were explicitly supportive of biotechnology that met with the least of local involvement in initiation of the project, ownership, influence and decision making processes, were not favourably perceived while those that were perceived as being supportive of locally important issues for poverty reduction were positively received. There could have been other reasons, but these were not given to this panel of interviewers.

It was doubted that detection capacity would be comprehensive enough to prevent illegal trade and cross border movements. This concern alone had reduced substantially the relevance of the regulatory regime that was being put in place. With regard to capacity building content, there were concerns that the material presented for training had been of a general nature as to be of any use to the peasant farmers in the rural areas. This had demonstrated a lack of awareness of the local conditions. For instance, illustration was made of how much 'tractor time' farmers could be saved through the use of GMOs, when almost all Ugandan farmers did not use tractors in their work. This exposed the lack of relevance of some of the capacities that was being created by foreign funding. As we have seen above, most of the capacity building was based on promoting a "Science-based" communication and outreach approaches, with which rural farmers in Uganda were not familiar. As we shall also see below, such an approach ignored the vast amount of knowledge that the farmers possessed, which could have been the basis of training for new forms of innovation with this technology platform.

Apart from these concerns, there was also a general questioning of the importance that was being given attached to the focus on biotechnology, as well as biosafety, when Uganda had more pressing problems for poverty reduction and environmental protection, and ignoring other interventions that were seen as likely to have greater overall impact. There was also some concern that social and ethnical dimensions had received less attention in these interventions, while more emphasis was placed on technical advantages rather than on the actual experiences of the people on the ground, especially in rural communities. More specifically, there was dissatisfaction among some stakeholders about the failure to generate a truly consultative decision-making process on ethical and social dimensions of biotechnology at a point in the debate when discussion could have had real influence on policy formulation. This exercise of consultation should have been the first step in embarking on the discussions about the need to introduce this new technology platform in the country.

The implication of this view was that the capacity-building assistance that was being provided by the donor community had been a top-down affair. It was felt that a particular kind of capacity was being proposed even when the local actors, including the Uganda

government, felt less need for the speed with which the assistance was being offered. It was also felt that this pressure and lack of consultation on these crucial policy areas, had arisen as part of an ongoing course of action along a particular path that was desired by the donors, who were offering assistance rather than involving the Uganda government in decisions about which path should be followed in this very important technological development.

In the discussions that informed this stage of the relationship, it was argued by the donors that policy decisions were the realm of elected decision makers, following appropriate levels of consultations, while capacity building assistance was said to be an ' and 'independent' and 'neutral' technical area, which did not necessarily require political decision makers. This technical reasoning carried the day so that what was offered as 'technical capacity building' was in fact already overlaid by a certain ethical consideration that came to determine the policy framework, which the elected decision-makers adopted since; without their own researched position, they were not in a position to reject the policy proposals.

## GOVERNANCE PROBLEMS

There are governance problems in Uganda in the way political power is currently organized. The tendency to monopolise power and concentrate it in the hands of the president has bedevilled the country's governance. The current president, Yoweri Museveni, recently amended the constitution, removing term limits that had been inserted into the 1995 constitution. This opened the way for him to offer himself for re-election as many times as he likes, contrary to the new democratic mood on the continent. Concentration of power in one individual also undermines two of the essential aspects of development, which are capabilities and competence which Prof. Amartya Sen in his book: *Development as Freedom*, believes are crucial to a country's transformation. According to him, capabilities and competence include what he calls 'entitlements' such as attempts to avoid starvation and malnourishment, curable diseases and premature mortality. It also included freedom of being literate, able to participate in public life and in political processes, as well as having the possibility to work and to influence one's work conditions and environments. He gives the example of poverty and points out that, poverty in this perspective is a deprivation of basic capabilities than just being a reflection of low income.

Failure of governance can be said to result from this one-man power situation in the country because although some of the policies being pursued are supportive of the incumbent's idea of 'modernisation' and 'industrialisation' of the country, nevertheless his determination to hang on to power tends to be the overall determinant of everything. This results in the tendency to divert state resources towards the achievement of this objective, which undermines any long-term policy implementation. Recently oil was discovered in the western part of country and the incumbent is believed to fix his future in power on the financial strength this is likely to provide him in his stay in power. Many believe, however, that the exploitation of oil is likely to lead to more conflict in the country and given the fact that the country is still caught up in the 20-year northern war, there is a fear of another war brewing up on the western border with the DRC, where the oil is located.

High levels of corruption in the country have also plagued the country since the present government came to power. Several ministers are currently facing trial for theft of large amounts of aid money, which was intended for malaria and TB medicines for the poor.

The ministers involved have defended themselves by arguing that the money they took was in actual fact passed on to the President and his wife, and that they had only been used as a cover in these transactions. This is evidence of the dangers of concentrated presidential power. Due to a lack of transparency, it has become difficult to monitor the use of public funds and there cannot be consistency in the pursuance of long-term policies that benefit the economy and the country as a whole.

# EDUCATION AND UNIVERSITY SYSTEMS

## GENERAL EDUCATION POLICY

Uganda's educational policy has never placed premium on the teaching of the sciences, in comparison to teaching in the social and human sciences. As early as 1989, there were complaints that the education system in Uganda did not provide adequate manpower training to meet the development needs of the country. A report by the Education Policy Review Commission, chaired by Professor Senteza Kajubi, indicated that the curriculum placed too much emphasis on the acquisition of theoretical knowledge, and that curricular reforms had been introduced without ensuring that there were enough qualified and trained teachers as well as the instructional materials adequate for the purpose.

The government introduced the Universal Primary Education (UPE) policy in January 1997, leading to an increase in primary education enrolment of up to 100% by 1998, but without any change in the orientation of the policy towards the teaching of the sciences. In general, all primary education was made progressive, with emphasis put on the acquisition of study and vocational skills for the development of healthy attitudes among the children. Science and basic technology were highlighted as cardinal areas of study, but they were not significantly supported. Nevertheless, the science community has been considered a major stakeholder in the curriculum development and review in determining whether what has been proposed by way of reform links with the sectoral level and national concerns (UNCST Report, 2005A). This is a good sign and augurs well for future developments in policy and the provision of resources for this purpose.

The government has recently provided for introduction of Universal Secondary Education (USE), beginning with the 2007 budget, in addition to making it compulsory for all secondary schools to teach science subjects. Subjects, such as, physics, chemistry, biology, agriculture and mathematics have been identified. Under the new policy, once a student chooses to take science, a number of options are available to her/him in form of different subject combinations. These include combinations such as, Physics-Chemistry-Mathematics (PCM), Physics-Chemistry-Biology (PCB), Physics-Economics-Mathematics (PEM), and Biology-Agriculture-Geography (BAG). Students who take Mathematics-Economics-Geography (MEG) are categorised as having taken a science subject as long as the student gets a principle pass in Mathematics at the end of the A-level. It is believed that such training would equip students to enter the job market with strong generic skills in basic literacy, numeracy, and problem-solving skills.

