



**GOVERNMENT OF
THE REPUBLIC OF THE UNION OF
MYANMAR**



**INTERNATIONAL
ATOMIC ENERGY AGENCY**

**COUNTRY
PROGRAMME FRAMEWORK
2016 – 2021**

**On behalf of the
Government of the Republic of the Union of
Myanmar**

**On behalf of the
International Atomic Energy Agency**

Signature

Signature

Ambassador/ Permanent Representative

Permanent Mission of the Republic of the
Union of Myanmar to the United Nations Office
and Other International Organizations

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There are * symbol in the main text to represent the changes in institution and updated information since there are restructuring the government ministries which effected on 25 May 2016.

*=The Ministry of Science and Technology was reorganized as the Ministry of Education

*=The Ministry of Environmental Conservation and Forestry was reorganized as the Ministry of Natural Resources and Environmental Conservation.

*=The Ministry of Planning and National Development was reorganized as the Ministry of Planning and Finance.

*=The Ministry of Livestock, Fisheries and Rural Development was reorganized as the Ministry of Agriculture, Livestock Breeding and Irrigation.

*=The Ministry of Health was recognized as the Ministry of Health and Sports.

Acronyms

ADB	Asian Development Bank
ADF	Asian Development Fund
AEC	Atomic Energy Council
AIDS	Acquired Immune Deficiency Syndrome
ASEAN	Association of South East Asian Nations
ASEANATOM	ASEAN Network of Regulatory Bodies on Atomic Energy
BB	Bacterial Blight
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BMI	Body Mass Index
CPF	Country Programme Framework
CRO	Central Research Organization
DAE	Department of Atomic Energy, MOST
DAR	Department of Agricultural Research
DBM	Diamondback Moth
DFID	Development Finance Institutions Dept.
DMR	Department of Medical Research
DPWC	Development Partners Working Committee
EDXRF	Energy Dispersive X-ray Fluorescence
ELISA	Enzyme Linked Immuno Sorbent Assay
EU	European Union
FAO	Food and Agriculture Organization
FERD	Foreign Economic Relations Department
FMD	Foot and Mouth Disease
FOA	Field of Activity
FRN	Fallout Radio Nuclides
GDP	Gross Domestic Product
GMS	Greater Mekong Sub-region
HIV	Human Immunodeficiency Virus
HYV	High Yielding Varieties
IAEA	International Atomic Energy Agency
INIS	International Nuclear Information System
ISTRA	International Society of Tracers and Radiation Applications
JAIST	Japan Advanced Institute of Science and Technology
JICA	Japan International Corporation Agency
LBVD	Livestock Breeding and Veterinary Department
MCA	Multi Channel Analyzer
MDG	Millennium Development Goals
MOECAF	Ministry of Environmental Conservation and Forestry
MOST	Ministry of Science and Technology of Myanmar
MOU	Memorandum of Understanding
MSTRD	Myanmar Scientific and Technological Research Department
MYA	Country Identity symbol for TC Projects for Myanmar
NCDP	National Comprehensive Development Plan
NCEA	National Commission for Environmental Affairs
NDE	Non Destructive Evaluation
NDT	Non Destructive Testing
NPT	Non-Proliferation Treaty
NUE	Nitrogen Use Efficiency
NWP	National Water Policy

OPCW	Organization for the Prohibition of Chemical Weapons
PACT	Programme of Action on Cancer Therapy
PCR	Polymerase Chain Reaction
PET	Positron Emission Tomography
PRC	Professional Research and Consultancy
QA	Quality Assurance
QC	Quality Control
RCA	Regional Cooperation Agreement
RIA	Radio Immunoassay
SCA	Single Channel Analyzer
SDG	Sustainable Development Goals
SIT	Sterile Insect Technique
SPECT	Single Photon Emission Computed Tomography
SSDL	Secondary Standard Dosimetry Laboratory
SUN	Scaling up Nutrition
SWG	Sector Working Groups
TB	Tuberculosis
TC	Technical Cooperation
TSA	Thematic Safety Area
UBAEC	Union of Burma Atomic Energy Centre
UBARI	Union of Burma Applied Research Institute
UHC	Universal Health Coverage
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Fund
UNSF	United Nations Security Force
USAID	United States Agency for International Development
USD	United States Dollar
UVS	University of Veterinary Science
WFP	World Food Program
WHO	World Health Organization
Xoo	Xanthomonas oryzae pv oryzae
YTU	Yangon Technological University

EXECUTIVE SUMMARY

This Myanmar Country Programme Framework (CPF) is the frame of reference for the short-term and medium-term plan for technical cooperation (TC) between the Government of the Republic of the Union of Myanmar and the International Atomic Energy Agency (IAEA) for the period of 2016–2021.

This CPF was developed through in-depth consultations between the IAEA and the competent authorities of Myanmar, with the underlying basis of how nuclear science and technology can contribute towards the national development objectives of the Government of the Republic of the Union of Myanmar. CPF consultations involved various national stakeholders in Academia, Health, Agriculture, Water and Environmental Protection.

The CPF incorporates legislative and institutional frameworks, regional, multilateral and bilateral partnerships, and relevant international legal instruments. This comprehensive incorporation will enable transparency, efficiency and sustainability of government cooperation with the IAEA in supporting sustainable development for Myanmar nationally and furthermore, for Southeast Asia regionally. The Government has been and continues to be committed to having a strong TC programme with the IAEA, which can maximize the benefits of nuclear techniques, by means of optimizing its participation in all IAEA activities relevant to the needs and interests of the country. The Government is also committed to ensuring adequate local support in terms of the financial, technical and human resources required for the smooth implementation of TC project activities that derive from this CPF.

The TC programme covered in this CPF will broadly concentrate on Food and Agriculture, Human Health, Industry, Environmental Protection, Water Resource Management, Sustainable Energy Development and Radiation Safety and Security. In line with the larger scope of Myanmar's National Comprehensive Development Plan (2011-2031) and more specifically within Myanmar's five year action plan for 2011-2015 period known as the Poverty Reduction and Rural Development Plan, the CPF aims at halving the poverty rate by emphasizing the increase in agricultural production, livestock and fisheries output, and industrialization, strengthening and improving the rural-based social economy – including health, education and social welfare – and enhanced energy provision, as well as strengthened environmental protection and deforestation control in rural areas.

This CPF will promote, to the fullest possible extent, the utilization of radiation-based facilities and related expertise that have been built in Myanmar to support the socio-economic development of the country, as well as to integrate nuclear techniques into its national development plan. Such integration will enhance the relevance of nuclear sciences and applications, and thereby promote advocacy and potentially build partnerships with various stakeholders, by increasing the contribution of nuclear techniques towards achieving national development goals including, but not limited to, the Sustainable Development Goals (SDGs). This CPF will also assist Myanmar in establishing an Atomic Energy Commission, or an equivalent entity, as well as national nuclear institutions promoting socio-economic development in the above-mentioned areas. Future programmes under the present CPF are segmented into three categories, namely, (a) the Near-Term programme, (b) the Medium-Term programme, and (c) General Support Activities.

Near-Term programme

The Near-Term programme for IAEA technical cooperation in Myanmar is mainly focused on capacity-building efforts in the thematic areas of Human Health, Food and Agriculture, and Radiation Technologies. In Human Health, the objective is to strengthen human resource capacity and services in nuclear medicine and radiotherapy for improving the diagnosis and treatment of cancer patients. Furthermore, a Secondary Standards Dosimetry Laboratory is being set up to establish dosimetry services in Myanmar. In Food and Agriculture the major focus is to develop capabilities in utilizing nuclear and isotopic techniques in agriculture, and to support measures aimed at increasing the quality of agricultural production. In Livestock,

the objective is to develop policy and a regulatory environment for more inclusive livestock sector development with focused support on animal reproduction and breeding, nutrition and health feeding strategies linked specifically to capacity development of relevant stakeholders in the public and private sector. This will lay the foundation for long term future development of appropriate technical capacity and regulatory environment in support of balanced and equitable livestock sector development. In the area of Radiation Technologies, Myanmar is prioritizing the establishment of an Electron Beam Facility to contribute towards improving healthcare systems by providing radiation sterilized medical products and the safety and quality of food and agricultural products as well as to enhance the quality of the industrial products. Myanmar has also prioritized improving its measurement techniques involving Non-Destructive Testing, radiotracer and sealed sources applications. In water resource management, particular emphasis is on establishment of an isotope hydrology laboratory to address water-related problems for sustainable management of groundwater resources.

The priorities that are not addressed in the anticipated national technical cooperation programmes, will be covered through capacity-building activities under regional projects. One priority area that does not fall under the current national programme, is the area of environmental protection and monitoring, with a focus on studies of seawater, sediment, aqua products and other biota to identify pollutants, estimate radioactivity of main effluent in the coastal and in the marine environment, as well as the establishment of marine baseline data needed for the sustainability of the marine eco-system. In addition, the topical area of measurement of particulate matter in air using nuclear techniques will be addressed through regional projects as well.

Medium-Term programme

The medium-term programme under this CPF will place greater emphasis on human resources capacity building, skills retention, quality management, as well as building economic competitiveness. Enhanced IAEA technical cooperation is expected to make a significant contribution to national planned programmes aimed at maximizing crop productivity through enhancing food security through improvement of crop and food quality, as well as water utilization initiatives. Nuclear science and technology-related activities will promote available nuclear services and products to the public and potential end-users as well as focus on disseminating the results obtained through the different projects to gain stakeholders recognition and public acceptance. Along the same line, the medium-term programme will continue on and proceed with technical cooperation from the foundations set in the near-term programme as well as previously implemented TC programmes. As Myanmar continues to develop capacity, the scope of technical cooperation will become broader and with possible expansion to additional areas of nuclear applications.

