National Science, Technology and Innovation Monitoring and Evaluation Framework

National Commission for Science and Technology
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Contents

Acronyms

ARET	Agricultural Research and Extension Trust
ASTII	African Science, Technology and Innovation Indicators
ASTIII	African Science, Technology and Innovation Indicators Initiative
CHSU	Community Health Sciences Unit
COMESA	Common Market for Eastern and Southern Africa
CUM	Catholic University of Malawi
DAHLD	Department of Animal Health and Livestock Development
DARS	Department of Agriculture Research Services
DISTMS	Department of Information Systems and Technology Management Services
DoF	Department of Forestry
EMIS	Education Management Information System
FRIM	Forestry Research Institute of Malawi
GDP	Gross Domestic Product
IP	Intellectual Property
M&E	Monitoring and Evaluation
MAC	Malaria Alert Centre
MACRA	Malawi Communications Regulatory Authority
MANEB	Malawi National Examinations Board
MBS	Malawi Bureau of Standards
TRF	Tea Research Foundation
MCCCI	Malawi Confederation of Chambers of Commerce and Industry
MERA	Malawi Energy Regulatory Authority
MIRTDC	Malawi Industrial Research and Technology Development Centre
MoH	Ministry of Health
MZUNI	Mzuzu University
NAC	National Aquaculture Centre
NCIC	National Construction Industry Council
NCST	National Commission for Science and Technology
NEPAD	New Partnership for Africa's Development
NHBG	National Herbarium and Botanical Gardens of Malawi
NMCM	National Midwifery Council of Malawi
NPGRC	National Plant Genetics Centre
NSO	National Statistical Office
R&D	Research and Development
OECD	Organization for Economic Cooperation and Development
SADC	Southern African Development Community
SDAU	Seventh Day Adventists University
STI	Science, Technology and Innovation
TEVETA	Technical Entrepreneurial Vocational Education and Training Authority
TRF	Tea Research Foundation
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Education, Scientific and Cultural Organization
UNILIA	University of Livingstonia
UNIMA	University of Malawi
WICO	Wood Industry Company of Malawi

Tables and Figures

NATIONAL SCIENCE, TECHNOLOGY AND INNOVATION MONITORING AND EVALUATION FRAMEWORK FOR MALAWI

1.0 Introduction

The Science, Technology and Innovation system in Malawi has not had a comprehensive list of indicators that are commonly used to measure progress in the sector. The National Statistics Office (NSO) does not provide an indicative picture of how Science and Technology (commonly proxied by research and development) contributes to the country's Gross Domestic Product (GDP). At international level, United Nations Scientific and Cultural Organization (UNESCO) and Organization for Economic Cooperation and Development (OECD) have clearly defined indicators that are used to track science, technology and innovation developments and periodically they undertake surveys to make cross-country comparisons of performance by countries including those in SADC and COMESA regions.

1.1 Background

The National Commission for Science and Technology (NCST) was established by the Science and Technology Act of 2003 which was operationalized on 14th November 2008 following the publication of a Gazette notice on 20th February 2009. Recruitment of its first Director General was done in December 2009. One of the functions of the National Commission for Science and Technology is "to develop and synthesize science and technology indicators covering such aspects as research and development statistics, bibliometrics, technology balance of payments statistics, patents data, human resources and innovation data using internationally accepted standards.

According to the Science and Technology Act, the National Commission for Science and Technology is required to come up with a State of Science and Technology Report every two years for presentation to National Assembly. This report requires that the Commission undertakes data collection exercises on science, technology and innovation across the R&D spectrum.

Prior to the establishment of the Commission, there were various endeavors aimed at tracking science, technology and innovation by organizations such as UNESCO through UNESCO Institute for Statistics (UIS) which circulates questionnaires for collecting science and technology data from member countries. At the African Ministerial Conference on Science and Technology (AMCOST) it was observed by African leaders and Policy makers that science, technology and innovation indicators are crucial for monitoring scientific and technological development.

At the first AMOCST summit, countries committed themselves to develop and adopt common sets of indicators. The system of indicators will track the development and functioning of the African national systems of innovation and it will constitute the mainstay for the production of the African Innovation Outlook.

The African Science, Technology and Innovation Indicators Initiative (ASTIII) had two main projects which are: Development and Adoption of African Common Science, Technology and Innovation Indicators; and Establishing an African STI Observatory. These two projects are implemented by the New Partnership for African Development (NEPAD) under the African Union's flagship programmes. The flagship programmes were approved by Heads of State and Governments of African Union started in 2006 and are outlined in the Consolidated Plan of Action.

To ensure conformity to international standards, Malawi through the Department of Science and Technology (DST) was among the 19 African Countries that participated in the first pilot phase of the African Science, Technology and Innovation Indicators Initiative (ASTIII). Other participating countries in the initiative are Algeria, Angola, Burkina Faso, Cameroun, Egypt, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Mali, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Uganda and Zambia. Results from the pilot phase were published in the African Innovation Outlook (2010).

Phase II of the ASTIII has 28 participating countries. Phase II of the survey in Malawi is being coordinated by the Ministry of Education, Science and Technology and National Statistics Office (NSO). It is expected that results of this phase will provide a better picture of the state of science and technology in the country.

The Commission, however, believes that for the process of tracking and synthesizing STI indicators to be sustained it has to be institutionalized by strengthening monitoring and evaluation systems. In December 2011, the Commission undertook an independent survey in key research and development institutions to assess the availability of monitoring and evaluation frameworks for collecting science, technology and innovation data by statisticians and monitoring as well as monitoring and evaluation officers.

Figure 1 indicates availability of Science, Technology and Innovation frameworks in various R&D institutions in Malawi.