As if to demonstrate its seriousness about the teaching of science in schools, the government has recently (September 2007), through the UNCST, held a week-long "Science Week" in the in which it tried to demonstrate the benefits of science and technology for Uganda's development. During this week, the UNCST also made grants, amounting to Ushs 15 billion, to 12 research teams who made the best applications for

the grant. This was part of a $ 30 million Millennium Science Initiative of the Uganda government funded by the World Bank, which is aimed at boosting Uganda's level of S&T. The initiative will boost S&T development activities, including research and training leading to innovation. During the week, a World Bank representative advised that the S&T sector was pivotal for building engineering and industrial capabilities, and economic development[1]. A Brazilian keynote speaker at the function, Prof Luiz Castro, observed that donations from external sources will not cause a significant impact in this direction. He stated that Uganda needed to develop an ambitious policy for funding S&T initiatives through internally generated funds. He further pointed out that last year Brazil invested $ 1 billion in S&T, and urged Uganda to take similar steps.

The programmes/courses taken by students should give them the skills required to copy foreign technology, and adapt it to local technological capability, and with increased research, improve on the local technology. But there are no institutional and steering mechanisms in the industrial sector to promote this development. It is also important to note here that the new policy is not focused enough to deal with the serious weaknesses on the ground. In our view, the approach of the new policy should be aimed at identifying what technological capacities exist in the country so that a strategy for incremental learning can be put in place. For this to happen, institutional frameworks that have a vision of building on indigenous technologies, must be put in place.

## UNIVERSITY AND HIGHER EDUCATION SYSTEM

Currently, Uganda has five public and 12 private universities. As already shown, these universities produce more social and human science than science graduates. According to current estimates, the ratio between the two is 5:1, with the consequence that most Ugandan university graduates lack the necessary skills to effectively convert the knowledge they acquire at universities into material goods and services in their country. They are also unable to use modern tools and equipment to develop the necessary skills for the country's technological development and innovation. For example, in the year 2003, Makerere University produced only nine PhD graduates out of a student population of over 20,000 and of these only three were qualified in engineering.

Apart from Makerere University, which is the major national public university, the overall ranking of Ugandan universities and those specialised STI is very low, compared to similar institutions in other developing countries. Hence, the UNCST regarded Uganda as having a weak research culture and lacked capacity to implement any technological innovation in the country. This is evidenced by the very low level of publication of research results in internationally recognised journals. Given this low research capacity, the amount of research that has industrial relevance has been even more limited, because of the fact that basic research is given higher priority than applied research. Moreover, there was no evidence that research carried out by private sector actors, as well as Non-Governmental Organisations, was coordinated institutionally in order to have real impact.

Our research also reveals that most research done in Uganda is carried out in Universities (60%), followed by public research centres (30%) and the few private centres (10%) [UNCST, 2005A]. Public-private research initiatives are lacking due to the fact that government policy does not give room to the private sector to get involved in

[1] *The New Vision*, September 25, 2007.

public-private research initiatives. To make matters worse, the few linkages between government departments and some private sector institutions do not enhance coordination and knowledge sharing between them, and these linkages are the ones currently driving the few technology intensive programmes in the country. This limits the learning process that should be taking place in the development of the industrial and biotechnological base in the country. This is why it is important to consider the *Doing, Using and Interacting* mode as the primary means for the Incremental innovation in Uganda.

In this respect, the UNCST report, referred to above, observes that there is greater need to strengthen the linkage between industry and the tertiary institutions. The industrial and business sector needs to be consulted on areas of necessary research and at the same time encourage them to fund some of the research activities. Such an approach would not only increase the level of funding for R&D, but would also ensure the relevance of results to contemporary economic and social problems.

### Enrolment and science courses offered at universities

Enrolment in government supported universities is in two categories, government sponsored students and private students. The entry points for government sponsored students are higher entry than for the privately sponsored students. The government has recently increased its proportion of sponsorship for science-related enrolment, and decreased its sponsorship for the humanities. On the other hand, the privately sponsored students have increased the university in-take in the humanities.

Tertiary level training in Uganda has grown tremendously over the last decade following the liberalization of higher education. Government supported universities have increased from two, Makerere University and Mbarara University of Science and Technology, to four, to include the Kyambogo University and Gulu University. In addition, there are twelve private universities that have sprung up in the country within a few years. The National Council for Higher Education, which takes care of policy formulation, monitoring, evaluation and licensing, supervises these tertiary institutions.

There are a number of degree programs offered under S&T. These include: Human Medicine (Bachelor of Dental Surgery, Medicine, Nursing or Pharmacy); Engineering (Bachelor of Science in Civil, Electrical or Mechanical Engineering); Science (Bachelor of Science in Chemistry, Mathematics, Biology, Geology, or Botany); Agriculture (Bachelor of Agriculture in Agricultural Economics, Extension Services, Agribusiness or Agricultural Engineering); and Bachelor of Veterinary Medicine. In addition there are other science degrees offered in the institutes of statistics and applied economics and computer science. Table 1 below illustrates the point.

Table 1. R&D expenditure by major disciplines in million Uganda shillings

| Year | Medical& Veterinary Medicine | Social Sciences & Humanities | Natural Sciences | Agriculture & Allied Sciences | Physical Sciences | Industrial & Engineering Sciences | Total R&D Expenditure |
|---|---|---|---|---|---|---|---|
| 1990 | 1,506 | 278 | 236 | 21 | 6 | 99 | 2,146 |
| 1991 | 1,645 | 1,171 | 176 | 240 | 16 | 43 | 3,291 |
| 1992 | 1,424 | 2,172 | 164 | 550 | 5 | 21 | 4,336 |
| 1993 | 2,393 | 3,516 | 1,164 | 126 | 4 | - | 7,203 |
| 1994 | 2,542 | 1,192 | 320 | 281 | 136 | 7 | 4,478 |
| 1995 | 1,313 | 1,988 | 752 | 62 | 19 | 11 | 4,145 |
| 1996 | 1,689 | 1,275 | 1,868 | 333 | - | 5 | 5,170 |
| 1997 | 6,634 | 637 | 681 | 15 | 768 | - | 8,735 |
| 1998 | 2,952 | 1,955 | 257 | 278 | 19 | 13 | 5,474 |
| 1999 | 55,801 | 2,807 | 648 | 36 | 413 | 180 | 9,885 |
| 2000 | 14,096 | 1,568 | 2,338 | 54 | - | - | 18,056 |
| 2001 | 2,095 | 2,716 | 1,486 | 28 | - | 3 | 6,328 |

Source: UNCST, 2005A

The low level of enrolment in S&T has been attributed to limited attraction of S&T subjects at post primary level, as well as to higher tuition fees and limited job opportunities. The attraction of students into the science courses is largely affected by the following factors:

- Intake points are often relatively higher in order to limit the number of students,
- Performance of the sciences at A-level is poor compared to that of Arts,
- The tuition fees for private students is relatively high such that students, who are not sure of obtaining government sponsorship, will opt for Arts subjects,
- The duration of study for science courses is longer (between 4 and 5 years) and may not be justified by the rate of return from employment, and
- The job opportunities after qualifying are very low [UNCST, 2005A].