In human health, the focus will remain on enhancing the national nuclear medicine and radiotherapy infrastructure, training of professional and assistance to improve QA/QC and safety of the patients and the staff at the workplace to improve precision of cancer diagnosis and an increased quality of cancer therapy. In food and agriculture, Rice bacterial blight (BB) is one of the most destructive diseases of rice resulting in yield losses. Moreover, to mitigate the effects of the climate change, flooding and salt stress on rice yields, there is a need for improvement of rice varieties using radiation induced mutation breeding techniques. For livestock, the optimal application of forage to improve animal nutrition, the inclusive use of local and foreign animal breeds to select for favourable traits in animals (more and of better quality milk and meat) and the early and rapid diagnoses and control of transboundary animal and zoonotic diseases are critical. The use of the sterile insect technique (SIT) for insect pests should be explored. The existing Gamma Irradiation Facility is more than three half-lives old, resulting in a low dose unsuitable for some research and development work. Therefore upgrading of current gamma irradiation facility is required. Myanmar would like to further promote the use of radiation application technologies in medicine, food and agriculture, industry, environmental remediation and other research areas. For Water Management, the IAEA has already provided trainings to Myanmar in this field and additional support is still needed in the near and medium terms, in view of the extent of issues affecting the water sector nationwide. In particular, facilities for isotope

hydrology techniques will be established and applied for water quality survey and water resources management in the country. Regarding Nuclear Science and Technology education, nuclear science curriculum is old and most of the related laboratory equipment at the teaching institutions is out-of-order. It is necessary to refurbish the laboratory facilities and also to develop the nuclear science curriculum on modern lines. Such respect, it is crucially important to support the laboratory equipment and human resources, and also to provide specific training in line with advanced technologies especially to the universities and other concerned institutions.

General Support Activities

The focus of the general support activities is to strengthen the national capability in the area of nuclear science and technology with particular emphasis on the activities relating to the priorities identified in this CPF. The assistance of the Agency will remain, as necessary, within the limits of the TC resources available for the implementation of activities in which nuclear technologies are involved. In addition to any complementary support that can be meaningfully provided under the regional and/or interregional mechanisms to the priority areas identified under the Near Term Programme and the Medium Term Programme, the general support activities will include assistance in increasing local capacities in the field of nuclear instrumentation and maintenance of equipment, particularly medical equipment, to support the sustainable development of nuclear science and technology in Myanmar. Training and technical development in nuclear instrumentation will continue within the scope of the CPF, especially with regard to maintenance and repair. This will help reduce maintenance and repair costs and, in the long run, promote self-reliance and sustainability.

Cross-cutting all the priority areas identified in the CPF are the crucial aspects of capacity building, human resources development, nuclear knowledge management, quality management, and information & communication technologies (ICT). All projects will take these aspects into account as essential elements of self-reliance and sustainability of nuclear applications and technologies within Myanmar. Human resources development will remain the highest priority in all domains of nuclear science applications. It is important to note that the IAEA provides technical cooperation, not only through national programmes, but through regional programmes, in various areas of human resource development with respect to nuclear technology. Training of young professionals in nuclear sciences and applications will continue to be a priority for the period covered by the CPF, although the specific training needs might not always coincide with the objectives of dedicated and active TC national projects. As such, the possibility for training young scientists and researchers should continue to be an available option since human capacity development is instrumental to nuclear knowledge formation, preservation, and advancement.

I. INTRODUCTION

Myanmar became a Member State of the International Atomic Energy Agency (IAEA) in 1957 and has been participating in the IAEA Technical Cooperation (TC) programme since then. Atomic Energy Law was enacted in 1998, covering both promotional and regulatory aspects of atomic energy in the country. Following the Government Legislation, the independent Department of Atomic Energy (DAE) has reported directly to the Minister of Science and Technology (MOST)*. The DAE acts as the focal point of interaction with the IAEA and is charged with the task to develop and promote peaceful applications of nuclear technology, under appropriate radiation protection and nuclear safety regime, for the benefit and welfare of the peoples of Myanmar.

Myanmar has been taking interest in utilizing nuclear energy for peaceful purposes since long, yet there are no major nuclear facilities such as research reactors, semi-commercial irradiators, or even a particle accelerator for nuclear R&D organizations. The modest nuclear facilities established in the country include laboratories for radiation monitoring, radiation dosimetry, and repair and maintenance of nuclear instruments. A 12,000 Curie cobalt-60 gamma irradiation facility was established in 2000 for sterilization of tissues. The radioisotopes are used in health, industry, agriculture, livestock breeding, veterinary applications and research and development activities.

The legislative and statutory framework for radiation safety is provided primarily through the Atomic Energy Law (1998) and assigned regulatory duties with respect to the use of nuclear and radioactive materials to the DAE of the Ministry of Science and Technology (MOST)*. All radiation safety and protection matters such as occupational protection, public protection, medical exposure, radioactive waste, and transport of radioactive materials are dealt with by the DAE. In 2005, a TC project was initiated on strengthening radiation safety infrastructure, which contributed to the country's capabilities in enhancing knowledge on radiation and waste safety infrastructure, including the safe uses of radiation sources in Myanmar. The Government has increased the participation in regional and international events and cooperation with the regional and international organizations in accordance with the national development goals. Myanmar has been actively participating in the First Committee of the General Assembly of the UN that is the main committee for disarmament of the United Nations. In 1992, Myanmar signed the Non-Proliferation Treaty (NPT) and in 1995, the Safeguards Agreement with IAEA. In 1995, Myanmar together with other ASEAN member countries, also signed the agreement on establishing nuclear-free zone in Southeast Asia under the leadership of ASEAN. The agreement was ratified in 1996. Myanmar is a party to the Convention on Early Notification of a Nuclear Accident.

Country Profile

Geography

Myanmar is the largest country in mainland South-East Asia with a total land area of 676,578 square kilometers. The Republic of the Union of Myanmar and also known as Burma, is a sovereign state in South East Asia bordered by Bangladesh, India, China, Laos and Thailand. One-third of Myanmar's total perimeter of 1,930 km forms an uninterrupted coastline along the Bay of Bengal and the Andaman Sea. Its capital city is Naypyidaw and its largest city is Yangon (Rangoon). The population of the country in 2014 was estimated at 53.7 million with 48.6 per cent males and 51.4 per cent females. A land of hills and valleys rimmed in the north, east and west by mountain ranges forming a giant horseshoe, enclosed within the mountain barriers are the flat lands of Ayeyarwaddy, Chindwin and Sittaung River valleys where most of the country's agricultural land and population are concentrated. Myanmar has one of the lowest population densities in the region, with fertile lands, significant untapped agricultural potential, and a rich endowment of natural resources.

A largely rural, densely-forested country, Myanmar is the world's largest exporter of teak and a principal source of jade, pearls, rubies and sapphires. It has highly fertile soil and important offshore oil and gas deposits. The country resources include 7.8 trillion cubic feet of proven natural gas reserves, 3.2 billion

barrels of oil reserves, 19,000 cubic meters per capita per year of renewable water resources, and hydropower potential of about 100,000 megawatts.

National Development Strategy and Priorities

Myanmar's economy is predominantly based on agriculture. About 70% of the economically active population is engaged in agriculture, which accounts for 40% of GDP. Rice is by far the most important crop. Agriculture Products include rice, pulses, beans, sesame, groundnut, sugarcane, hardwood, fish and fish products. The Industrial sector mainly comprises agricultural processing, knit and woven apparel, wood and wood products, copper, tin, tungsten, iron, construction materials, pharmaceuticals, fertilizer and cement. Major exports include natural/petroleum gas, wood products, and legumes, while the major imports include vehicles, iron and steel, and other metal products. Once the top exporter of rice in the world, Myanmar's rice exports now account for a negligible share of the world market. Myanmar's exports of natural resources such as gas and gems are becoming increasingly significant.

During 2013/14, the country's GDP was estimated at \$56.8 billion. The per capita GDP is around \$1,105, one of the lowest in East Asia and the Pacific, with 26% of the population living below the poverty line. Most social indicators are very low, with one in four people considered poor. The average life expectancy is 64.8 years, while infant mortality of 41.1 per 1000 live births. The consumption of electricity— 20 times less than the global average— is one of the lowest in the world. Access to drinking water is also limited in many areas. Myanmar has maintained GDP growth at around 5 percent annually in recent years and has seen improving trends in poverty-related indicators. The country has further growth potential, with its rich variety of natural resources, a rich and diversified agricultural base and open access to sea. The eight development priorities identified in the Government's Rural Development and Poverty Alleviation Strategy include agricultural production, livestock and fishery, rural productivity and cottage industries, micro saving and credit enterprises, rural cooperative, rural socio-economy, rural energy, and environmental conservation.

Myanmar is prone to natural disasters, in particular floods, vulnerable to the effects of climate change, which affects socio-economic progress. The coastal regions are exposed to cyclones, tropical storms and tsunamis, while the hilly regions are exposed to landslides. Rainfall-induced flooding is a recurring phenomenon across the country. The risks from climate change reinforce the need for investment in irrigation and drainage infrastructure. They also suggest that efforts to disseminate crop varieties tolerant to abiotic stress, increased temperatures, and shorter growing seasons are essential to maintain and expand productive potential.

The existing National Health Programme (NHP) of Myanmar includes hypertension and diabetes among the six most prevalent diseases. Obesity is an established risk factor for cardiovascular diseases and hypertension, type 2 diabetes, complications of these diseases and other chronic health problems. Hypertension and diabetes are the main health problems in Myanmar with increasing morbidity and mortality rates.

Non-communicable diseases, including coronary artery diseases and cancer, are common health problems in Myanmar, where the prevalence of relevant risk factors is very high due to lifestyle changes. Furthermore, the incidence of cancers is high; the age standardized rates per 100 000 per year (ASR) for cancers are 149.4 for males and 134.6 for females

(see Table I on next page).