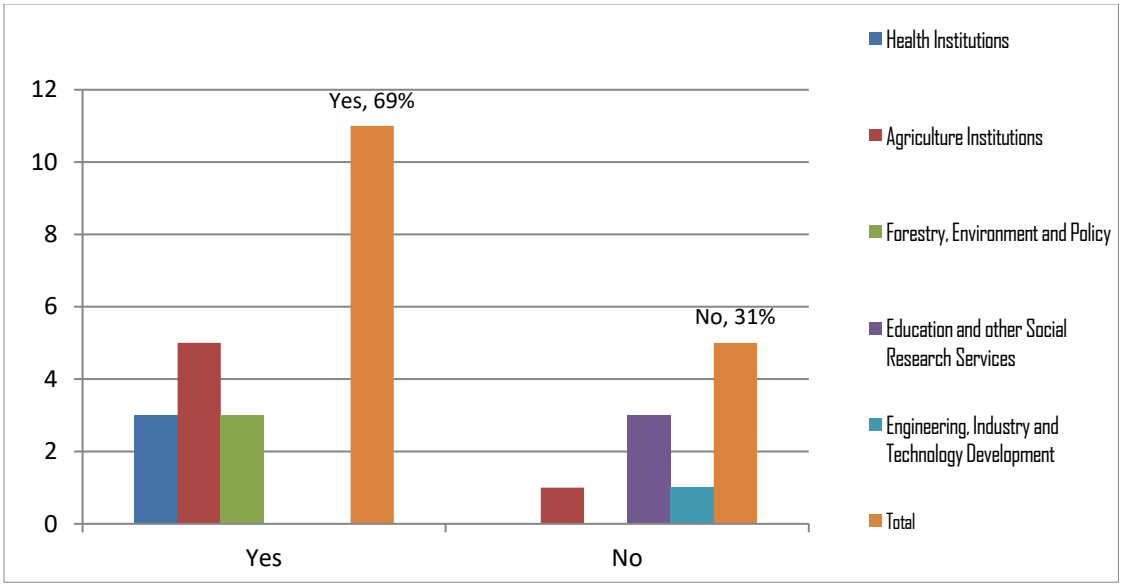

Figure 1 Availability of Frameworks

The assessment revealed that about 69 percent of the institutions have frameworks for tracking indicators on R&D while 31 expressed that they do not have monitoring and evaluation frameworks. The survey results show that there are a lot of indicators being captured in science, technology and innovation at institutional level but very little is captured at national level. Most science and technology institutions, through their sectoral reports provide different ways of how science and technology contributes to development. Findings further reveal that there are a number of research and development institutions which still do not have monitoring and evaluation frameworks making efforts by various development partners in their respective sectors unnoticeable.

1.1.1 Capacity Building of Monitoring and Evaluation in Science, Technology and Innovation

In recognition of challenges faced by institutions in tracking and synthesizing Science, Technology and Innovation (STI) data and information, the Commission organized a stakeholders' training workshop to discuss indicators collected by various organizations involved in Research and Development in November 2011.

Following up on the recommendations from the November 2011 Stakeholders' meeting, the Commission organized another M&E workshop for experts, technocrats as well as Heads of institutions at KIMS Koreana Lodge in Lilongwe from 8th to 10th February 2012 to train them in aspects of Science, Technology and Innovation Monitoring and Evaluation and also to review the draft STI M&E framework.

Representatives of research and development institutions, academia and government ministries/department with various backgrounds attended the meeting. The institutions that sent representatives were University of Malawi; Mzuzu University; National Herbarium and Botanic Gardens; Malawi Investment and Trade Centre; National Statistical Office; Department of Climate Change and Meteorological Services; Makoka Research Station; Malawi Bureau of Standards; Tea Research Foundation; Malawi Industrial Research and Technology Development Centre; Ministry of Health; Kamuzu College of Nursing; Forestry Research Institute of Malawi; Ministry of Agriculture, Irrigation and Water Development; Chancellor College; Malawi Institute of Education; Geological Surveys Department; Bvumbwe Research Station; Malawi Confederation of Chambers of Commerce and Industry; Bunda College of Agriculture; Department of Energy; College of Medicine (Research Support Centre); Registrar General's Department; National Construction Industry Council; Ministry of Finance; National Aquaculture Centre; Department of Nutrition, HIV and AIDS; Centre for Social Research; Department of Science and Technology; Community Health Science Unit; and National Commission for Science and Technology.

2.0 Monitoring and Evaluation

2.1 Definitions

Monitoring and Evaluation (M&E) System is understood as a set of planning, information gathering and synthesis, reflection and reporting processes, along with the necessary supporting conditions and capacities required for the outputs of M&E to make a valuable contribution to decision making and learning processes. For M&E to succeed, it needs to be driven by an institution's need for information, their use of the information and their desire to create a learning environment. M&E will, therefore, only ever be as good as the quality of overall management.

2.2 Highlights of the Science, Technology and Innovation Indicators

Gross Expenditure on Research and Development (GERD)

Malawi Gross Expenditure on Research and Development (GERD) was estimated at 1.7% of GDP in 2008. The recent survey has roughly estimated a reduction of GERD to 0.737% of GDP in 2010. There are indications that the reduction may be attributed to two main reasons: The reduction in financing by the Government Sector as witnessed by the Zero Deficit Budget and secondly, due to the frozen aid from development partners which was outspoken in particular in year 2011.

Total number of researchers in Malawi

There is some evidence of human capital development in Malawi. The current figures indicate that in 2009 there were 360 researchers per million inhabitants. The figure rose to1846 researchers per million inhabitants by 2010. This is a significant achievement considering that in 90's Malawi's total number of researchers was only less than 50 researchers per million inhabitants. For example, in 2007/08, Malawi had an estimated 49 professionals against a minimum target for African countries of 200 per million inhabitants. This steady growth is a positive development though should be looked at with caution.

ICT Indicators

Malawi continues to make progress in development and use of ICTs and related applications. Although, E-infrastructure is still not robust, Malawi has now provided the much required broadband Internet services through fibre networks system.