In contrast, the easier attraction of the students to non-S&T courses is explained by a number of factors:

- The humanities and social science courses are cheaper in terms of cost, since these courses require less capital investment and can easily be afforded by many students,
- The courses are more flexible because they are broken down to allow various levels of qualifications (i.e. certificate, diploma and degrees),
- The human resources for courses in the Arts are much more readily available and affordable compared to S&T related courses, and
- Employment opportunities are greater than in the S&T qualifiers [UNCST, 2005A].

Table 2 below shows the breakdown and the distribution of enrolment amongst S&T, arts and business courses at the undergraduate and postgraduate levels.

Table 2. University enrolment in Science, Technology, Arts and Business

| Year | 2001 | | | 2002 | | | 2003 | | |
|---|---|---|---|---|---|---|---|---|---|
| Category | S&T | Arts | Bus. | S&T | Arts | Bus | S&T | Arts | Bus |
| U/graduate (diploma) | 10 | 40 | 119 | 3 | 32 | 58 | 57 | 71 | 179 |
| U/graduate (degree) | 898 | 2569 | 584 | 361 | 2728 | 295 | 1818 | 5164 | 1347 |
| P/graduate (diploma) | 73 | 179 | 0 | 27 | 0 | | 123 | 129 | 0 |
| P/grad(degree) | 130 | 172 | 23 | 54 | 86 | 9 | 270 | 315 | 28 |
| PhD | 9 | 14 | 0 | 5 | 7 | 0 | 11 | 31 | |

Source: Makerere University

# PUBLIC RESEARCH INSTITUTES

## INSTITUTIONS

There are a number of institutions that the government has established to deal with biosectoral issues, which provide technical support in the form of technical assistance, training programmes, information services, and joint research opportunities.

### The National Environment Management Agency-NEMA

NEMA has a cross-sectoral mandate and is the principal national authority on environment matters, including biodiversity. The mandate of NEMA for the environment includes responsibility for the implementation of the provisions of the Convention on Biological Diversity (CBD). NEMA performs a coordinating, supervisory and monitoring role, working with other lead agencies (described below).

### National Agricultural Research Organisation (NARO)

NARO was established in 1994 as an autonomous research organisation. The various institutes of NARO address different aspects of biodiversity conservation and sustainable utilisation. For example, the Fisheries Research Institute (FIRI) is responsible for aquatic biodiversity, while the Forestry Research Institute (FORI) deals with biodiversity in forest areas. The various agricultural research institutes have also set up crop and livestock genetic resources conservation programmes. NARO and its institutes work closely with the Consultative Group on International Agricultural Research (CGIAR) and its various international agricultural research centres (IARCs).

### Uganda National Bureau of Standards-(UNBS)

UNBS is a statutory body set up by the government and established under Act 1 of Parliament in 1983 to formulate and promote the use of national standards; and to develop quality control and quality assurance systems that can enhance consumer protection, public health and safety, industrial and agricultural development and international trade, among others.

### Other institutions

Other institutions include the Management Training and Advisory Centre-MTAC and Mbarara University of Science and Technology, which was created recently and is dedicated to development, research and the teaching of S&T.

Most of the research on agriculture and biotechnology that has been carried out in the country has been done by public institutes, sometimes in collaboration with universities. These are key sectors that government has prioritised in public policy. The predominance of agriculture, as the backbone of the Ugandan economy, has engendered an R&D structure that is biased towards agriculture. The metal industry is not elaborately developed, mainly using imported materials for its production. Indeed, much of the metal works fall under metal fabrication. The same applies to the chemical industry. For the purposes of this study, the focus is on two areas of research, agriculture and biotechnology.

## MODERNISATION OF AGRICULTURE

The emphasis on agricultural research has meant that most research is undertaken in government and donor-supported research institutes such as, the National Agricultural Research Organisation-NARO. NARO, as we have seen above, is under the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and coordinates R&D and technology transfer in animal production and health, biotechnology, fisheries, aquaculture and food. NARO oversees a number of other research institutes: the Agricultural Engineering and Appropriate Technology Research Institute (AEATRI) for conducting agricultural engineering R&D and technology transfer; the Agricultural Research Information Service (ARIS) which coordinates and accesses national and international agricultural information for the benefit of both the public and private sector; the Coffee Research Institute (CORI) for R&D and technology transfer for the coffee crop; Kajjansi Fisheries Research (KFRS) for R&D and technology transfer; KARI for agricultural R&D on a wide range of crop enterprises; the Livestock Health Research Institute (LHRI); the Seed Industry Rationalization Project (SIRP) which conducts R&D on a wide range of crop enterprise; Namulonge Agricultural and Animal Research Institute (NAARI) for R&D and technology transfer; the Fisheries Resource Training, Research Institute (FRTRI) for R&D and technology transfer in the fisheries and aquaculture, land and water, socio-economic and farming systems; and the Uganda National Tree Seed Project.

There is a Memorandum of Understanding-MoU between Makerere University and NARO, aimed at enabling the two institutions to collaborate in planning and conducting research on all aspects of crops, livestock, fisheries, forestry and socio-economics as well as in higher degree training, exchange of expertise for purposes of research and teaching and exchange of information. In the area of research, the MoU provides that the NARO and the faculties of the university continues to conduct basic and applied research activities through the faculty staff participating in NARO research programmes in the priority areas approved by NARO. Provision is also made for the faculties to conduct basic research on problems referred to them by NARO. The collaboration between NARO and the Faculty of Agriculture and Forestry is much closer than with other faculties. At present, the Dean of the Faculty of Agriculture is also the Chairman of the NARO Board.