Table I: Cancer Incidence and Mortality Data (GLOBOCAN 2012)

Cancer incidence					Number of new cancer cases per year:63600				
Males					Females				
Cancer site	Number of cases	% of cancers	Crude rate	ASR (W)*	Cancer site	Number of cases	% of cancers	Crude rate	ASR (W)*
Lung	4810	15.6	20.0	25.0	Breast	5648	17.2	22.9	22.1
Liver	3421	11.1	14.2	16.1	Cervix uteri	5286	16.1	21.4	20.6
Stomach	3109	10.1	13.0	15.3	Lung	3694	11.1	14.9	16.2
Oesophagus	2441	7.9	10.2	11.4	Stomach	1804	5.5	7.3	7.7
Colorectum	2083	6.8	8.7	10.3	Colorectum	1779	5.4	7.2	7.4
Other Pharynx	1943	6.3	8.1	9.1	Liver	1491	4.5	6.0	6.4
Total**	30770	100	128.2	149.4	Total**	32863	100	133.0	134.6

*ASR (W): Age Standardized Rate using the World population

** excluding non-melanoma skin cancer

*** *Incidence*: no data, the rates are those of neighbouring countries or registries in the same area

Mortality: no data, estimated from national incidence estimates using modeled survival

Prevalence: was estimated from incidence estimates and regional average of observed survival by cancer and age group

According to the hospital-based data, there are four main malignancies in Myanmar, namely cervical, breast, head and neck and gastrointestinal tract cancer. Annually, approximately more than 7500 new patients are registered in the four radiotherapy centers (Yangon, Mandalay, Nay Pyi Taw and Taungyi) and radiotherapy is offered to cancer patients for curative and palliative treatment free of charge. Chemotherapy treatment is very expensive and the majority of patients rely on radiation treatment only.

II. NATIONAL DEVELOPMENT PRIORITIES AND ACTIVITIES RELEVANT TO THE AGENCY'S TECHNICAL COOPERATION PROGRAMME

The abundance of natural and agricultural resources and a highly favorable geography underpin Myanmar's strong growth potential. The country is blessed with large offshore deposits of natural gas, plenty of arable land, teak forests, metallic minerals, jade, rubies, and other precious stones. It has proven reserves of 7.8 trillion cubic feet of natural gas and oil reserves of 3.2 billion barrels. Renewable water resources, at about 19,000 cubic meters per capita per year, are among the highest in Southeast Asia, while the current utilization rate is only 5%. The availability of inland water sources and 2,400 kilometers of coastline provide great potential for the production and export of fish and shrimp, industries that have grown rapidly recently. Forests cover about 31.7 million hectares, close to 50% of the total land area. Arable land is plentiful, with only about 16.5% of the total land area under cultivation.

For achieving the long-term goals of the 20-year National Comprehensive Development Plan (NCDP) 2011–2031, this consists of four 5-year plans. The NCDP objectives are as follows:

Productive Capacity

- (i) To accelerate growth, achieve equitable and balanced development and to reduce socio-economic development gap between rural and urban areas.
- (ii) To deliver comprehensive energy access for socio-economic development of people and fuel the engines of commerce and industry.

Agriculture, Food Security and Rural Development

- (i) Prior to fulfilling the needs of local consumptions and export of more surplus of agriculture products for the increase of the exchange earnings.
- (ii) Assist to rural development through agriculture development.

Trade

- (i) Export policy; to penetrate into global market by using existing natural and human resources.
- (ii) Import policy; priority import the capital goods, construction materials, other essential goods, hygienic materials for people health, supporting products for export promotion and support the import substitute products.

Commodities

- (i) Export commodities; animals, marine, mining, forestry and finished industry products.
- (ii) Import commodities; raw materials and commodities.

Human And Social Development

- (i) MDG and covered the national development plans and achievements of MDG's reflect many priority areas.

Further to the NCDP, there is the Framework for Economic and Social Reforms (FESR) which was developed to set the policy priorities of the government in 2012–2015. The FESR identified four policy priorities:

- (i) Sustained industrial development while maintaining the momentum of agricultural reforms and attaining poverty alleviation and rural development;
- (ii) Equitable sharing of resources, both budgetary and foreign aid, among regions and states while promoting foreign and local investment for regional development;
- (iii) People-centered development through community-driven and participatory approaches to improvements in education, health, and living standards;
- (iv) Reliable and timely gathering of statistics and other information to better inform public policy decisions.

The first five-year plan is already underway and being undertaken as a public-centered plan, with a focus on public works projects. The second five-year plan 2016-2020 develops Myanmar's small and medium enterprise industries, the third five-year plan aims to improve larger businesses and improve the special economic zones and the fourth envisages building the country as an industrialized nation.

Various ministries are taking steps to enhance and strengthen diversification among crops, products and exports. The process for transitioning from traditional to modern farming techniques, and irrigation and modernization will play a vital role in the development process of Myanmar.

II.1 Food and Agriculture

Agriculture remains the backbone of the economy, with nearly 70% of the population living in rural areas, with the sector accounting for about 30% of GDP, more than 50% of employment, and 20% of exports. By supplying affordable food, generating farm incomes, and providing employment, the sector can play an essential role in economic progress and poverty reduction. The government recognizes the importance of agriculture to economic development, as reflected in recent reform initiatives.

Myanmar's abundant land, water and labor resources, and proximity to major emerging food markets offer very considerable competitive advantages. Cultivated land, covering 12.8 million hectares, has the potential to be increased by nearly 50%. The country's diverse topography and ecosystems allow farmers to produce a range of cereals, pulses, horticultural products, and fruits, as well as livestock and fishery products.

Myanmar is making efforts for overall domestic food self-sufficiency, promoting external trade and also providing raw materials to meet the domestic agro-based industries. As for the food security programme, Myanmar is giving priority to expanding the production in agriculture, livestock production and fisheries for self-sufficiency and for export of the surplus to other countries.

II.2 Livestock Production and Fisheries

There is an increasing recognition in Myanmar of the role of livestock in sustaining and supporting poor people's livelihoods and nutritional status. Throughout Myanmar, farm households raise and depend on a range of farm animals including ruminants, chickens and pigs for income support, supplementary nutrition, draft power and risk mitigation. Women play an important role in this sector and a growing demand for livestock products offers attractive opportunity for strengthening household level food security, nutrition and rural livelihoods. But, the sector's ability to capitalize on these opportunities is constrained by poor productivity of animals at farm level. Developing the pastures of appropriate forages having good nutritive values to improve animal nutrition, the inclusive use of local and foreign animal breeds to select for favourable traits in animals (more and of better quality milk and meat) and the early and rapid diagnoses and control of transboundary animal and zoonotic diseases, are critical factors to raise the income of substance farmers and to promote export in animal and animal products. An integrated approach to identify alternative feed resources (whilst protecting the environment), synchronize reproduction and breeding actions to optimize birthing of livestock with selected genotypes and phenotypes, and the timely diagnoses of animal and zoonotic diseases such as Foot-and-Mouth disease, Avian Flu. The short, medium and long term livestock improvement strategy is important to ensure improved livelihoods and to reduce poverty.

Myanmar has about 2,400 kilometer long coast. Fishery resources in Myanmar's coastal areas are typical of Southeast Asia. There are large quantities of fish and shrimp in the exclusive economic zone (EEZ) which have been important export items. The unpolluted sea along the Rakhine and Tanintharyi coasts is ideal for pearl culture. The fishery sector is of major importance to Myanmar since most of the protein in the diet of the population comes from fish. It is also the fifth largest foreign currency earner for the country. Coast, island and marine ecosystem in Myanmar are all interdependent and related such as fishery resource, aquaculture resources, marine resources and tourism resources. Sustainable management of these ecosystems is vital for national development. Moreover: In East Bengal where exploitation of fishery resources is

drastically increasing, attention must be paid to regulated contaminants as well as to biotoxins associated to harmful algal blooms (HAB) to assure seafood safety.

II.3 Human Health and Nutrition

The Government of Myanmar is committed to improving access and quality of health as part of its reform agenda aimed at raising the overall level of social and economic development in the country. Myanmar aspires to achieve Universal Health Coverage (UHC) as part of its Vision 2030, which is a long term (30 years) plan, for a healthier and more productive population.

The National Health Committee has formulated long term and also short term health plans for uplifting the health status of the entire nation. The National Health Plan (2007-2011) aimed at reducing the maternal, newborn, infant and child morbidity and mortality. Myanmar Vision 2030 has been drawn up with one of its objectives to reducing the under-5 and infant mortality rates. The MDG-5, which was to reduce maternal mortality by three-quarters by 2015, signifies the country's commitment to achieve the time-bound improvement of the global targets. Under the new SDG framework, this MDG will be superseded by SDG3 'Ensure healthy lives and promote well-being for all at all ages', with targets in child and maternal health. Positive tendencies have been developed in combating HIV/AIDS, TB and malaria (also the subject of a specific target under the new SDG3). The prevention and control activities have been undertaken under the National AIDS Program, National Malaria Control Program, nationwide Tuberculosis (TB) prevalence survey activities and collaborative TB/HIV prevention and control activities. One unique and important feature of Myanmar health system is the existence of traditional medicine along with allopathic medicine.

As Myanmar moves on the path of socioeconomic development and changing lifestyle, there has been a shift in epidemiological transition towards non-communicable diseases. Myanmar is now facing double burden of diseases - Communicable Diseases & Non-Communicable Diseases. In the National Health Plan (2011-2016), priorities and actions have been developed with the aim to prevent, control and reduce disease, disability and premature deaths from chronic non-communicable diseases and conditions. The program of prevention and control of NCDs in the country for 2013-2020 is based on WHO recommendations on the need for concerted and coordinated actions, improved integration into NCD control at the national level, based on the Political Declaration of the UN High-level Meeting on NCDs and the new policy of WHO/EURO "Health 2020". The main directions of this program implementation are aligned with the activities, envisaged in the National Health Sector Reform Program for 2013-2020.

The establishment of comprehensive programmes is critical in regards to control non-communicable diseases. Cancer management cannot be viewed as treatment-related only, but rather as one component of a complete agenda, each contributing to bringing about tangible improvements for cancer patients. This includes the role of nuclear medicine in the diagnosis, staging and response to therapy of patients with cancer. It is important to integrate treatment (such as radiation therapy) within a comprehensive cancer control programme to maximize its therapeutic effectiveness and impact, and improve patient outcome. Hence, a comprehensive cancer control programme should address not only the diagnosis and treatment of cancer, but prevention, early detection, palliative care and registration as well. The Government of Myanmar through the Ministry of Health is addressing the health issues of Myanmar urgently which include:

- (a) Raising the budget allocation of the healthcare sector,
- (b) Allowing communication and collaboration with external institutes,
- (c) Installation of infrastructure like SPECT/CT, PET/CT, and cyclotron facilities throughout the country.
- (d) Establishment of the National Cancer Center and National Heart Center (Located in the Yangon General Hospital) starting implementation in 2016.