This has resulted in increased fixed line density, mobile density, increased Internet Service Providers and Internet subscribers and users. Recently, MACRA has expended tele-services through construction of additional telecentres across the country. Malawi had 13 telecentres in 2009 and by 2010 there were 18 telecentres which provide necessary ICT services.

Genetic Resources

Malawi is richly endowed with genetic resources. To ensure that such diversity of plant and animal life is protected and sustained for over long periods, it is necessary to protect endangered plant and animal species, rare and economic species for the country's natural heritage. Malawi had about 824 rare, endemic, economic, and medicinal plants propagated in 2009 and the figure rose to 827 by 2010. Various species of plants and animals continue to be endangered. In 2009, there were 248 species on Red List and by 2010, there were 250 species.

Intellectual Property

Malawi IP services are improving. There are a lot of activities which have resulted in filing for patents and trade marks. In 2010 and 2011 there were 2149 and 1566 patents respectively approved at Registrar General. In relation to trade marks, figures indicate that they were 2039 trade marks in 2010 and 1199 trademarks in 2011. The decline in the total volume of IP rights approved may be attributed to economic recession experienced in 2010 when Government implemented a Zero Deficit Budget.

Higher Education

Generally, there is an increase in the supply of human resources as well as Science lecturers from the country's main universities. In 2010, the aggregate number of graduates in science disciplines was 1,336 and the number rose slightly to 1350 in 2011. During the same period, the aggregate number of science teachers increased to 770 in 2011 from 598 in 2010.

Health Indicators

There are many health indicators, but in a few have been highlighted in this section in relation to science and technology. The doctor – patient ratio was estimated at 1 doctor per 35,180 patients in 2010. The nurse – patient ratio was estimated at 1 nurse for every 2,884 patient. There is great disparity in the two ratios on the ground due to shortage of human resources and health care centres as a result of a growing population.

The indicators on disease diagnosis reveal that there is progress in diagnosis of Malawi, TB, HIV and AIDS and other diarrhea related diseases. In 2010, there were about 10 technologies for diagnosis of the diseases mentioned. By 2011, the number of technologies increased to 12 which could mean that it would take less time to diagnose a disease or less efficient technologies are being replaced which increased the chances of treatment.

2.3 Why Should M&E be undertaken in Science, Technology and Innovation at National Level

Effective M&E has the following advantages:

- To assess progress and achievements and report to, boards, funding agencies, clients, taxpayers and the general public (enables accountability requirements to be met) Financial accountability (was money well spent)?
- To assess efficiency (use of resources).
- Hold implementers accountable for delivery of inputs/outputs. It provides managers with information they need for day-to-day decisions in their ever-changing contexts
- It provides stakeholders with the information they need to guide the project strategy towards achieving the goal and objectives
- It provides early warning of problematic activities and processes that need corrective action. To identify the constraints or bottlenecks
- To assess effectiveness (purpose & outputs achieved)
- To evaluate and adjust strategies and activities (learning). It motivates and stimulates learning amongst those committed to making the project a success. It helps empower stakeholders by creating opportunities for them to critically reflect on the project direction and help decide on improvements
- To assess relevance (priorities) and sustainability (continued impacts after the project funds run out)

- To draw lessons from the implementation experience for learning, re-planning and sharing with others and for use in design of future programmes (programming)

What are the consequences of not doing M&E or Inadequate M&E

- Limited learning by implementers about the project's/programme progress, opportunities and problems: consequently, the limited ability of those involved to correct operations and strategy, leading to sub-optimal impact on goal/objective realization.
- Unclear impact performance leading to limited accountability to funding agencies and to primary stakeholders of projects in terms of their stated goals

2.4 Key M&E Stakeholders and their Roles

M&E can not be done without sharing information and developing communication systems among various stakeholders. Table 1 shows key stakeholders a system can have and their roles.

Key Stakeholder	**Role**
Primary Stakeholders/ Beneficiaries	Their views count in impact assessment
Project Management	Establish and operate the reflection and learning process Ensure that the project has clear and relevant plans Reviewing and approving work Ensuring financial flows Reporting to supervising bodies, funding agencies and local people
Implementing Partners	Monitor the activities they implement

Table 1: Roles of Key M&E stakeholders

2.5 Characteristics of a Good M&E System

A good M&E system will have the following characteristics:

Characteristic	Description
Has a clear focused purpose	The partners collect data on impact and meet to regularly consider if impacts can be seen and whether they meet expectations
Provides a learning environment	Partners regularly and openly discuss progress and problems. Problems and mistakes are the basis for learning how to work better. People feel safe to share their ideas and observations with higher authorities and peers.
Contributes to effective operations	Clear systems exist for tracking staff performance, equipment use, etc. People are clear about their responsibilities and deadlines, and the resources they need to do their work. The managers allocate sufficient budget and are building capacity where needed.
Makes available quality information on time.	Managers have quick and easy access to information about progress. Staff and partners generate information about outcomes and impact achievements. Information about project progress is shared regularly with all stakeholders in a visually appropriate way. Studies are undertaken to explain any emerging problems. Project reports make interesting reading, and tell both the good and bad and how improvements will be made

Table 2: Characteristics of a good M&E system

2.6 Science, Technology and Innovation M&E System and Government Policy

The need to align the Science, Technology and Innovation Monitoring and Evaluation System is so paramount if the target is to achieve the overarching Government policy goals. As is commonly understood, indicators can only be effectively used if they are embedded in the policy process, and that requires interaction between policy makers and statisticians.

Here is a demonstration of how the STI M&E system should operate. Policy makers must be able to formulate objectives, such as the need to improve food security for instance by increasing domestically produced food, and programmes to move the economy and the society towards the objectives. These programmes may include improving genetic research leading to more robust breeds of crops and animals, or new breeds, the development of vaccines and of better diagnostic tests for food safety. As stated earlier, the statistician's work would be to develop survey questions to measure the impact of those programmes and the policy makers is expected to utilize the information synthesized in the system. This is the theoretical expectation of how the M&E system can work.