## BIOTECHNOLOGY AND TRADITIONAL KNOWLEDGE

Currently, the **biotechnological sector** is in its initial stages, with a lack of coordination between the different sections of the bureaucracy, the private sector and the rural communities. External donors, who are mainly interested in specific types of capacity building, have dominated the policy and research activity thus far. The results of such

research are not relevant to the needs of the rural farming communities, whose knowledge base is not strengthened and improved by such research. The research strategy is still predominantly a 'science-based' approach, which under-estimates and downplays the role of the **traditional knowledge economy**. Donors' interests in promoting a certain approach to biotechnology are often aimed at using the government to access traditional knowledge and indigenous products, in Uganda, on the ground in order to exploit them, without any compensation being paid to the rural farmers. Some research has, however, been conducted in support of the development traditional knowledge (TK) that could be beneficial to the farmers and such research tends to be participatory. To demonstrate its awareness of the importance of TK, these individuals have encouraged the adoption of TK in the area of pharmaceuticals, especially in the field of developing a vaccine to deal with the HIV/AIDS pandemic as well as other diseases. Already, capacity is emerging with the research that is being undertaken by NARO in the use of biotechnology to deal with problems of the rural peasant farming community. For example, a biotechnological response to the banana wilt that has reduced the farmer's banana output. This drop in output is due mainly to the inability of the banana crop to tolerate or adapt to environmental stress, pests, and diseases such as the wilt disease. Uganda is one of the largest banana producers in the world and this disease has caused a loss of about $ 200 million in exports per annum. The biotechnologists have identified a gene in other traditional crops that is responsible for resistance against bacterial wilt and the expertise is now available to remove and insert genes that can enable the receiving plant to possess the biological defence against certain diseases and insects. The same principle is being applied to bananas using the gene responsible for resistance against bacteria wilt, which has been identified in a variety of sweet pepper, which can protect the banana against the wilt. Other traits being sought after are genes that help crops to better withstand harsh conditions, such as drought.

In the field of medicine, biotechnology has revolutionised this field through the development of new pharmaceutical, diagnostic, and other traditional medical products. For instance, currently genetically altered micro-organisms, such as *Escherichia coli* or yeast, are being used for the production of substances like insulin or antibiotics for global markets. Another new biotechnological application is the development of plant-made pharmaceutics. Improved safer vaccines can be designed and produced by organisms transformed by means of genetic engineering. These vaccines can elicit an immune response in patients without the attendant risks of infection.

Biotechnology is also commonly associated with landmark breakthroughs in new medical therapies to treat diabetes, hepatitis B and C, cancers, arthritis, haemophilia, bone fractures, multiple sclerosis, cardiovascular, and molecular diagnostic devices that can be used to define the patient population. Modern biotechnology can also be used to manufacture existing drugs, more easily and cheaply, from genetic materials. This is why big pharmaceutical companies are rushing to capture the 'commanding heights' of the industry by claiming that TK forms part of the 'public goods' to be exploited freely by them, without compensation to the owners of this intellectual property, the rural farmers and traditional medical practitioners.

We have also seen an effort on the part of private individuals and indigenous community-based organisations, such as Prometra, beginning to develop capacity to process and export herbal medicine. For example, Prunus Africana (Pygeum) is the

leading herbal export from Uganda to other parts of the world. It is considered an effective cancer treatment. The annual trade in this herb, all of Africa, is estimated at US$ 200million. This means that the advancement of this sector presents an opportunity for substantial expansion in trade, and improvement in the Ugandan economy and its path dependence, which ought to be explored. According to Dr Leena Tripathi, a Biotechnologist with the International Institute of Tropical Agriculture (IITA) based in Uganda, these medicines will be inexpensive, stable, easy to store, and capable of being engineered to carry several strains of pathogen [Tripathi, 2007:6].

## RESEARCH BY NON-GOVERNMENTAL INSTITUTIONS

In addition to the above innovations within certain state institutions, albeit in an uncoordinated manner, there is also innovative research being carried out by Non-Governmental organisations, especially about traditional medicine practitioners. Traditional and indigenous knowledge is generated by a given people from their lived experiences in the local context of the local culture and environment. Its dynamics changes with time, depending on the prevailing situation in the particular community and the general situation in the country. Traditional Medicine Practitioners (TMP), including, herbalists, bonesetters, psychic healers and traditional birth attendants, use indigenous knowledge for developing materials and procedures.

The ratio of traditional practitioners and university-trained doctors in relation to the whole population is one traditional healer to 290 people, compared to one western trained medical practitioner to 10,000 people in urban areas and 50,000 people in rural areas. Thus, traditional healers are easily accessible to a greater part of the population as they have become an integral part of the local culture, and are appreciated as key and sustainable sources of care and knowledge on disease and illness. As indicated above, about 80% of Uganda's population relies on traditional medicine because western-trained medical personnel are limited or are not readily accepted by the community. The other reason is that modern medicines, which these medical personnel dispense, are out of reach to the majority of the population due to high costs. On the other hand, the herbal medicines and materials are also important export goods in addition to their use in the communities. A few examples will illustrate the point

*Prunus Africana* (Pygeum) is the leading herbal export from Uganda to other parts of the world. It is considered effective in the treatment of cancer. The annual trade in this herb, from all over Africa, is estimated at US $ 200million. The advancement of this sector presents an opportunity for substantial expansion in trade and improvement in the Uganda economy - especially among the poor in the rural areas, who are familiar with and have access to this herb. Its exploitation on a large scale, given the application of GMO methods, can lead to Uganda relying less and less on multinational pharmaceuticals, which the country can hardly afford. There is also the likelihood that the indigenous communities will become beneficiaries of any new blockbuster drugs that could emerge from such a production. Such exploitation will also provide an opportunity for innovation in this sector by improvement in the technologies that are used in their extraction, processing, packaging and exporting.

There are a number of organisations engaged in the promotion of traditional medicine and healing. These include **Prometra Uganda**, which is an affiliate of Prometra International. This Association promotes traditional medicine as well as being engaged in the enhancement of traditional knowledge and practices for improved health through

natural cooperation amongst health systems. There is also another organisation by the name **THETA**, 'Traditional and Modern Health Practitioners Together against Aids'. It is a Ugandan NGO in which both modern and traditional health practitioners work together. Its activities include: (a) Comprehensive training of traditional healers as trainees in THETA outreach centres; (b) Herbal medicine processing as well as the maintenance of herbal gardens. Another organisation by the name **IIACM** – the International Institute of Alternative and Complementary Medicine carries out the following activities: managing over 10,000 different medicinal plants; improving formulation of herbal medicine; teaching of various healing methods, including the use of traditional approaches from other countries (such as China and India), using treatments such as acupuncture, music therapy and yoga. Another traditional medicine organisation, **MAKO**, is a herbalist association engaged in the following activities: (a) Training of herbal medicine users on the basis of clinical diagnosis as well as supporting their efforts to provide quality patient handling and care; (b) Generating information through documentation and research about herbal medicine, and making information available to and cooperating with researchers; (c) Complementing the activities of traditional birth attendants by using skill and knowledge in areas such as traditional family planning methods; (d) Transfer of knowledge on traditional medicine; and (e) Continuous identification of indigenous plants with medicinal values.