Myanmar, as many other low income countries, is also facing nutritional challenges. Deficiencies of micronutrients are prevalent; approximately 75% of children under 5 years of age are anemic (National Nutrition Census, NNC 2003), 32% have subclinical Vitamin A deficiency, one third are either stunted (height-for-age z-score < -2 standard deviations) or underweight (weight-for-age z-score < -2 standard deviations) and almost one tenth is wasted (weight-for-height z score < -2 standard deviations) [The Multiple Indicator Cluster Survey 2010]. .

The National Nutrition Programme in Myanmar goes back to 1954. The aim of the National Nutrition Programme is the attainment of nutritional wellbeing to support health and longevity of live for every citizen. In 1994, Myanmar formulated a 20-year plan in line with the National Development Plan and the National Health Plan. A five-year strategy supporting the implementation of the National Plan of Action for Food and Nutrition (NPAFN) for the period 2011-2015 has been developed with actions promoting infant and young child feeding practices such as extending maternity leave to 6 months, nutrition education and counseling and food fortification. Myanmar programmes are in line with the SDG2 “end hunger, achieve food security and improved nutrition and promote sustainable agriculture”. Moreover, Myanmar signed up to the Scaling up Nutrition (SUN) initiative in mid-2013. The post 2015 actions aim at:

- (a) Reducing stunting to below 10% and wasting to below 5%;
- (b) Increasing exclusive breastfeeding (0-6 months of age) to at least 60%;
- (c) Reducing low birth weight to below 10%;
- (d) Reducing anemia for children under 5 and women of reproductive age to below 30 percent;
- (e) Reducing rates of childhood overweight.

II.4 Industry

The Industrial Sector in Myanmar consists of energy, mining, industry, electric power and construction. The country accounts for more than 90% of the global rubies trade and is the largest source of jade. It is very rich in sapphires and limestone, and has extensive tracts of copper, lead, zinc, tin tungsten, gold, and barite. Research on radiotracer and sealed source techniques have been successfully conducted in the laboratory to apply in the petroleum refineries and petrochemical plants.

II.5 Environmental Protection and Climate Change

Myanmar has an abundance of natural resources including minerals and energy potential, and fertile ecological zones which have traditionally provided extensive agricultural production. These resources have supported a large population and thriving civilizations over many centuries, and continue to provide the bulk of Myanmar’s economic output to this day. In recent years, population growth, unsustainable extraction of mineral and forest resources, over-utilization of soils and water and climate-related hazards have combined to progressively undermine the resource base on which Myanmar’s economy and society are based.

Myanmar will continue to depend heavily on its natural resource assets. In 2011, 39% of GDP derived from primary industries, including agriculture, forestry, fisheries, mining, electricity, water, oil, and gas. Exploiting these sustainably requires immediate measures to eliminate the economic incentives that destroy natural habitats and to prevent over-extraction of renewable resources. The country is already facing increasing environmental pressure having the fastest rate of deforestation in Southeast Asia, as well as poor regulations on pollution and emissions. As Myanmar’s economy strengthens, the environment will come under severe pressure from increasing industrialization and overexploitation of natural resources, principally through forest conversion for commercial agriculture and water diversion for hydropower. Deforestation is a major cause of land degradation, biodiversity loss, declining water quality, and greenhouse gas emissions.

Many environmental challenges need to be addressed in the country to achieve sustainable economic development. Key among these are:

- (a) Deforestation, which leads to biodiversity loss;
- (b) Land-use changes and commercial agriculture development;
- (c) Unrestricted and unregulated mining activities;
- (d) Accelerating industrial and transport emissions, waste, and effluents;
- (e) Expanded hydropower development; and
- (f) Water pollution.

The Environmental Conservation Law was promulgated in 2012 and the Ministry of Environmental Conservation and Forestry* promulgated the Environmental Conservation Rules in 2014. The Environmental Conservation Department was established under the Ministry of Environmental Conservation and Forestry* in 2012. An Environmental Conservation Committee has been established at the highest level. The Environmental Conservation Department issued the Environmental Impact Assessment Procedures in December, 2015. The environmental Quality Standards are being formulated by the Environmental Standards Committee. To address the environmental sustainability requirement of MDG7 ('Ensure environmental sustainability'), the Government, among other measures, established the National Commission for Environmental Affairs, adopted new forest policy, implemented the Greening of Arid Areas in Central Myanmar project, extended reserved forests and protected public forest areas, adopted the Myanmar Agenda 21, ratified the UN Framework Convention on Climate Change and accession of the Kyoto Protocol. Going forward, the SDG framework establishes several goals related to the environment. These are: SDG6 ('Ensure availability and sustainable management of water and sanitation for all'), SDG13 ('Take urgent action to combat climate change and its impacts'), SDG14 ('Conserve and sustainably use the oceans, seas and marine resources for sustainable development') and SDG15 ('Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss'). National targets under these SDGs will be identified, creating potential linkage points with IAEA technical cooperation projects.

II.6 Water Resource Management

The National Water Policy (NWP), approved by the National Water Resources Committee on 13 March 2014, is the first integrated water policy for the watersheds, rivers, lakes, reservoirs, groundwater, aquifers and coastal and marine water of entire Myanmar.

The freshwater resources in Myanmar are mainly used by the agriculture sector, with small quantities being used for domestic, industrial and other purposes. A programme for safe drinking water supply to water-scarce rural areas under the 10-Year rural water supply plan has been completed.

The sources of groundwater, its recharge mechanism, mixing of aquifers, surface water/groundwater interrelationship, contamination of the groundwater and residence time distribution are the major factors which play an important role in management of groundwater resources. Myanmar is interested in building the capacity in the application of isotopic techniques in groundwater resources investigation, and to establish the facilities for the application of isotope methodology for sustainable management of water resources. It would enable to investigate the groundwater flow dynamics, recharge rate and quality for sustainable groundwater resource management.

II.7 Sustainable Energy Development

Myanmar's Energy Policy is based on maintaining the status of energy independence, to employ hydroelectric power as one of the vital sources of energy sufficiency, to generate and distribute more electricity for economic development, to save non-renewable energy for future energy sufficiency of the nation, to promote efficient utilization of energy and impress on energy conservation and to prevent deforestation caused by excess use of fuel wood and charcoal.

II.8 Radiation Safety and Security

In the area of nuclear safety and security, Myanmar is adapting measures in nuclear and radiation safety control systems to bring its national infrastructure in conformity with international standards and requirements, ensuring adequate physical protection for all nuclear and radioactive material and facilities, and the transport of such materials, ensured safety of radiation resource, radioactive isotopes and radioactive waste, etc. Myanmar has no nuclear fuel cycle facilities, power reactor or research reactor. The radioisotopes and radiation apparatus are used in health, industry, agriculture, livestock breeding, veterinary applications, and research and education. The legislative and statutory framework for radiation safety is provided primarily through the Atomic Energy Law (1998), and assigned regulatory duties with respect to the use of nuclear and radioactive materials to the Department of Atomic Energy (DAE), Ministry of Science and Technology (MOST).

III. RELEVANT INTERNATIONAL DEVELOPMENT ASSISTANCE

The Government of Myanmar has developed mechanisms for aid management and donor coordination following the first Myanmar Development Cooperation Forum, held in January 2013, at which the Nay Pyi Taw Accord on Aid Effectiveness was adopted. The Nay Pyi Taw Accord for Effective Development Cooperation has been developed in collaboration between the Government and partners in a spirit of mutual benefit and accountability. It reflects the conclusions of the international dialogue on aid effectiveness, including the Paris Declaration and Accra Agenda for Action. The Accord commits the Government to create systems for regular, national-led dialogue with development partners and to establish active working groups to support manageable, Ministry-led, sectoral and thematic coordination mechanisms to achieve efficient and effective aid coordination for mutual accountability.

The Foreign Economic Relations Department (FERD) of the Ministry of Planning and National Development is the principal government focal point for development cooperation. FERD meets with the Development Partners Working Committee (DPWC) approximately every two months to ensure active dialogue and coordination between the Government of Myanmar and development partners. The meetings cover issues related to Myanmar's overall development and the effectiveness of assistance provided by development partners. The development partners that constitute the DPWC are ADB, Australia, EU, Japan/JICA, DFID, UN, USAID and the World Bank.

III.1 Partnerships and Resource Mobilization

While implementing this programme, the importance of close partnership with other United Nations agencies, international developmental organizations and other stakeholders will be given due consideration in order to maximize the contribution of nuclear science and technology to the achievement of development priorities, including national SDG targets. Collaborative work through partnerships ensures the coordination and optimization of complementary activities and allows a more streamlined international response to current development issues magnifying the end results and ensuring the best possible socioeconomic impact of the technical cooperation programme.

In order to foster complementarity and avoid duplication, and for building partnerships with other international organizations and multilateral and bilateral donors working for development, efforts will be made to identify and mobilize such opportunities of strategic partnerships and working in cooperation with relevant key UN partners like FAO, UNDP, WHO and UNCCD, etc.

Looking at the Myanmar United Nations Strategic Framework (UNSF) 2012-2015, the IAEA can specifically contribute to two Strategic Priorities, namely Strategic Priority-1 with respect to agriculture-related activities and Strategic Priority-2 with respect to human health-related activities. IAEA may contribute towards the UN Strategic Framework process for the next cycle through its technical cooperation activities in Agriculture (Rice mutation breeding), Livestock Breeding (artificial insemination) and Sterile Insect Techniques to control the Diamondback Moth, as well as IAEA activities in human health (nutrition, cancer control, including radiation medicine), and environment and climate change.