Having looked at the theoretical aspects of an M&E System, it is essential therefore to provide a classification of Monitoring and Evaluation System of indicators that are commonly tracked by the institutions in science, technology and innovation. These are:

i. **Input monitoring indicators**

Emphasis is on resource availability and use

ii. **Process monitoring indicators**

Emphasis is on the unfolding of planned activities and whether unplanned activities are taking place and why.

iii. **Output monitoring indicators**

Emphasis is on achievements realized versus planned

iv. **Impact/ Outcome indicators**

Emphasis is on tracking down impacts of a project or programme. They could be long term e.g. behaviour factors linked to capacity building programmes, publications, patenting etc

v. **Indicators of sustainability**

Emphasis is on on tracking the capacity to continue the activity and benefits that flow

In addition, as we seek to provide reliable data, there is need to look at other important aspects such as:

vi. Provision of baseline information where desirable; and

vii. Assessment of impacts where desirable and feasible

2.7 Development of the Science, Technology and Innovation Indicators Framework

The Science, Technology and Innovation indicators framework was developed and compiled covering the following aspects or areas:

1. Research Projects and Programmes;
2. Research and Development financing;
3. Education and Training
4. Seed Technology;
5. Water and Irrigation;
6. Agro-processing,
7. Food Processing;
8. Health;
9. Mining;
10. Climate Change;
11. Energy (Renewable and Non-Renewable);
12. Intellectual Property (IP);
13. Livestock and Pig Production; and Aquaculture
14. Genetic Resources;
15. Transport;
16. Construction;
17. Information, Communication and Technology (ICT)

Table 3: Science, Technology and Innovation Monitoring and Evaluation Framework

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
A. Research, Projects and Programmes									
No. of research projects implemented by field	***Total number of research projects implemented in a particular field***	Number	N/S			Progress reports	Administrative data through field surveys	Annually	All R&D institutions
No. of targeted project beneficiaries by type	***Total number of beneficiaries earmarked by the project interventions***	Number	N/S			Progress reports	Administrative data	Annually	All R&D institutions
Technology refers to the making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organization in order to solve a problem or perform a specific function. It can also refer to the collection of such tools, machinery, and procedures									
No. of technologies developed by sector	***Total number of technologies developed in a particular sector***	Number	N/S			Progress reports	Field visits to collect administrative data	Annually	All R&D institutions
No. of technologies released by sector	***Total number of technologies approved by the established clearing committees for use in a particular sector***	Number	N/S			Progress reports	Field visits to collect administrative data	Annually	All R&D institutions
No. of technologies being used by sector	***Actual number of technologies that are in use by sector***	Number	N/S			Progress reports	Field visits to collect administrative data	Annually	All R&D institutions
B. Human Resources involved in R&D									
Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods, systems and also in the management of projects									
No. of researchers by highest education level, field, gender, nationality and age	***Total number of researchers at an institution in a particular field***	Number	360		1846[1]	Survey report	ASTII	Annually	All R&D institutions
Technicians/Technologists refer to persons that possess at-least secondary education plus additional technical training at Diploma level doing technical tasks in support of R&D normally under the direction and supervision of a researcher									
No. of technicians by highest education level, field, gender and age	***Total number of technicians at an institution in a particular field***	Number	339		1548[2]	Survey report	ASTII	Annually	All R&D institutions

[1] *For Researchers the Reference year is 2010*

[2] *For Technicians the Reference year is also 2010*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
Executive and management staff refer to executive and directors primarily concerned with budgets and human resources in support of research, rather than project management and possess at-least secondary education plus additional professional training									
No. of executive and management staff by highest education level, gender and age	***Total number of staff occupying executive and management positions at an institution***	Number	Na		Na	Survey report	ASTII	Annually	All R&D institutions
Administrative and support staff refer to skilled and unskilled staff supporting research work including secretarial and administrative and clerical personnel working on or directly associated with R&D activities									
No. of administrative and support staff by highest education level, field, gender and age	***Total number of staff occupying administrative and support positions at an institution***	Number	32		418	Survey report	ASTII	Annually	All R&D institutions
Proportion of time devoted to research and development by each staff member	***Number of hours staff (including researchers) spend on Research and Development activities per day***	Percentage (%)	Na		Na	Survey report	ASTII	Annually	All R&D institutions
Research and Development Financing									
Sources of Research and Development Funds and amounts	***Total amount of resources sourced by an institution from the Government and other development partners***	Number	Na		Na	Reports	Administrative data	Annually	MoEST (DST)
Amount spent for operations, capital items and salaries for research and support staff	***Total amount of actual expenditure by an institution***	Amount	Na		Na	Reports	Administrative data	Annually	MoEST (DST)
Gross Expenditure on R&D	***Total amount of actual expenditure on Research and Development by all institutions in an economy***	Amount	0.754%		0.797%				
Technology balance of payments registers international flow of industrial property and know-how and covers patents, licences, know-how (not patented), models and designs, trademarks, technical services, finance of industrial R&D outside national territory									
Technology balance of payments	***The amount realized from sales of technologies versus the amount used to import technologies***	Amount	Na		Na	Reports	Field visits	Annually	Ministry of Trade and Industry, NSO, RBM, MoEST (DST)