The above examples demonstrate the dynamic role that TK can play in a strategy of development, if such knowledge and production is well protected legally. But to do so, a positive policy environment is a critical prerequisite for the successful sustainable development of traditional knowledge in Uganda based on the central idea of the learning economy. Considering the scientific and socio-economic implications of TK, it is vital that an enabling environment be created that aims at maximizing benefits of TK through effective policy-making processes, including the use of biotechnology to enhance its quality, productivity and profitability. A comprehensive legal framework to prevent exploitation of TK needs to be enacted.

However, the recent construction of a high-tech medical factory in Uganda - that was commissioned in the second week of October 2007 - has demonstrated that Uganda can pursue a policy of innovation that combines the modern aspects of the pharmaceutical industry with the traditional herbal medicine. For instance, it is understood that once the new factory begins producing Triomune for the treatment of HIV/AIDS, the factory will also be able to produce the first-line of anti-malarial combination drug system. This will be equivalent to Coartem, which the government now uses as the first-line anti-malarial drug.

The advantage of this scientific approach is that the factory will be able to buy artemisia from rural farmers in Kabale for making the anti-malarial drug. Kabale has been found to have one of the best soils for to growing of Artemisia in Uganda, as a result there is a company that has started large-scale the growing of artemisia in this region as well. There are over 10,000 hectares of Artemisia being grown in this way by peasant producers. The new factory also projects that it is going to buy artemisia from the rural farmers in order to export it to India for extraction of the active artemisinin. In the long run, the company expects to build the capacity to carry out the extraction in Uganda instead of taking it to India for the purpose and then import it.

## FIRMS AND INDUSTRY STRUCTURES

Uganda, as already shown, is a predominantly agricultural country - although the contribution of agriculture to total GDP has been shrinking over recent years, from 40.8% in 2000/01 to 35.6% in 2004/05 and 34% in 2005/06. The **agricultural sector** is based on small peasant producers, who still produce most of the cash crops for export, and food crops for their own consumption and for processing for domestic consumption and export. The industrial sector is small and mainly agriculture-based. It contributes about 20.5% to GDP. However, its growth has been volatile owing to persistent infrastructural, energy and regulatory impediments underpinned by constant political instability.

On the whole, agro-related industries account for 39.3% of the industrial sector, followed by tobacco and beverages (18.6%) and production of iron and steel products (10.5%). The industrial sector is characterised by: small scale processors of food products notably, grains, bread, diary products, fish, meat, fruit juices, vegetables, animal feeds, apiary products, jaggery and home-produced brews and spirits. The formal manufacturing sector is predominantly foreign-owned and dominates the production of basic simple consumer goods such as, sugar and confectioneries, alcoholic and soft drink beverages, tobacco, textiles and apparel, leather and footwear, wood products, metal products, clay products, cement and lime, roofing products, plastics and chemicals, flowers, coffee and tea. It accounts for about 10% of GDP. Capacity utilisation in this sub-sector is very low; at less than 50% of installed capacity for most industries.

In any case most of these industries are high cost producers because factory machinery is old and of low quality. It is also characterised by inadequate technical skills and poor worker morale - due to low wages - , which often translate into productivity losses, high input costs and poor access to credit. The geographic distribution of the industries also mirrors other regional imbalances as the industrial belt of the country covers five districts in central Uganda, Kampala, Mpigi, Masaka, Wakiso and Mukono; four districts in the east, Jinja, Bugiri, Mbale and Tororo; and five districts in the in the west, Hoima, Masindi, Kasese, Bushenyi and Mbarara.

## THE WAY FORWARD FOR UGANDA

### THE LEARNING ECONOMY

This study has demonstrated that for Uganda to move forward in its development, the knowledge necessary for its transformation must come from a two-pronged strategy that takes into account Uganda's weaknesses and strengths in the structure of its economy. The evidence presented here, has revealed that firm structure is characterised by very low capacity utilisation in manufacturing; Less than 50% of installed capacity for most manufacturing enterprises is utilised. It has also revealed that the sub-sector is a high cost producer because of the fact that factory machinery is old, antiquated and of low quality. In these circumstances, it is advisable that Uganda adopts both the STI and DUI modes of learning and innovation for its economy to make new breakthroughs that will lead to a more sustained development.

In this context, therefore, innovation must be viewed as an *interactive learning process* where an attempt is made to move a way from the linear approach to innovation, based

on the idea of the 'transfer' of technology, towards a DUI model in which the actors increase their competence incrementally while engaging in the innovation process. The approach involves 'learning by doing' as an experience-based learning process [Arrow, 1962]; 'learning by using' [Rosenberg, 1982], a process in which efficiency in using new systems increase over time; as well as a 'learning by interaction' [Lundvall, 1988], a process in which the interaction between producers and users in innovation enhances the competence of both.

In this context, 'learning' is defined as a process, "the core of which is the acquisition of competence and skills that allow the learning individual to be more successful in reaching individual goals or those of his/her organisation". Lundvall therefore regards the 'learning economy' as an economy, "where the success of individuals, firms, regions and countries will reflect, more than anything else, their ability to learn". He adds that, "The speeding up of change reflects the rapid diffusion of information technology, the widening of the global market place, with the inclusion of new strong competitors, and deregulation of and less stability in markets" [Lundvall, 2003:13]. An aspect that must not be forgotten when we advocate the 'learning economy' model is to recognise the crucial relevance Prof Amartya Sen's argument of the need to see development as being more than an increase in gross national product or with the rise in personal incomes, or with industrialisation, or with technological advances, or with social modernisation. He adds that while these determinants may be important for a country, there are also other influences on development, which come from other sources such as social and economic arrangements, and political and civil rights - including the liberty to participate in public discussions and scrutiny of public affairs [p.3].

## SCIENCE, TECHNOLOGY AND INNOVATION-STI MODE

Hence, for Uganda to enhance its path of development it has to build on the most positive experiences in its 'path dependence', which is anchored in its agricultural economy - which arose out of its 'moral' and 'natural' character of its economy in the pre-colonial era. The current post-colonial economy has been unstable, reflecting its colonial and post-colonial political history. However, experience has shown that in periods of crisis, the country has tended to fall back on its 'natural economy', which in its current form is highly based on its natural resources and ecological biodiversity. It should promote STI, while at the same time enhancing DUI in a combined way that leads to an integration of the two modes [Jensen and others, 2007]. But for the STI policy to be anchored as the basis of a technological and innovation system, it must build on the existing experiences in agricultural, manufacturing and industrial development. Currently, Uganda's manufacturing sector is weak and has very little engineering skills that can promote industrial development.