It was agreed at the first Myanmar Development Cooperation Forum to establish Sector Working Groups (SWGs) to ensure effective coordination at the sector/thematic level and promotes development effectiveness in Myanmar. SWGs aim to ensure that sectoral strategies and priorities are elaborated by the Government of Myanmar as well as identifying priority programmes. Of particular interest to IAEA's TC programme are the SWGs on Agriculture and Rural Development, Environmental Conservation, Electric Power, Health, and Water Supply, and Disaster Risk Reduction.

III.2 Cooperation with United Nations Organizations system

The UN System has been providing assistance to Myanmar since its independence in 1948 and is the largest provider of international humanitarian and development aid in the country, with a total in-country programme of around USD 150 million per annum. UN Country Team is focused on supporting the people of Myanmar, particularly the poor and the vulnerable, in partnership with the Government at all levels, non-governmental organizations, private sector, members of the donor/diplomatic community and other stakeholders. The UN Strategic Framework for 2012-2015 identified four Strategic Priorities areas to help address the priority development needs and challenges that the country faces:

- (i) Encouraging inclusive growth (both rural and urban), including agricultural development and enhancement of employment opportunities,
- (ii) Increasing equitable access to quality social services,
- (iii) Reducing vulnerability to natural disasters and climate change, and
- (iv) Promoting good governance and strengthen democratic institutions and human rights. In addition to these joint activities, each Agency will continue with agency-specific activities that can now be referenced to the common framework when supporting its outcomes.

III.2.1 World Health Organization (WHO)

Under WHO Country Cooperation Strategic Agenda (2014-2018)¹, strategic priorities include improving access to quality care, strengthening implementation of the National Health Plan, controlling the growth of non-communicable disease burden, and promoting health throughout the life course. WHO support to cancer-related activities includes: screening for breast and cervical cancers and building referral systems for management of cancer as part of the support in strengthen the prevention and control of NCDs.

III.2.2 United Nations International Children's Fund (UNICEF)

The strategic focus of cooperation between the Myanmar Government and UNICEF includes strengthening health, education and social welfare systems and make them accessible to the most disadvantaged, including through opportunities generated by decentralization and greater cooperation with other UN agencies, UNAIDS, UNFPA and WHO. Building on its long term partnership with the government-convened Myanmar Nutrition Technical Network, UNICEF will strengthen its leveraging role to foster intra-government, development partners, and academia and private sector partnerships to collectively achieve SUN objectives. Specific examples of technical assistance include support to update the Strategy for Infant and Young Child Feeding (IYCF) and guidelines for implementing the nutrition surveillance system. Building on its previous support, UNICEF, will use its convening role, to bring together a coalition of CSO, development partners, private sector and the media to support the government to plan and implement the scaling up nutrition initiative. Using its comparative advantage of a multi-sectoral approach, it will help foster linkages with Water Sanitation Hygiene (WASH), to work collectively to reduce child malnutrition.

III.2.3 United Nations Development Programme (UNDP)

UNDP has been providing development assistance to the people of Myanmar since the 1960s, support to the national political and socio-economic reforms that underpin the country's transition. UNDP's support is channeled through a programme that seeks to strengthen institutions of democratic and local governance, support the environment and disaster risk management, and support government efforts for poverty reduction over the three-year period 2013-2015. UNDP's programme in the country has been extended until 2017. During the course of 2016, consultations will take place for the development of the new UNDAF and UNDP Country Programme.

¹http://www.who.int/countryfocus/cooperation_strategy/ccs_mmr_en.pdf

III.2.4 World Food Program (WFP)

The nutrition program under World Food Program aims to reduce ante- and post-natal under nutrition by addressing the nutritional needs of children under 5 and pregnant and lactating women. Malnutrition in the first 1,000 days of a child's life – from conception to 2 years of age – can lead to irreversible damage. WFP provides fortified foods for children to reduce the prevalence of malnutrition in targeted areas, and provides food and micronutrient supplements for pregnant and lactating women that maximize their caloric and micronutrient intake. WFP's Assets Creation activities help communities to build or repair community assets once acute food needs have been met. These activities build household and community assets that can: i) mitigate the impact of future disasters, such as land terracing projects that counter soil erosion; ii) increase access to markets such as the construction of road networks; and iii) diversify income sources. Food is the main source of assistance during asset creation, but WFP will also use cash transfers where appropriate.

III.2.5 Food and Agriculture Organization (FAO)

Development in the agriculture sector has contributed directly to progress in MDG-1 and indirectly to all other MDGs through its critical role in rural livelihoods and income. Looking forward, progress towards the targets in SDG2 ('End hunger, achieve food security and improved nutrition and promote sustainable agriculture') will likely underpin social and economic development in rural communities.

Myanmar's agricultural potential means that it is an important country in the context of regional and international food security. FAO is the main agency providing technical and policy advice to the agriculture sector by (i) Creating sustainable increase in the supply and availability of food and other agricultural products; (ii) Promoting and developing policy and development frameworks for food, agriculture, livestock, fisheries and forestry sectors; (iii) Promoting sustainable use of natural resources for food and agriculture; (iv) Improving decision-making through the provision of information, including sector assessments and the fostering of knowledge management systems for food and agriculture. The technical FAO focus areas include: (i) Support to rice production (ii) Development of oil crop production and processing (iii) Enhancing food security through the strengthening of the institutional capacity for seed production (iv) Ongoing support to the rehabilitation of farming, coastal fisheries and aquaculture livelihoods in the Ayeyawady Region, (v) Support to country efforts to control avian influenza and other animal diseases, linked to regional disease control efforts, (vi) Sustainable small-scale fisheries and aquaculture livelihoods in coastal mangrove ecosystems, etc.

III.3 Asian Development Bank (ADB)

As a key multilateral development partner, ADB is actively engaged in supporting overall aid coordination policy dialogue between the government and other multilateral and bilateral mechanisms. In 2013, ADB processed a first concessional Asian Development Fund (ADF) project loan of \$60 million for the Power Distribution Improvement Project to improve the efficiency of power distribution by an estimated 4% in 16 townships. Another highlight in 2013 was the approval and disbursement of a \$512 million policy-based loan, Support for Myanmar's Reforms for Inclusive Growth, to support implementation of economic and social reforms that form the foundation for improved policy frameworks in macroeconomic policy, public finance, trade, investment and finance sector development, agriculture, and education.

In 2013, ADB approved 14 technical assistance projects (including supplementary financing for an ongoing technical assistance project), with \$6.7 million of ADB resources and \$12.6 million of co-financing. The assistance covered post-primary education development; skills development; off-grid rural renewable energy; energy planning and legal frameworks; improvement of the investment climate; national statistics development; public-private partnerships; public debt management; finance sector reforms; and road asset management, capacity building, and project feasibility studies.

III.4 Regional Cooperative Agreement (RCA)

Myanmar joined the Regional Cooperation Agreement for Research, Development and Training in Nuclear Science and Technology (RCA) in 1997. In 2013, Myanmar chaired the RCA as well as hosted The Annual Meeting of the RCA National Representatives in Nay Pyi Taw that year. The RCA priority programmatic areas are in agriculture, health, industry and environmental protection.

The Regional Cooperative Agreement (RCA) is an intergovernmental agreement for the East Asia & Pacific region, under the auspices of the IAEA, in which the Government Parties undertake, in cooperation with each other and with the IAEA to promote and coordinate cooperative research, development (R&D) and training projects in nuclear science and technology through their appropriate national institutions.

III.5 Greater Mekong Sub-region (GMS) and Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTECH)

Myanmar is a participating member of the Greater Mekong Sub-region Economic Cooperation Program (GMS Program), as well as the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). In that capacity, Myanmar participates in regional meetings and workshops supported by ADB's regional technical assistance along with other GMS members, namely, Cambodia, PRC, Lao People's Democratic Republic, Thailand, and Viet Nam.

III.6 ASEAN Network of Regulatory Bodies on Atomic Energy –(ASEANTOM)

Myanmar is participating in ASEAN network of regulatory bodies on atomic energy (ASEANTOM), an informal network that serves as a venue for sharing of best practices, exchange of views and information as well as discussion on safety, security, and safeguards in the use of nuclear energy amongst nuclear regulatory bodies or relevant authorities in ASEAN member states.

III.7 Organization for the Prohibition of Chemical Weapons (OPCW)

Myanmar joined the Chemical Weapons Convention on 09 July 2015 and furthers its scope in adhering to the global disarmament regime and initiating its cooperation with the OPCW, in parallel and in line with its adherence and with the Nuclear Non-Proliferation Treaty and cooperation with the IAEA. Myanmar is committed to fulfilling its obligations under the Convention and looks forward to cooperating with other States Parties to bring about a world completely free of chemical weapons.

III.8 World Intellectual Property Organization (WIPO)

The World Intellectual Property Organization (WIPO) is one of the 17 specialized agencies of the United Nations and it's headquartered in Geneva, Switzerland. WIPO was created in 1967 "to encourage creative activity, to promote the protection of intellectual property throughout the world. Myanmar joined the World Intellectual Property Organization (WIPO) on February 15, 2001.

III.9 Bilateral Cooperation

The Ministry of Science and Technology* of Myanmar has signed collaborative Science and Technology agreements with India, Malaysia, Brazil, China, Japan, Korea and the Institute of International Education in USA, Rosatom State Nuclear Energy Corporation(ROSATOM) in Russia.

Yangon Technological University (YTU) and Mandalay Technological University (MTU) are actively cooperating with international research institutes and organizations in order to strengthen and develop Myanmar's science and technology. As at September 2015, YTU has signed a Memorandum of Understanding with the University of Applied Sciences Georg Agricola and German Mining Museum BOCHUM, the Osaka University, Nagaoka University of Technology, Saitama University, Kyoto University in Japan, Seoul National University, Gwangju Institute of Science and Technology in the

Republic of Korea, Khon Kaen University of Thailand, Turku University in Finland, University of New South Wales in Australia and Institute Teknologi Sepuluh Nopember in Indonesia.