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
Proportion of Research and Development expenditure to GDP	***Aggregate expenditure on R&D by institutions divided by GDP***	%	0.607%[3]	1%	0.193%[4]	Audit reports	ASTIII	Annually	MoEST (DST)
Seed Technology									
Certified Seed refers to seed that has been produced to standards set down by Government in a quality assurance scheme. Or seed of a known variety produced under strict seed certification standards to maintain variety purity									
Tonnage of certified seed produced for each variety	***Total quantity of certified seed produced***	Tonnage	N/S			Progress reports	Field visits	Annually	Monsato/ARET/Seed Co/PANNAR/Pioneer/ DARS
Tonnage of certified seed sold	***Total quantity of certified seed sold***	Tonnage	N/S			Progress Reports	Field visits	Annually	Monsato/ARET/Seed Co / PANNAR/ Pioneer / DARS
No. of registered organizations involved in certified seed production	***Headcount of organizations permitted to produce certified seeds***	Number	N/S			Progress reports	Field visits to collect administrative data	Annually	TRF, SCPA, STA, FRIM, DARS
Water and irrigation									
Water abstraction or water extraction, or groundwater abstraction means the process of taking water from any source, either temporarily or permanently.									
No. of water abstraction technologies by type	***Total number of technologies for water abstraction***	Number	N/S			Reports	Administrative data	Annually	Dept. of Water/ NGOs
No. of technologies in irrigation by type	***Total number of technologies available for irrigation***	Number	N/S			Reports	Administrative data	Annually	Bunda College/ Dept. of Irrigation/ NGOs
Food processing									
Food processing is the set of methods and techniques used to transform raw ingredients into food or to transform food into other forms for consumption by humans or animals either in the home or by the food processing industry. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life food products.									

[3] *Corresponds to 2009*

[4] *Corresponds to 2010*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of technologies in food processing from locally produced materials	***Total number of technologies which are made from locally produced materials available for food processing***	Number	N/S			Reports	Administrative data	Annually	MBS, TRF, MCCCI, Bakhresa, Rab Processors, MIRTDC, Bunda College and DARS
Technologies in food packaging involve use of materials that ensure protection, tampering resistance, and special physical, chemical, or biological properties and also shows labelling to show any nutrition information on the food being consumed									
No. of technologies in food packaging	***Total number of technologies available for food packaging***	Number	N/S			Reports	Field visits to collect administrative data	Annually	MBS, TRF, MCCCI, Bakhresa, Rab Processors, MIRTDC, Bunda College
No. of technologies in food storage from locally produced materials	***Total number of technologies available for food storage that are produced from local materials***	Number	N/S			Reports	Field visits to collect administrative data	Annually	MBS, TRF, MCCCI, Bakhresa, Rab Processors, MIRTDC, Bunda College, SCPA
No. of technologies in food preservation	***Total number of technologies available for food preservation***	Number	N/S			Reports	Administrative data	Annually	MBS, TRF, MCCCI, Bakhresa, Rab Processors, MIRTDC, Bunda College, SCPA
Disease diagnosis is the act or process of identifying or determining the nature and cause of a disease or injury through evaluation of patient history, examination, and review of laboratory data									
Health									
No. of technologies in disease diagnosis by type	***Total number of technologies available for disease diagnosis***	Number	10[5]		12	Reports	Administrative data	Annually	MoH
No. of technologies in disease treatment by type	***Total number of technologies available for disease treatment***	Number	NA[6]			Reports	Administrative data	Annually	MoH, CHSU, MAC
No. of technologies in disease prevention by type	***Total number of technologies available for disease prevention***	Number	NA			Reports	Administrative data	Annually	MoH, CHSU, MAC
No. of doctors and field of specialization	***Headcount of doctors and their field of specialization***	Number	N/S			Reports	Administrative data	Annually	Medical Council of Malawi

[5] *Malaria 2, HIV and AIDS 4, TB 2, and diarrhoea related diseases 2 in 2010: Whereas in 2012 Malaria 2, HIV and AIDS 4, TB 4, and diarrhoea related diseases 2*

[6] *NA: Not available and it may also be difficult to have a technology in disease diagnosis*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of nurses	***Headcount of nurses***	Number	N/S			Reports	Administrative data	Annually	NMCM
Mortality rate	***Number of deaths per 100,000 population***	Ratio	N/S			Reports	Administrative data	Annually	Ministry of Health
Doctor – Population ratio	***Total number of doctors divided by the total population***	Ratio	1:35,180	1:31,000	?	Reports	Administrative data	Annually	Ministry of Health
Nurse – Population ratio	***Total number of nurses divided by the total population***	Ratio	1:2,884	1:2,500	?	Reports	Administrative data	Annually	Ministry of Health
Climate Change									
Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years									
No of technologies in flood control by type	***Total number of technologies available for flood control***	Number	N/S			Reports	Administrative data	Annually	Dept. of Disaster Preparedness, Relief and Rehabilitation
No. of technologies for adaptation of climate change	***Total number of technologies available for adaptation to changes in climate***	Number	N/S			Reports	Administrative data	Annually	DoF, ARET, TRF, FRIM, NHBG, NGOs
No. of technologies in mitigation of climate change	***Total number of technologies available for mitigation against climate change effects***	Number	N/S			Reports	Administrative data	Annually	DoF, ARET, TRF, FRIM, NHBG, NGOs
No. of technologies for monitoring climate change	***Total number of technologies available for monitoring changes in climate***	Number	N/S			Reports	Administrative data	Annually	DoF, ARET, TRF, FRIM, NHBG, NGOs
Mining									
Mineral exploration is the process of finding ore (commercially viable concentrations of minerals) to mine									
No. of technologies in mineral exploration and evaluation	***Total number of technologies available for mineral exploration and evaluation***	Number	N/S			Reports	Administrative data	Annually	Geological Survey Department
No. of technologies in Geo-hazards mapping	***Total number of technologies available for mapping geo-hazards***	Number	N/S			Reports	Administrative data	Annually	Geological Survey
Tonnage of mineral produced by usage	***Total quantity of minerals produced***		N/S			Reports	Administrative data	Annually	Dept. of Mines, Paladin