In discussing the Tanzanian experience of innovation, Diyamett and Wangwe have argued that an undeveloped country like Tanzania should pursue an innovation approach that is incremental rather than a linear one. The incremental approach to innovation in process technology involves significant improved methods, which may involve small changes in production equipment, human ware or production organisation, or a combination of these. The method may be intended to produce technologically new or improved products, or essentially to increase the production or delivery efficiency of existing products. But the cumulative effect of these small changes can be as large, and bring about as much productivity growth as major innovations are capable of generating [Diyamett and Wangwe, 2004: 184].

The two authors have pointed out that competence starts with individuals, but to move to a higher level these individuals must create the organisations that can assemble and administer such skilled individuals and move further to a situation in which these individuals are imbued by a country's technical organisation with a sense of a common purpose fostering a common goal. The mastery of a known technology can be captured by measures based on production capabilities of various types. The two authors point out that the ability of a developing country to produce engineering goods is especially important partly because this requires skills in metal processing and fabrication that are fundamental to manufacturing as a whole. In addition, they add, the engineering sector functions as the training ground for a wide spectrum of managerial and entrepreneurial skills. It also plays a fundamental role in the assimilation of foreign imported technology.

This model is appropriate to the Ugandan 'path dependence'. During the crisis of the period 1971-1979 (the era of the 'Economic war'), Ugandan small manufacturers were able to give direction, which could have been the basis of a learning experience in interactive innovation in Uganda. When the sugar manufacturing economy collapsed, the small sugar producers resorted to small-scale production of jaggery (sugar) plants based on locally fabricated factories. These small factories were able to maintain a level of sugar production that supplied a segment of the market.

The Commonwealth Team of Experts that were invited by the UNLF Interim administration in 1979 observed that during this period, gains had been made, especially in smallholder or informal sectors. The report noted that some backyard and "village level skills" in implement repair and manufacturing had been emerged or "re-established" [Commonwealth Secretariat, 1979: 106-9, Nabudere, 1990: 46-7]. The reversion to the 'informal sector' also had forced people to engage in metal fabrication to produce certain goods - such as, windows, doors frames and metal suitcases for students -, which were available on the market at reasonable prices. This experience had built on the indigenous culture of blacksmiths, which was widespread in the pre-colonial period in Uganda.

Currently, the predominance of agriculture as the backbone of the Ugandan economy has engendered an R&D structure, which is biased towards agriculture. The metal industry is not well developed, mainly due to the fact that it uses imported materials for its production. Indeed much of the metal works fall under metal fabrication, which is undertaken in small-scale enterprises with very little skills. The same applies to the chemical industry. Moreover, as the research has demonstrated, these factories' capacity is utilised to the extent of less than 50%, which points to the need to improve and expand existing capacity to full utilisation. This expansion and improvement can be built on existing knowledge, but with added engineering skills provided by the universities and training institutes in a learning way.

This does not mean that Uganda should not pursue innovations that can draw from the 'cutting edge' technologies in its development side by side. Indeed, currently Uganda has explored investments in this area in the pharmaceutical sector, which has led to the construction of a high-tech factory, which is a joint venture between the Uganda Company Quality Chemical Industries (QCI) and the Indian pharmaceutical CIPLA. As we noted above, it will produce Triomune, a combination that contains lamivudine, stavudine and nevirapine. The factory will also produce the first-line anti-malarial combination Lumartem, containing artemisinin and lumefantrin. This is equivalent to

Coartem, which the government now uses as the first-line anti-malarial drug. The factory was launched in the first week of October 2007 and was expected to begin trial runs as soon as the President had commissioned the plant. The trial runs, technically referred to as validation, were likely to go on until November or December 2007. The validation would help to ensure that the machines measure the ingredients accurately, mix in the right proportions and produce pills that are perfectly uniform in size and concentration. The factory would then be in a position to manufacture for the market by January 2008. The factory, according to sources, would be the first of its kind on the whole of sub-Saharan Africa because it will produce the full triple therapy combination of antiretroviral (ARV) drugs, something that has not been done in Africa before. South Africa has a plant for producing ARVs, but they do not produce triple therapy combinations, according to the factory sources. Likewise, a few African countries (such as, Egypt and Nigeria) have ARV factories, but none of them produces the full range of three drugs required for the treatment of HIV/AIDS. According to the same sources, the factory will initially produce two million pills a day, but this will eventually increase to six million. This means that in future it can produce 1.8billion pills a year. This number includes ARVs and anti-malaria pills and will be used first to meet Ugandan needs and the surplus will then be exported to neighbouring countries.

These other countries are likely to turn to Uganda because, from January 2008, they will not be able to import from India, which has been the biggest supplier of generic ARVs to Africa. This is because India has ratified the WTO TRIPS agreement, so it will cease to be the source of generic drugs for Africa and to that extent Uganda feels it has been able to exploit this gap to build its own factory. Previously, since the late 1990s Indian companies had been able to produce and sell generic drugs without the consent of the patent holders in Europe and USA. However, having ratified the TRIPS agreement of the World Trade Organisation, India will be required to ban the exportation of generic drugs by the end of this year. Uganda has therefore drawn from India's high-tech innovations to build a factory, within its borders, that can export drugs, showing the possibilities of pursuing both the STI and DIU modes as complementary and not as alternatives.

Another example shows how to trigger technological improvements is Uganda's fisheries industry. The changes here arose out of an external market pressure that was motivated by the existence of a supportive government policy, which encouraged the fisheries industry to embark on technological changes that would enable the fish industry to regain markets in the EU after the EU issued a ban against the entry of Uganda fish into the EU under the Council Directive 91/493/EEC in 2000. The increase in the exports of fish after the ban was attributed to structural plant improvements, which were due to technological changes embodied in process improvements that permitted the re-entry of Ugandan fish into better but demanding markets. Some of these improvements were compulsory, while some were not, and it was these compulsory and non-compulsory demands that transformed Uganda's fish industry and helped it regain its position in high income markets.

The trigger leading to technological change here did not come spontaneously, but out of pressure. Some have argued that this case supports observation in the literature to the effect that investment in technology diffusion, adoption and adaptation may not necessarily occur through invisible market forces. In the Uganda case it is argued that these invisible market forces were simply too weak to trigger technological upgrading of outdated and antiquated technology and processing. Instead pressure from international standards coupled with an enabling policy environment yielded strong pressure to

upgrade. The support structure consisted of a joint effort between the state, international development agencies, the industry association, some buyers, local and foreign private firms, with the state playing a pivotal role in an interactive learning process. However, this framework was not part of a well targeted public policy effort to catch up or even move ahead of international standards with the consequence that critical linkages and further structural improvements were not introduced and could therefore dissolve with the passage of time [Oyeleran-Oyeyinka & Gehl Sampath, 2006: 31-5].