The Universities and organizations that MTU is cooperating with also include Nagasaki University, Six National Universities Network (SUN) in Japan, Kyoto University, State Polytechnic of Jakarta, Universitas Negeri Semarang, Sekolah Tinggi Manajemen Informatika Dan Komputer Bani Saleh Bekasi, Polytechnic Raflesia Curup, Polytechnic Piksi Input Serang, Jiangsu Agri-animal Husbandry Vocational College, Sekolah Tinggi Manajemen Informatika Dan Komputer Ikmi Cirebon, Akademi Manajemen Informatika Dan Komputer Dcc Lampung, Bojonegoro Community College in Republic of Indonesia, Southeast Asian Ministers of Education Organization Regional Open Learning Centre (SEAMEO SEAMOLEC), IIC University of Technology in Cambodia, China Center for Resources Satellite Data and Application (CRESDA) in China.

Other universities in Myanmar are also cooperating with international research institutes and organizations in order to strengthen human resource development and knowledge advancement in science and technology.

IV. OVERVIEW OF AGENCY'S PAST AND PRESENT TECHNICAL COOPERATION ACTIVITIES IN THE COUNTRY

Myanmar became a Member State of the International Atomic Energy Agency in 1957 and has been participating in the IAEA Technical Cooperation (TC) programme since then. Over USD 12 million in TC has been delivered to enhance national capacity by way of human resource development, provision of equipment and improvement of infrastructure. The main activities have been in the areas of food and agriculture as well as human health.

IV.1 General Development of Atomic Energy and Capacity Building in Nuclear Science and Technology

Myanmar has been taking interest in utilizing nuclear energy for peaceful purposes since long, yet there were no major nuclear facilities. With the help of IAEA, several facilities were established over time under the Department of Atomic Energy, including Radiation Measurement Laboratory, instrumentation laboratory, radiation dosimetry laboratory, non-destructive testing facilities, etc. These facilities are helping DAE for radiation monitoring, nuclear instrumentation repair and maintenance, personnel dosimetry, irradiation services for medical and agricultural research applications, and providing NDT services to the local industry.

With IAEA's assistance, human resource development activities have been carried out in the fields of nuclear science and technology. The main fields of training include the applications of radiological and nuclear techniques in agriculture, industry and medicine, such as diagnostic radiology, radiotherapy, nuclear medicine, radioimmunoassay techniques, radiation processing for sterilization and food preservation, sterile insect technique, mutation breeding, nuclear instrumentation, industrial radiology, non-destructive testing, livestock breeding and radiation protection

The Nuclear Instrumentation Laboratory at DAE was established to provide a nationwide service for maintaining, troubleshooting and repairing nuclear instruments. Project MYA/0/009: Establishing an Information Communication Technology (ICT) based National Training Capacity building, human resource development and knowledge management is under implementation to strengthen and expand the national capacity for sustainable human resource development in the field of nuclear instrumentation. The Agency has provided necessary equipment, accessories and software for this laboratory. The IAEA also has provided assistance through the national human resource projects for the repair and maintenance of nuclear instruments. Practical experience was acquired in the maintenance and repair of nuclear detectors, spectrometers, amplifiers, counting systems, analyzers (MCAs, SCAs) and power supplies. A Nucleonic Laboratory was established at the University of Mandalay for nuclear teaching and applications through project MYA/4/008 for training and provision of equipment such as an alpha spectrometer, nuclear instruments and sample preparation equipment, and an energy dispersive X-ray fluorescence (EDXRF) system. The project has strengthened the capability of the existing laboratory to provide effective teaching and research applications, particularly in the area of nuclear physics. Under IAEA TC project MYA/0/006, a laboratory for environmental radiation monitoring was established at the Department of Atomic Energy. Nuclear analytical techniques were introduced for airborne particulate matter pollution monitoring, elemental analysis and contamination monitoring of environmental samples. In 1964, a Nuclear Physics Lab was first founded in Physics Department, University of Yangon, both aiming of providing facilities for post-graduate research Lab and a Nuclear MSc degree by TC project namely (MYA/1/007). IAEA provided the Lab with a Kaman A-170 Neutron Generator possible of the study of neutron flux distribution and yield measurement, neutron dosimetry, neutron cross section measurement at 14 MeV, measurement of neutron threshold reactions, fast neutron activation analysis (MYA/1/008 Neutron Physics 1976-1980). Through TC project (MYA/1/010) "Nuclear Physics" (1982-1983) and (MYA/1/012) "Nuclear Physics" (1987-1991) a 14MeV Neutron Generator (Multivolt, Model NA 150-04) was supplied in date 1988 of which installation was completed in 1990, then after (MYA/1/013) "Applied Nuclear Physics and Nuclear Instrumentation" (1991-1993) also provided with X-ray generator, MCA's, HPGe detector, Scintillation Counters.

TC Projects on General Development of Atomic Energy and Capacity Building in Nuclear Science and Technology implemented in previous cycles are as follows:

MYA0006

Title: Human Resource Development and Nuclear Technology Support

FOA: General Atomic Energy Development

Objective: *To upgrade and strengthen the skills and capabilities of human resources within the broad range of the applications of nuclear science and technology.*

MYA0008

Title: Human Resource Development and Nuclear Technology Support

FOA: General Atomic Energy Development

Objective: *To upgrade and strengthen the skills and capabilities of human resources within the broad range of the applications of nuclear science and technology.*

MYA0009

Title: Establishing an Information Communication Technology (ICT) Based National Training Centre for Nuclear Instrumentation

FOA: Capacity building, human resource development and knowledge management

Objective: *To strengthen and expand the national capacity for sustainable human resource development in the field of nuclear instrumentation.*

MYA4009

Title: Enhancement of the Capacity of the Nuclear Instrument Laboratory at the Department of Atomic Energy

FOA: Nuclear Instrumentation, Electronics and Reactor Control

Objective: *To strengthen laboratory capacity for the provision of effective and timely services in the repair and maintenance of nuclear instruments.*

IV.2 Food and Agriculture

Myanmar's economy is predominantly based on agriculture. About 70% of the economically active population is engaged in agriculture, which accounts for 40% of GDP. Rice is by far the most important crop. Agriculture has been and continues to be the largest sector of the IAEA TC Programme. The range of projects in the current TC Programme include improving local rice varieties through mutation-breeding, Sterile Insect Techniques to control Diamondback Moths, and improving animal productivity through the use of DNA-based technology and artificial insemination.

Several breeding programmes have been implemented in the past to improve rice productivity. To further improve the efficiency of the current breeding programmes and face the challenges posed by climate change, capacity development support has been provided by the IAEA in the field of modern breeding techniques. Equipment has been provided by the IAEA for establishing a basic molecular biology laboratory in the country to support breeding programmes. The projects supported ministerial objectives in rural development and poverty alleviation, helping end-consumers and farmers who are the vast majority of country's population. In addition, TC projects greatly helped Myanmar's research and development sector for the advancement of science and technology in the country. Nuclear technology is playing an important role in generating mutant populations by using Gamma irradiation. In addition, stable isotope (C-13 and N-15) based techniques applied to screen for desirable traits such as salinity and drought tolerance and high nitrogen use efficiency. The Department of Agricultural Research (DAR) and Livestock Breeding and Veterinary Department (LBVD) had been the partners in development through the Technical Cooperation Programme of the Agency.

The IAEA provided technical assistance and support through MYA/5/017 project by fellowship training, expert advice and supply of appropriate equipment and reagents, etc. IAEA TC project (MYA/5/020) has been implemented by the Department of Biotechnology as a phase II of previous project (MYA/5/017) to improve rice variety with photoperiod insensitive and salt tolerant rice by using radiation induced mutation technique. Four promising mutant lines which are photoperiod insensitive are now under General Yield Trial

and seven salt-tolerant mutant lines are also selected for the next generation. A follow-up project is expected in the 2018-2019 TC cycle.

IAEA TC projects have helped the Seed Division of the Myanmar Agricultural Service, and Central Agricultural Research Institute to develop varieties of food legumes with improved yield potential and tolerance to stress by using radiation-induced mutation techniques. Improved mutant varieties of crops with larger seeds, early maturity, disease resistance, and higher yields have been produced. Drought-tolerant rice mutants for rain-fed uplands and hilly areas, and salt-tolerant rice mutants for coastal areas have been developed in addition to developing rice varieties with improved iron content using nuclear techniques. Under the IAEA RAS/5/065 project, flooding and drought-tolerant rice mutants for rain-fed rice growing area and upper Myanmar, twelve flooding-tolerant rice mutant lines and four drought-tolerant rice mutant lines were selected. The yield trial of these mutant lines will be tested in the next summer growing season.

In Myanmar, the lowland rice based cropping system is the major cropping system, and the total rice sown area is 6.81 million hectares. The varieties used by the majority of farmers are fertilizer responsive high yielding varieties (HYVs), but the amount of fertilizer applied to the field never meets the crop requirements, resulting in low yield. This is one reason for the resulting gap between potential yield of HYVs and actual yield observed in the farmers' fields. Therefore, low-N tolerant rice varieties, evaluated during the screening of rice genotypes for better nitrogen use efficiency (NUE) experiments are urgently needed for seed distribution among resource poor farmers. Before releasing these low-N tolerant rice varieties to the farmers' fields, Nitrogen-15 isotope dilution method is used to identify better N-use efficiency of low N-tolerant rice varieties under an ongoing TC Project.