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of technologies used in mineral extraction and processing	***Total number of technologies available for mineral extraction and processing***	Number	N/S			Reports	Administrative data	Annually	Dept. of Mines
No. of technologies in geological, geochemical and geophysical mapping	***Total number of technologies available for geological, geochemical and geophysical mapping***	Number	N/S			Reports	Administrative data	Annually	Geological Survey
No. of technologies in environmental geology	***Total number of technologies available for environmental geology***	Number	N/S			Reports	Administrative data	Annually	Geological Survey
No. of technologies in laboratory analysis	***Total number of technologies available in laboratory analysis***	Number	N/S			Reports	Administrative data	Annually	Geological Survey
No. of technologies in mineral data management and information dissemination	***Total number of technologies available in mineral data management and information dissemination***	Number	N/S			Reports	Administrative data	Annually	Geological Survey
No. of technologies applied in occupational safety and health	***Total number of technologies available for occupational safety and health***	Number	N/S			Reports	Administrative data	Annually	Mines Department
No. of technologies used in Environment monitoring	***Total number of technologies available for environment monitoring***	Number	N/S			Reports	Administrative data	Annually	Mines Department
Cadastre system (data management)	***Total number of mineral deposit pointers in a country***	Number	N/S			Reports	Administrative data	Annually	Mines Department
Agro-processing									
No. of technologies in agro-processing by type	***Total number of technologies in agro-processing***	Number	N/S			Reports	Administrative data	Annually	Rab Processors, Nali, Proto Feeds, Charles Stewart, Central Feeds, SEBA Foods, MBS
Forestry									
No. of technologies developed in management of indigenous tree species	***Total number of technologies developed for managing indigenous trees species***	Number	N/S			Progress reports	Administrative data	Annually	FRIM
No. of technologies in wood preservation	***Total number of technologies available for wood preservation***	Number	N/S			Progress report	Administrative data	Annually	FRIM, WICO, RAIPLY

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of technologies in wood Storage	***Total number of technologies available for wood storage***	Number	N/S			Progress report	Administrative data	Annually	FRIM,WICO, RAIPLY
No. of technologies in wood Processing	***Total number of technologies available for wood processing***	Number	N/S			Progress report	Administrative data	Annually	FRIM,WICO, RAIPLY
No. of technologies in tree/ plant protection	***Total number of technologies available for tree or plant protection***	Number	N/S			Progress report	Administrative data	Annually	FRIM
No. of technologies being used in tree breeding and improvement	***Total number of technologies available in tree breeding and improvement***	Number	N/S			Progress report	Administrative data	Annually	FRIM
No. of technologies tree seed storage and processing	***Total number of technologies available for tree seed storage and processing***	Number	N/S			Progress report	Administrative data	Annually	FRIM/NPGRC
Tonnage of certified wood and non-wood products produced	***Total quantity of certified wood and non-wood products produced***	Tonnage	N/S			Progress report	Administrative data	Annually	FRIM, RAIPLY,WICO, FRIM
Number of organizations/groups/ individuals supplying certified wood and non wood products	***Headcount of organizations / groups / individuals permitted to supply certified wood & non wood products***	Number	N/S			Progress report	Administrative data	Annually	FRIM
Transport									
Length of unpaved roads	***Total length of all roads or pavements not improved to allow safe travel***	Kms	N/S			Reports	Administrative data	Annually	Roads Authority
Length of bitumen/tarmac roads	***Total length of all improved roads or pavements to allow safe travel***	Kms	N/S			Reports	Administrative data	Annually	Roads Authority
Per capita ownership by transport technology	***The number of transport technologies divided by total population***	Number	N/S			Reports	Administrative data	Annually	NSO
No. of Vessels	***Total headcount of vessels operating on the waters of Lake Malawi and other rivers***	Number	N/S			Reports	Administrative data	Annually	Marine Dept.
No. of Aircrafts	***Total headcount of aircrafts operating on Malawian airspace owned by residents and non-residents***	Number	N/S			Reports	Administrative data	Annually	Civil Aviation Dept.

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of Vehicles by type (Passenger and Goods)	***Total headcount of vehicles registered in Malawi***	Number	N/S			Reports	Administrative data	Annually	Road Traffic Directorate
Renewable Energy			N/S						
Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished).									
Share of energy in gross energy mix by type *{wind, biogas, Hydro Electric Power, bio-fuels, Biomass Energy, Solar, and Geothermal}*	***Total percentage share of an energy source in the total energy mix***	Percentage (%)	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA
Non Renewable Energy									
A non-renewable energy source is a natural resource which cannot be produced, grown, generated, or used on a scale which can sustain its consumption rate, once depleted there is no more available for future needs. For example, Fossil fuels such as coal, petroleum and natural gas can be classified as non renewable. Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms									
Volume of fossil fuels imported by usage	***Total amount of fossil fuels imported in Malawi (Petroleum + non petroleum e.g. natural gas)***	Cubic Litres	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA
Tonnage of coal produced by usage	***Total volume of coal produced in Malawi per annum***	Tonnage	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA
Tonnage of coal imported	***Total volume of coal imported into Malawi***	Tonnage	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA
Tonnage of coal exported	***Total volume of coal exported outside the country***	Tonnage	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA
Tonnage of uranium produced	***Total volume of uranium produced in the country***	Tonnage	N/S			Reports	Administrative data	Annually	Dept. of Energy /MERA/ Dept. of Mines
Bibliometrics									
Bibliometrics is a set of methods to quantitatively analyze scientific and technological literature									
No. of publications in national journals and gray literature by field	***Total number of papers published in refereed national journals and total number of gray literature available by field***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of publications in international journals	***Total number of papers published in refereed international journals***	Number	N/S			ASTII Reports	Administrative data	Annually	All R&D institutions
Number of active journals	***Total number of local journals publishing papers***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
Education & Training									
No. of science teachers in primary schools by gender and by field/type	***Total number of science teachers in all primary schools in Malawi***	Number	N/S			Reports	Administrative data	Annually	EMIS
No. of science teachers in secondary school by gender and by field/type	***Total number of science teachers in all secondary schools in Malawi***	Number	N/S			Reports	Administrative data	Annually	EMIS
No. of training institutions offering science and technology courses	***Total number of training institutions offering science and technology studies***	Number	N/S			Reports	Administrative data	Annually	EMIS /TEVETA
Proportion of science and technology subjects offered to the total number of subjects	***Ratio of science and technology subjects offered to the total number of subjects multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	EMIS
Proportion of science and technology teachers to the total number of teachers in secondary school by gender, field, nationality and division	***Ratio of science and technology teachers to the total number of teachers in secondary school multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	EMIS
Proportion of pupils taking science and technology subjects in secondary school disaggregated by gender	***Ratio of pupils taking science and technology subjects in secondary school to the total number of subjects multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	EMIS
No. of university graduates by field of study, gender, and nationality	***Aggregate number of university graduates***	Number	1,336[7]		1350	Reports	Administrative data	Annually	UNIMA,UNILIA, MZUNI