## LEARNING BY DOING, USING, AND INTERACTING-DUI

In the processes that have been outlined above, the model of *Doing, Using and Interacting* [Jensen and others: 2007] is made imperative by the fact that the mainstream model of the global economy adopts a linear model of technological innovation that ignores other sources of innovation. The model proposed by Jensen and others, as we have seen, distinguishes two modes of innovation and learning is therefore persuasive. This second DUI Mode relies on internal processes of learning in that it recognises tacit knowledge and experience-based know-how, which exists in poor communities. This mode of knowledge acquisition can be acquired on the job in both small manufacturing firms, and through activities in the traditional systems of production and distribution in agriculture and animal husbandry. Thus, apart from being strongly related to the diffusion, adaptation and assimilation of technology at the firm level, the DUI mode also considers the learning process taking place at the individual level and individuals in communities through tacit knowledge.

According to Gregersen and colleagues [2001], in a system of national innovation, if there is adequate knowledge infrastructure and intellectual property rights and if there is good networking capability and high levels of trust, there is also a suitable basis for an efficient R&D system. It may then be quite possible to analyse the details of the subsystem (such as R&D) without worrying too much about the rest of the innovation system. The authors, however, point out that this is not possible in developing countries, transition economies or in less favoured regions, and this makes the broad approach to innovation necessary. They conclude that:

> In these types of economies, it is crucially important to build on local knowledge. This would underline the importance of their knowledge and it would also draw attention to the need not to loose important parts of largely not codified and undocumented local competencies. Local knowledge is easily de-learnt and forgotten when commodities in a quick tempo are opened up to international competition and societies accordingly restructured. A broad concept of innovation systems helps to see the importance of different kinds of knowledge and the ways they complement each other [p.14].

This requires that the relationships between the global systems and local and regional systems be researched in order to find the way globalisation processes might affect the possibilities of building national and local systems of innovation, which are part of it. Such research would also enable the understanding of power relationships of development:

> The focus on interactive learning- a process in which agents communicate and even co-operate in the creation and utilisation of new economically useful knowledge-may lead to an underestimation of the conflicts over income and power, which are also connected to the innovation process. It may be more common in the South than in the North that interactive learning possibilities are

> blocked and existing competences destroyed (or de-learnt) for political reasons related to the distribution of power. ... It is thus, clear that the innovation system approach needs to be adapted to the situation in developing countries if it is to be allied to system building. It seems also clear, however, that the holistic and systematic character of the approach and its focus on production based tacit knowledge and on learning by doing, using and interacting should make it possible to implement such adaptations [Ibid: p. 15].

A broad innovation system requires that the government pursue a new development strategy and perspective on a wide range of policies including social policy, labour market policy, educational policy, industrial policy, energy policy, environment policy and S&T policy. This concept calls for a high level of coordination across these policy levels. It also implies the adoption of a strategy that increases the country's capacity to absorb change without destroying social and natural capital, which tends to undermine continuous learning as well. This can be achieved by slowing down the pace of change to allow the process of continuous learning to take root and absorb change. In the case of Uganda, which is at the same time pursuing a fast-tracking of the East African federation, this may require the country pursuing this change at both national and regional levels in terms of human resource policy. The basic objective is to create a learning economy that can cope with rapid change and, at the same time, be successful in developing new products and services in a sustainable manner.

One of the ways in which Uganda can promote its own strategy towards innovation is to build on the innovative capacities in its traditional knowledge systems, as we have already shown in an earlier section. Many communities in Africa regard indigenous traditional knowledge (TK) as a valuable cultural and socio-economic asset for their survival. In recent times, the debate of its value at international forums, has gained economic value since elements of TK are vital in the multi-billion dollar agricultural as well as pharmaceutical industries. The appropriation of TK by multinational business has been widespread, but not well documented. However, it is generally unauthorized and, in many cases, uncompensated. This arises out of the fact that the Ugandan government does not have in place policy frameworks that can protect this form of knowledge economy. The major reason advanced is that the tools created to protect formalized 'modern scientific knowledge' when incorporated into new products - such as, patents, plant breeders' rights (PBR) and copyrights - , offer only limited legal protection for TK.

However, the Ugandan government, through the UNCST, has proposed a number of measures that are meant to address the needs of indigenous knowledge (or TK) protection, and some proposals are under way. These began with the national strategy developed in 1999 leading to the establishment of the IK Steering Committee in 2000. So far, IK is being applied in agriculture-farming systems incorporating traditional knowledge systems, traditional medicine, conflict management in low level governance structures, environmental management, management of HIV/AIDS in the treatment of opportunistic diseases (e.g. diabetes, diarrhoea, high fevers, etc.), as well as agricultural biodiversity and local storage methods. These examples demonstrate that if properly articulated and coordinated with other systems, this intensification of TK can constitute part of the NSI for Uganda.

Some of the activities encouraged by the government in primary health care include involving traditional healers and maternal attendant's use of traditional medicine, with successful experiences being adopted in neighbouring communities by way of cross

learning. TK is also being integrated into child development programmes as part of TK mainstreaming policy, and up-scaling of TK utilisation for sustainable development and poverty eradication. It is also being integrated into agricultural research, training and production through ARTPII, civil action for the promotion of organic agriculture, etc. At the same time, there is also the activity involving disease treatment undertaken by Mbarara University where the results of the experimentation with traditional drugs have been used in the treatment of the president's cattle, in a nearby district, using an indigenous product known as *Phytollaca dodocandra* for the prevention of worm infestation of watering dams. There has also been some amount of collection and documentation of IK by traditional healers and published by the National Foundation for Research and Development.

With this approach, the policy has so far attracted some stakeholders in the private sector, as well as the universities of Makerere, Mbarara, Gulu and the NARO. A National Innovation Fund was also set up to support IK development, from which four institutions have so far benefited for the improvement of agronomy, conservation, processing and packaging of indigenous medicines for the treatment of human and animal diseases. From this experience, the regional Committee on Education, Research and Culture of the East African Community has adopted IK as one of the priority areas of focus for the region as a whole. These activities have resulted in the development of infrastructure, including a coordinating secretariat that was established in 2001 for coordinating IK development initiatives; telecentres for training communities in the collection and storage of TK, Community Indigenous Resource Centres in 6 of the then 54 districts of Uganda. There was, at the same time, a proposal by NFRD to set up a Centre for Development of Indigenous Knowledge that will house a national museum of TK. Mbarara University has also set up a centre for research on TK. In addition, the government is currently considering the establishment of a Centre for Analysis, Validation and Standardisation of Indigenous Medicine and Natural Products that will work closely with the other TK development institutions and the National Chemotherapeutic Laboratories that have been involved in the analysis of herbal medicine. In 2002, the Uganda TK Information Society (UGIKIS) was established as a national community based organisation, which acts as a Forum for IK stakeholders and also as a framework for collecting and documenting of IK and administering IK education programmes (nationally) through regional action centres.