The sustainable development of Inle Lake and environmental conservation project are rooted in conventional techniques. However, isotope based environmental monitoring and assessment techniques can certainly provide valuable information for water and nitrogen dynamic as well as erosion/ sedimentation processes especially on the assessment of current environmental status of Inle Lake. Analysis of surface water quality, eutrophication and sedimentation processes and ground water contamination processes can be done more precisely, effectively and timely by using nuclear technology, especially isotope based techniques. The invaluable environmental baseline information will support decision processes towards sustainable development of Inle Lake. IAEA is providing relevant isotope based techniques for water resource and watershed monitoring and assessment through a project MYA 5/025: Monitoring and Assessment of Watershed Management Practices on Water Quality and Sedimentation Rate of Inle Lake.²

TC Projects on Food and Agriculture implemented in previous cycles are as follows:

MYA5010

Title: Development of Improved Rice with Tolerance to Drought and Soil Salinity

FOA: Plant Breeding and Genetics

Objective: *To develop drought-tolerant rice mutants for rain-fed uplands and hilly areas, and to develop salt-tolerant rice mutants for coastal areas.*

MYA5016

Title: Development of Rice Varieties with Improved Iron Content/Bioavailability through Nuclear Techniques

FOA: Plant Breeding and Genetics

Objective: *To combat iron deficiency through food based strategies.*

MYA5017

Title: Studying Yield Improvement of Local Rice Varieties through Induced Mutation

FOA: Plant Breeding and Genetics

Objective: *To strengthen food security through increased yield in rice by induced mutation.*

²Reference to MYA5025 is made in the Near Term Programme

MYA5020

Title: Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)

FOA: Crop production

Objective: *To strengthen food security and to help local farmers and consumers through the development of new high yielding rice varieties with good eating quality.*

IV.3 Livestock and Fisheries

With the help from the IAEA, nuclear techniques for diagnosing animal diseases and for improving cattle productivity were introduced at the Livestock Breeding and Veterinary Department (LBVD). A Radio Immunoassay (RIA) laboratory was established and successfully performed cattle fertility monitoring. Enzyme Linked Immuno Sorbent Assay (ELISA) technology was used for surveillance of rinderpest and accurate and rapid diagnosis of foot-and-mouth disease (FMD). In addition, an animal nutrition laboratory was established to improve livestock production through better feeding practices. Assistance was provided to Yangon Veterinary Diagnostic Laboratory to diagnose and control swine vesicular disease and swine brucellosis and to increase pig reproduction. FMD is endemic in Myanmar, with a large population of FMD susceptible animals. To control FMD, millions of doses of FMD vaccine are required for cattle, buffalo, sheep and goats, and for pigs. IAEA is supporting development of ELISA and PCR technologies which increase diagnostic capability with more sensitivity and, specificity, for early detection of FMD and also provide improvements in vaccine production.

The efforts of the Ministry of Livestock, Fisheries and Rural Development to enhance the productivity by integrated approach and to produce quality veterinary vaccines to control infectious diseases in livestock production were supported in the past through TC projects. A project on “Integrated Approach for Improving Livestock Production using indigenous resources and conserving the environment” was implemented at LBVD, with the two specific objectives to improve animal nutrition and reproduction. Special efforts were made to improve the artificial insemination service in dairy cattle with the support of progesterone radioimmunoassay. Under TC Project MYA5013, the Livestock, Breeding and Veterinary Department under the Ministry of Livestock, Fisheries and Rural Development is upgrading Animal Genetic Upgrading and Research Centre in Mingalardon (Rangon) and Mandalay Laboratory for livestock sector development, training for farmers and vaccinated the animals for prevention of infectious animal diseases.

Project MYA5/022 on Improving Animal Productivity through the Use of DNA-Based Technology and Artificial Insemination, has been implemented with the objective of improving livestock productivity through the selection of superior breeding stock and to improve capacity in the use of molecular and related technologies for raising the genetic quality of local and adapted livestock breeds. An IAEA TC Project (IAEA/ MYA /5/018) has been carried out by the LBVD for Enhancing the lifetime health and performance of offspring and improving the profitability of livestock production systems through selective breeding and management of the maternal environment.

TC Projects on Livestock and Fisheries implemented in previous cycles are as follows:

MYA5011

Title: Development of Supplementary Feeding Strategies Based on Local Feed Sources

FOA: Animal Production

Objective: *To establish an animal nutrition laboratory and train staff on evaluating the nutrition of locally available feed resources by using isotopic and non-isotopic techniques; to develop appropriate supplementary strategies for improving livestock production; and to increase the income of small farmers through better feeding practices.*

MYA5012

Title: Diagnosis and Control of Swine Vesicular Disease and Swine Brucellosis

FOA: Animal Diseases

Objective: *To diagnose swine vesicular disease (SVD) and swine brucellosis; to improve control of these two diseases; and to increase pig production.*

MYA5013

Title: Integrated Approach for Enhancing Cattle Productivity

FOA: Animal Production

Objective: *To improve smallholder dairy cattle production in Yangon and Mandalay regions.*

MYA5015

Title: Strengthening the National Capacity for the Production of Veterinary Vaccines

FOA: Animal Diseases

Objective: *To enhance the national capacity for quality vaccine production to support efforts to control infectious diseases in livestock production, particularly FMD.*

MYA5018

Title: Enhancing the Lifetime Health and Performance of Offspring and Improving the Profitability of Livestock Production Systems through Selective Breeding and Management of the Maternal Environment

FOA: Application of Isotopes and Radiation in Food and Agriculture / Animal Production

Objective: *a) To improve livestock production and thereby increase profitability through improved management of the maternal environment and health care programmes; b) To train technicians in advanced technologies in the field of research and development, breeding, reproduction, dairy production, nutrition and waste management and train technical staff in livestock data analysis and data processing.*

IV.4 Insect Pest Control

In Myanmar, the diamondback moth (*Plutella xylostella*) has become a serious problem in regions where cruciferous vegetables are grown almost throughout the year. Myanmar has inadequate knowledge of target insect monitoring techniques and poor experience of Sterile Insect Technique (SIT) at pre-release suppression and releasing. Although SIT is environment-friendly and effective, it is not a stand-alone technique, and an integrated approach is more systematic and effective. Moreover, the country initiates the studies on genetic pest control techniques for target insects, with the aim of strengthening the role of agricultural biotechnology. Entomologists from Myanmar have been trained in the use of the Sterile Insect Technique within integrated area-wide fruit fly pest management. A feasibility study was carried out for using the Sterile Insect Technique against the Diamondback Moth. The IAEA TC Project MYA/5/014, entitled "Support for a Feasibility Study on Using the SIT against Diamondback Moth (DBM)", was implemented at the Department of Biotechnology under the Ministry of Science and Technology. A project MYA5021 is under implementation to integrate Sterile Insect Technique with other biocontrol tactics to improve Diamondback Moth Control.

The technical knowledge and capacity of project counterparts have been significantly increased to integrate sub-sterile insects and natural enemies with other Diamondback Moth control techniques that reduce the use of insecticide and increase vegetable production, through the establishment of a monitoring system for Diamondback Moth, as well as capacity-building activities in Diamondback Moth in mass-rearing and suppression activities.

TC Projects on Insect Pest Control implemented in previous cycles are as follows:

MYA5014

Title: Support for a Feasibility Study on Using the Sterile Insect Technique against the Diamond Back Moth

FOA: Insect Pest Control

Objective: *To assess whether the use of SIT is feasible and appropriate for the integrated control of the DBM in Myanmar.*

MYA5021

Title: Integrating Sterile Insect Technique with Other Biocontrol Tactics to Improve Diamondback Moth Control

FOA: Insect Pest Control

Objective: *To integrate SIT into other biocontrol techniques for DBM control in promoting the crop protection system.*

IV.5 Human Health

Human health is one of the top priorities for Myanmar. During the last decade, the TC programme covered a wide scope of projects from radioisotope-based techniques for detecting drug-resistant malaria, to production of monoclonal antibodies for radioimmunoassay, etc. TC Projects have provided assistance and expertise in strengthening the radiotherapy infrastructure and human capacity in Myanmar. The continuing assistance includes expert advice on optimizing the utilization of the radiotherapy infrastructure, training of professionals and assistance to improve QA/QC and safety at the workplace. The radiotherapy and nuclear medicine facilities at the Yangon General Hospital and other hospitals in Myanmar are old and dilapidated. In 2012, an old Cobalt 60 teletherapy unit at the Yangon General Hospital was refurbished. In 2015 The Ministry of Health procured new equipment in terms of 6 new linear accelerators nationally. TC projects have made a major contribution towards the improvement of radiotherapy in Myanmar, e.g., under the project MYA6025 implemented from 2007 to 2010, project MYA 6027 on Improving Radiotherapy for Common Malignancies implemented from 2012 and the projects MYA6030 and MYA6031 to provide Support for Radiotherapy Capacity Building.

Nuclear medicine plays an important role in the diagnosis and management of complications associated with non-communicable diseases, such as cardiac disease and cancers. The existing facilities require assistance for upgrading of instrumentation and for the provision of training of professionals. The IAEA is supporting training and providing expert missions to consolidate these activities in Myanmar by implementing a project MYA6029 for Strengthening Human Resource Capacity in Nuclear Medicine for Improving Diagnostic Procedures in Cardiology and Oncology. The TC project addressed the gap between the need for updated nuclear medicine procedural capacity in the public health system, thereby improving diagnosis and the management of non-communicable diseases including cancers and cardiac diseases, by strengthening nuclear medicine facilities in Myanmar.

TC Projects in Human Health implemented in previous cycles are as follows:

MYA6025

Title: Improvement of Quality Assurance in Brachytherapy for Cervical Cancer

FOA: Radioisotope and Radiation Treatment

Objective: *To improve the country's response to cervical cancer through the improvement of quality assurance for brachytherapy.*

MYA6027

Title: Improving Radiotherapy for Common Malignancies

FOA: Radiation oncology in cancer management

Objective: *To improve the treatment of common malignancies in Myanmar.*

MYA6028

Title: Establishing a National Secondary Standards Dosimetry Laboratory (Phase I)

FOA: Dosimetry and medical physics

Objective: *To improve dosimetric accuracy in various fields of radiation dosimetry and to foster the safe use of every application of radiation technology in Myanmar through establishment of a National Secondary Standard Dosimetry Laboratory in accordance with relevant IAEA Safety Standards and guidance and following the methodology and essential elements of Thematic Safety Area (TSA -1).*

MYA6030

Title: Support for Radiotherapy Capacity Building in Myanmar.