[7] *The figure represents science graduands in 2010 for all accredited Universities in Malawi excluding Catholic and Seventh Day Adventist University*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of lecturers in the universities by field of study, gender and nationality	***Aggregate number of lecturers in the University***	Number	598[8]		770	Reports	Administrative data	Annually	UNIMA,UNILIA, MZUNI, CUM, SDAU, EMIS
Pass Rate in science subjects by gender	***Ratio of passes in science subjects to total number of passes in all subjects***	Percentage (%)	N/S			Reports	Administrative data	Annually	UNIMA/ MANEB
Intellectual Property Rights									
No. of patents filed by field	***Total number of patents filed and granted in Malawi(both residents and non residents)***	Number	2149	?	1566	Reports	Administrative data	Annually	Registrar General
No. of Registered designs filed	***Total number of registered designs granted in Malawi***	Number	3	?	16	Reports	Administrative data	Annually	Registrar General
No. of Trade Marks filed	***Total number of trade marks granted in Malawi***	Number	2039	?	1199	Reports	Administrative data	Annually	Registrar General
No. of Patents held by Malawians	***Total number of patents granted and held by Malawians***	Number	?	??	?	Reports	Administrative data	Annually	Registrar General
Livestock and Dairy Production									
No. of chickens by breed	***Total number of chickens by breed and sold at a particular period***	Number	N/S			Reports/NACAL Report	Administrative Data Agricultural Production Estimates (APEs)	Annually	Dept. of Animal Health and Livestock Development
Litres of milk produced	***Total volume of milk produced and sold at a particular period***	Litres	N/S			Reports	Administrative data	Annually	Dept. of Animal Health and Livestock Development
Per capita meat consumption by type	***Total amount of meat consumed by an individual per annum***		N/S			eports	Administrative data	Annually	Dept. of Animal Health and Livestock Development
Research and Development Infrastructure and Services									
No. of laboratories and workshops	***Headcount of labs and workshop in all R&D institutions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions

[8] *For University of Malawi only. Data for other Universities not available*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No. of laboratories/ workshops in good working condition	***Headcount of labs and workshop in all R&D institutions in good working conditions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
No. of critical/major laboratory/workshop equipment by type	***Headcount of lab and workshop equipment in all R&D institutions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
No. of accredited laboratories by type	***Headcount of accredited labs in all R&D institutions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
No. of libraries by type	***Headcount of libraries in all R&D institutions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
No. of data and specimen repositories by type	***Headcount of data and specimen repositories in all R&D institutions***	Number	N/S			Reports	Administrative data	Annually	All R&D institutions
Genetic resources									
Percentage of forest illegally cleared (Preservation Project data)	***Total of forests area illegally cleared for agricultural or non agricultural use***	Percent	N/S			Reports	Administrative data	Annually	Museums of Malawi/ Environmental Affairs Department/Forestry Dept.
No. of rare, endemic, economic, and medicinal plants propagated	***Headcount of rare, endemic, medicinal plants propagated***	Number	824		827	Reports	Administrative data	Annually	National Herbarium & Botanic Gardens of Malawi/ FRIM
No. of trees replanted (afforestation)	***Total number of trees replanted***	Number	N/S			Reports	Administrative data	Annually	Forestry Dept.
No. of trees harvested	***Total number of trees cut down for timber production and other economic use***	Number	N/S			Reports	Administrative data	Annually	Forestry Dept.
No. of museums, herbarium and genebank specimen maintained	***Total number of museums, herbarium and genebank specimen conserved***	Number	N/S			Reports	Administrative data	Annually	Dept. of Fisheries/ Museums of Malawi DAHLD /NHBG/ Genebank
No. of new plant, fish and animal including invasive species introduced (No. of biotic introductions)	***Total number of new plant, fish and animal species introduced in their habitats***	Number	66	?	66	Reports	Administrative data	Annually	Dept. of Fisheries/ DAHLD /NHBG

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
Endangered species on Red List	***Total number of endangered species on a Red List***	Number	248	?	250	Reports	Administrative data	Annually	Dept. of Fisheries / DAHLD/ NHBG/Dept of Parks and Wildlife
Construction									
No. of construction technologies by type and origin	***Total number of construction technologies***	Number	N/S			Reports	Administrative data	Annually	NCIC, Board of Engineers,
No. of people trained	***Total number of people trained in use of construction technologies***	Number	N/S			Reports	Administrative data	Annually	NCIC, Board of Engineers, Academic institutions
No. of registered construction firms	***Headcount of registered construction firms***	Number	N/S			Reports	Administrative data	Annually	NCIC
ICT									
No. of computers per 1000 population	***Total number of computers per 1,000 people***	Number	na		na	Reports	Administrative data	Annually	E-Government
No. of fixed phone subscribers (fixed line density)	***Headcount of fixed phone subscribers***	Number	0.85%		1.19%	Reports	Administrative data	Annually	MACRA
No. of mobile phone subscribers (mobile density)	***Headcount of mobile phone subscribers***	Number	16.9%		17.13%	Reports	Administrative data	Annually	MACRA
No. of Internet Service Providers	***Headcount of Internet Service Providers***	Number	10		12	Reports	Administrative data	Annually	MACRA
Type of internet connectivity[9]	***Headcount of types of Internet services***	Number	Na		Na	Reports	Administrative data	Annually	MACRA
Broadband			86,957		473,684				
ADSL			8,005		9,800				
No. of Internet users	***Total number of users of Internet services***	Number	150,000		300,000	Reports	Administrative data	Annually	MACRA
No. of Internet subscribers	***Total number of subscribers of Internet services***	Number	2.26		3.33	Reports	Administrative data	Annually	MACRA
Mobile phone coverage	***Total area under mobile phone coverage***	Sq. Km	Na		Na	Reports	Administrative data	Annually	MACRA