These activities reveal the importance the Ugandan government has attached to the use and development of TK for development. The policy has produced a good number of institutions, but perhaps these lack an over-arching development strategy and coordination. The clear articulation of this strategy, within an innovative learning economy, could include all of these activities into a coherent national strategy that includes SIT as well as the DUI mode that works side by side in a NSI for the country. One of the components of the TK approach could focus on certain products that could be processes and manufactured for export, and marketed in the internal market. This could be in the organic food products or traditional herbal medicines sector.

## CONCLUSION

This study aimed at investigating how and why university industry linkages differ from country to country in a comparative manner, by focusing on incentives and constraints, their extent, intensity and performance. This was intended to provide a basis for considering how universities can contribute to local and national goals. Our research

surveyed the policy context and examined the government's policy frameworks within these dimensions. We focused on the biotechnology platform, and found that there was a very weak linkage between universities and industry. We found that even in situations where there was a small linkage, such a linkage was an indirect one through institutes. Makerere University was for instance involved in research on biotechnology through a Memorandum of Understanding with the National Agricultural Research Organisation (NARO).

Even then, the research found that such linkages, which could have led to the realisation of industrial and commercial potential in the use of biotechnology, was judged by the UNCST to be "unexploited" [UNCST, 2005B]. Under these circumstances, we came to the conclusion that the hope that university-industry linkages could lead to economic growth in the country, creating a new space for the university to become a **"developmental university"**, could not be realised. Instead the research found that most of the research and the promotion of capacity building in biotechnology had been donor determined with all the consequences discussed in the body of the report.

This is why this study adopted the two-pronged strategy for Uganda's development, as argued above. It is important here to refer to the recent developmental strategies adopted in China, which aim to promote endogenous innovation and 'harmonious development', and examine to what extent countries like Uganda could learn from this. According to Gu and Lundvall [2006], China's rapid industrial development after the inauguration of its policy of "Modernisation" - which included decentralisation, privatisation and openness in the 1980s - had resulted in high growth rates and high levels of capital accumulation (especially in manufacturing), which had created new challenges for China. These developments had led to inherent contradictions in this model of growth, calling attention to new approaches. Hence, in 2005, the Chinese leadership adopted a new economic development strategy based on two pillars: 'endogenous innovation' and 'harmonious development'. The new approach was to be based on 'innovative driven growth and learning based development'. The two authors point out that endogenous innovation and harmonious development implies a growth model that gives attention not only to *production capital* and *intellectual capital*, but also avoids the degradation of *natural capital* (natural resources). The combination of these forms of capital must be deployed as a key element in a strategy favouring harmonious development. The new strategy must also be based on stimulating the formation of *social capital*, key to long-term success in promoting endogenous innovation. They add that since social capital is the basis for interactive learning, the 'lubrication' of this capital and the trust upon which it is based, will make the innovation system work better. This is because the interaction between users and producers of knowledge and technology remain pertinent in a major transition. Therefore, strengthening domestic demand and the competence of domestic users of technology is the key to success. They insist that:

> Enhancing the knowledge base of strategic sectors producing process equipment and knowledge intensive business services for the market is another important element. Investing in social capital-designing institutions so that citizens become more ready to collaborate and learn from each other is a way to promote endogenous innovation [Ibid].

This model seems to be based on the integration of the bottom-up growth approach and the top-down approach that had produced earlier higher rates of growth, but then produced challenges that could only be solved through a bottom-up endogenous innovation strategy. Uganda could learn from this learning economy approach and

develop a new economic development strategy that will avoid the challenges that are bound to occur from a top-down industrial development strategy that ignores the bottom-up approaches to self-transformation.
It is recommended that Uganda adopt a STI and DUI learning economy model that builds on existing technologies in the metal fabrication sector and links with universities to build up an engineering potential that can give rise to a cumulative learning process. In the biosectors, aspects of DUI can draw heavily on indigenous (traditional) knowledge based on farmer innovative activities to enhance the university industry linkages for the benefit of Ugandans.

The conclusion is that for the learning economy process to succeed, the Ugandan government must give priority to policies that aim at human resource development, creating new forms of organisation, building innovative networks, re-orienting innovation policy towards service sectors in which TK elements are involved, and integrating universities into the innovation process. This means adopting new educational policies, which promote the capability to learn and encouraging the formation of combinations of theoretical knowledge and social skills in a slow movement. The policy should also aim at creating new forms of organisation - especially those that increase connectivity and interaction between different branches and departments - for accelerating innovation, as well as between producers of technology and their users in the communities and firms. Innovative networks, including inter-firm cooperation for innovation and knowledge institutions networking, are essential for creating a knowledge intensive network to promote regional and national development.

It is suggested that in order to bring about a sharper and more elevated focus on technological change as an important driver of economic growth and development, there should be a delegation of power to some kind of high-profile competent authority, for example, a renewed and upgraded UNCST. Through unambiguous policy specification and with the involvement of all relevant stakeholders and actors, this competent national authority should provide leadership aimed at encouraging technological upgrading in industry. This would include leadership in organising background research across carefully selected sectors, evolving standards and performance targets for technological change, developing new reward systems, supportive and enforcement mechanisms, and a budget that would support the entire effort. A World Bank study report has advised that:

> Technological upgrading solutions will have to take account of sector specific requirements and conditions. In this context, the competent authority should encourage knowledge, skill and resource flows across all relevant public and private agencies such as the Investment Authority, banks, government ministries- local and foreign- and others that need to interact better to stimulate and sustain technical change in various sectors. In other words, the government might need to restructure and improve UNCST in a manner that permits it to coordinate and strengthen national and sectoral innovation systems in the country [Oyeleran-Oyeyinka & Gehl Sampath, 2006: 34-5].

This conclusion has come out of the analysis of Uganda's path of development, which has hitherto been characterised by instability caused by political violence. This experience has also revealed the strengths and weaknesses of Uganda's economy. On the negative side is the inconsistency in government responses to the crises due to the volatility of the political situation and the rapid change of regimes. This volatility has meant that government policies have been inconsistent and have lacked an in-depth

understanding of the problems faced by industry, institutions of higher learning and rural communities. On the positive side has been the strength of the traditional sector, which has enabled the country to survive the crises that have occurred from time to time, and have even pointed to certain innovative initiatives that can be built upon incrementally. This strength in the traditional sector should be strengthened by elements of the STI and DUI modes, both of which must coalesce into a coherent and sound development strategy that can build on a cumulative process of innovation. But to do this, a coherent policy framework combined with institutional reform, are absolutely necessary.

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