[9] *Wifi, Dial-up, Mobile data cards not available*

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
No of households with a phone	***Headcount of households with telephones***	Sq. Km	Na		Na	Reports	Administrative data	Annually	MACRA
Radio station coverage	***Total area under radio and TV station coverage***	Sq. Km	75%		75%	Reports	Administrative data	Annually	MACRA
TV station coverage		Sq. Km	40%		40%		Administrative data		
No. of telecentres and users by type	***Headcount of telecentres constructed and in use***	Number	18		33	Reports	Administrative data	Annually	MACRA
No. of graduating students in ICT at Tertiary Level	***Headcount of students having pursued ICT as a course at higher level i.e. above Secondary School***	Number	Na		Na	Reports	Administrative data	Annually	E-Government
No. of people who are ICT literate	***Headcount of people who are able to apply basic principles in ICT e.g. operating a computer/ writing a letter using a computer package***	Number	Na		Na	Reports	Administrative data	Annually	E-Government
No. of schools teaching computer studies at pre-school level, primary, secondary and Tertiary	***Headcount of all schools that are teaching ICT at various levels***	Number	Na		Na	Reports	Administrative data	Annually	E-Government
Aquaculture									
Fish seed production (fingerlings production)	***Total volume of fish seed produced per annum***	Number	N/S			Reports	Administrative data	Annually	Fisheries Dept
Fish breeding	***Total number of institutions involved in fish breeding***	Number	N/S			Reports	Administrative data	Annually	Fisheries Dept
Fish feed development	***Total number of fish feed produced***	Tonnes	N/S			Reports	Administrative data	Annually	Fisheries Dept
Fish pond number and area	***Headcount of fish ponds constructed***	Number & Sq metres	N/S			Reports	Administrative data	Annually	Fisheries Dept
Annual fish production from cage culture	***Total fish catch from cages per annum***	Tonnes	N/S			Reports	Administrative data	Annually	Fisheries Dept
Annual Fish production from fishponds	***Total fish catch from fishponds per annum***	Tonnes	N/S			Reports	Administrative data	Annually	Fisheries Dept
Percentage increase in household income from aquaculture	***Change in household income from the sale of fish***	Percentage (%)	N/S			Reports	Administrative data	Annually	Fisheries Dept

Performance Indicator	*Proposed Definition*	Measuring Unit	Baseline 2010	Target 2011	Actual 2011	Data Sources / MoV	Approach/ Methodology of data Collection	Schedule/ Frequency	Person/ Entity Responsible
Percentage of households incorporating fish in their diets	***Total number of households incorporating fish as food divided by total number of households in the sample***	Percentage (%)	N/S			Reports	Administrative data	Annually	Fisheries Dept
Percentage of fish farming households with energy food reserves in critical months of December to March	***Total fish farming households with food reserves divided by total fish farming households multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	Fisheries Dept
Fish production per unit area of pond	***Total fish harvested divided by total pond area that produced the fish***	Tonnes/ hectare	N/S			Reports	Administrative data	Annually	Fisheries Dept
Fish production per unit area of cage	***Total fish produced from each cage***	Tonnes/ cubic metre	N/S			Reports	Administrative data	Annually	Fisheries Dept
No. of households involved in aquaculture (both integrated and commercial aquaculture)	***Headcount of households doing fish farming***	Number	N/S			Reports	Administrative data	Annually	Fisheries Dept
Capture Fisheries									
Estimated annual fish catches	***Total amount of fish produced per annum***	Tonnage	N/S			Reports	Administrative data	Annually	Fisheries Dept
Percentage increase in household income from capture fisheries based enterprises	***Total number of households with increased income from capture fisheries divided by total households engaged in capture fisheries multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	Fisheries Dept
Percentage of households incorporating fish from capture fisheries in their diets	***Total number of households eating fish from capture fisheries divided by total number engaged in capture fisheries multiplied by 100***	Percentage (%)	N/S			Reports	Administrative data	Annually	Fisheries Dept
No. of Beach Village Committees with Fisheries Management Plans	***Headcount of Beach Village Committees with plans on fisheries management***	Number	N/S			Reports	Administrative data	Annually	Fisheries Dept

3.0 Conclusion

The document provides the Science, Technology and Innovation Monitoring and Evaluation framework for the Science and Technology Sector and looks at the purpose and justification for instituting monitoring and evaluation mechanisms. Monitoring looks at goals, purpose and targets of projects and programmes and the relevant tools that make it possible to identify and measure the results. Evaluation is an episodic event usually conducted when it is essential to assess impacts or outcomes of a particular intervention. It is essential to note that M&E is important at all levels. At institutional level monitoring is necessary to check whether implementation is being done according to plan. At macro level, there is need to identify whether expected impacts in science and technology have been achieved. The impact is "intended or unintended" in the lives of the poor people and sustainability enhancing change. Oftentimes, impacts or outcomes refer to the highest goal level achievements of a project such as "improved food security" and "increased household income".

In this framework, it is essential to establish M&E system in Science, Technology and Innovation sector in order to ensure to track scientific, technological and innovational developments. As the M&E system becomes established, there will be need to update information at both institutional level and macro level through use of commonly approved indicators both at local and international level.