FOA: Radiation oncology in cancer management

Objective: *To improve radiotherapy treatment in Myanmar, including a QA/QC programme of radiotherapy practice and staff training.*

MYA6031

Title: Improving Radiotherapy Services in Myanmar

FOA: Radiation oncology in cancer management

Objective: *To improve radiotherapy treatment in Myanmar, including staff training in treatment techniques and QA/QC programme of radiotherapy practice.*

IV.6 Nutrition

Obesity and overweight are increasing in low and middle income countries in transition. For women, the studies documenting these important trends often rely on body mass index (BMI) to define overweight or obesity, despite the fact that excess body fat (BF) is the specific factor associated with increased disease risk. For these reasons, obesity among Myanmar women needs to be monitored and reassessed. Under TC project MYA6/026: Assessing Risk Factors Associated with Obesity in Women using stable isotope techniques, support was provided for using stable isotopic method to assess and monitor obesity in women, and analysis of obesity-related hormones in obese women leading to effective treatment of obesity to reduce hypertension and diabetes morbidity and mortality.

TC Project on Nutrition implemented in previous cycles are as follows:

MYA6026

Title: Assessing Risk Factors Associated with Obesity in Women

FOA: Assessment of Micronutrients in Nutrition

Objective: *To assess obesity and other risk factors associated with obesity in Myanmar women using stable isotope techniques*

IV.7 Industry

With the help of IAEA, non-destructive testing (NDT) capabilities in Myanmar are being upgraded, especially in radiography and ultrasonic testing. Under the TC projects MYA/8/004, MYA/8/007 and RAS/1/013, NDT laboratory was established and NDT personnel were trained on the most common NDT methods. A regional project RAS/1/020 helped in building capacity in the advanced NDT techniques. Non-destructive testing techniques are also being developed and applied in construction activities. The establishment of a Radioisotope Techniques Laboratory will help in promoting the NDT services from conventional stage to advance levels in industrial applications.

With assistance from IAEA, through the project MYA/1014: Building National Capability to Use Radiotracer and Sealed Source Techniques in Industry, the Department of Atomic Energy is building up national capability in radiotracer and sealed source techniques for industrial applications for providing services to national industries. NDT services are now being provided by the Ministry of Science and Technology* to governmental departments and private companies.

Myanmar is rich in precious stones (rubies, sapphires, jade), oil, natural gas and other mineral resources such as tungsten, tin, lead and silver. Radioisotope technology is applied not only in private companies but also in government departments for industrial applications. Sealed sources have been used mostly for logging in oil industries. Applications of radioisotope technology for level measurement (gauges) have been used in the urea fertilizer factory since 1983. Gamma column scanning was initiated under the supervision of IAEA experts in 1996. Radiotracer techniques are also utilized for the natural gas pipeline inspection. A project on strengthening radiotracers and non-destructive techniques in the country is under implementation.

TC Projects on Industry implemented in previous cycles are as follows:

MYA8005

Title: Multi-Purpose Irradiation Facility

FOA: Radiation Processing Facilities and Applications

Objective: *To set up a multi-purpose irradiation facility in Yangon to sterilize medical products, supplies, and human tissue grafts.*

MYA8007

Title: Development and Application of Non-Destructive Testing Techniques in Construction Activities

FOA: Non-Destructive Testing (NDT) and Examination (NDE)

Objective: *To enhance national capacity for NDT technology in order to provide quality control and assurance for concrete structures in construction activities.*

MYA1014

Title: Building National Capability to Use Radiotracer and Sealed Source Techniques in Industry

FOA: Radioisotopes and radiation technology for industrial applications

Objective: *To build up national capability in radiotracer and sealed source techniques for industrial applications including for the provision of services to national industries*

IV.8 Radiation Protection and Safety

Myanmar's TC programme has seen a steady and incremental development in its radiation safety infrastructure, and that of radiation protection and safety. A sound radiation safety infrastructure is an essential component in having effective technical cooperation in nuclear applications. Mostly in the recent TC cycles, Myanmar's technical cooperation in radiation protection and safety has been implemented through the relevant Thematic Safety Areas in regional projects and/or directly with the Nuclear Safety and Security Department.

The below TC Project was designated as Footnote A with no implementation of activities:

MYA9005

Title: Strengthening Radiation Protection Infrastructure

FOA: Regulatory Infrastructure for Radiation and Waste Safety

Objective: *To strengthen the national capability for improvement of radiation protection infrastructure and mechanisms for the safety and security of radiation sources.*

IV.9 Capacity Building in Nuclear Science and Technology

With IAEA's assistance, human resource development activities have been carried out in the fields of nuclear science and technology. The main fields of training include the applications of radiological and nuclear techniques in agriculture, industry and medicine, such as diagnostic radiology, radiotherapy, nuclear medicine, radioimmunoassay techniques, radiation processing for sterilization and food preservation, sterile insect technique, mutation breeding, nuclear instrumentation, industrial radiology, non-destructive testing, livestock breeding and radiation protection

The Nuclear Instrumentation Laboratory at DAE was established to provide a nationwide service for maintaining, troubleshooting and repairing nuclear instruments. Project MYA/0/009: Establishing an Information Communication Technology (ICT) based National Training Capacity building, human resource development and knowledge management is under implementation to strengthen and expand the national capacity for sustainable human resource development in the field of nuclear instrumentation. The Agency has provided necessary equipment, accessories and software for this laboratory. The IAEA also has provided assistance through the national human resource projects for the repair and maintenance of nuclear instruments. Practical experience was acquired in the maintenance and repair of nuclear detectors, spectrometers, amplifiers, counting systems, analyzers (MCAs, SCAs) and power supplies. A Nucleonic Laboratory was established at the University of Mandalay for nuclear teaching and applications through

project MYA/4/008 for training and provision of equipment such as an alpha spectrometer, nuclear instruments and sample preparation equipment, and an energy dispersive X-ray fluorescence (EDXRF) system. The project has strengthened the capability of the existing laboratory to provide effective teaching and research applications, particularly in the area of nuclear physics. Under an IAEA TC project, a laboratory for environmental radiation monitoring was established at the Department of Atomic Energy. Nuclear analytical techniques were introduced for airborne particulate matter pollution monitoring, elemental analysis and contamination monitoring of environmental samples.

TC Project on Capacity Building in Nuclear Science and Technology implemented in previous cycles are as follows:

MYA0007

Title: Nuclear Science and Technology Training Centre

FOA: Nuclear Centres and Laboratories

Objective: *To establish a nuclear science and technology training centre for scientists, engineers, technicians, and graduate students in the field of nuclear science and technology; and to develop local human resources for application of nuclear techniques in various fields.*

V. OUTLINE OF THE PROPOSED PROGRAMME

The basic principles of technical cooperation under the Country Programme Framework require the agreed programme to be an integral part of, and support the sectorial priorities established by the Member State. In order to achieve impact, the technical cooperation pursues a limited number of sectorial objectives. Moreover, it is expected that the national recipients of assistance are closely involved in the preparation and later on will have the main responsibility for the execution of the projects, and particular attention will be paid to the involvement of the Government and private institutions, nuclear research institutes and universities in the implementation of the projects, notably in association with national organizations where the necessary infrastructure is available. The projects, inter alia, should be realistic, oriented towards the end user, respond to a major need of the country with strong Government commitment for ensuring sustainability.

The Country Programme Framework for IAEA's TC and assistance for Myanmar during 2016-2021 has been developed in line with the policy priorities of the government for achieving the long-term goals of the 20-year National Comprehensive Development Plan (NCDP) 2011–2031. The outline of the future programme is consistent with the national development priorities identified in Chapter 2. Through a process of dialogue and extensive consultations among various stakeholders, and the development directions and goals set forth by the Government, the extent and scope of the cooperation between the IAEA and Myanmar for the peaceful application of nuclear science and technology for socio-economic development has been formulated for the near-term and the medium-term.

The proposed IAEA Myanmar TC Programme for the near-term is focused on capacity-building efforts in the thematic areas of electron beam capacities, human health, livestock, industry, water resources management, agriculture, environmental and radiation safety.

The envisioned IAEA Myanmar TC Programme for the medium-term has a broader scope which includes but is not limited to Human Health and Nutrition, Food and Agriculture, specifically in Plant Mutation Breeding, Soil and Water management, Insect Pest Control, Livestock Production, Radiation Technologies utilizing Irradiation and for Measurement, as well as Isotope Hydrology, Radiation Safety and Nuclear Science and Technology Education.

V.1 Near-Term Programme

In the near term, the priority for IAEA technical cooperation in Myanmar is mainly focused on capacity-building efforts in the thematic areas of electron beam capacities, human health, livestock, industry, water resources management, agriculture, environmental and radiation safety.

Human Health: With over 50,000 cancer incidences per year since 2008, and inadequate cancer control infrastructure and old and ill-equipped hospitals, Myanmar needs a major boost in hospital facilities and equipment as well as human resource development. The technical assistance of the IAEA is required to strengthen human resource capacity and services in nuclear medicine and radiotherapy for improving the diagnosis and treatment of cancer patients. Thus there is a strong need to strengthen human resource capacity in PET-CT, Cyclotron, and Linear Accelerator and HDR Brachytherapy services in Myanmar.

▪ Nuclear Medicine and Radiotherapy

Capacity building in the near term will be focused on human resource development in PET-CT, Cyclotron, and Linear Accelerator and HDR Brachytherapy services.

▪ Secondary Standard Dosimetry Laboratory

In the framework of IAEA TC project MYA 6028 " Establishing a National Secondary Standards Dosimetry Laboratory (Phase I)" a new premises fulfilling IAEA requirements for SSDL infrastructure have been designed, constructed and accepted during 2014-2015. The new premises, located at the Department of Atomic Energy (DAE) in Yangon consist of one control room and three irradiation rooms dedicated for installation of calibration systems for protection, diagnostic and therapy level dosimetry.

In the near term (2016-2017) further Agency assistance under a new IAEA TC project MYA6033: Establishing a National Secondary Standard Dosimetry Laboratory (Phase II), will be required to (i) provide adequate training of SSDL staff through FE and SV (ii) procure equipment for protection and diagnostic level calibrations that include (i) gamma Cs-137 and kilovoltage X ray calibration systems (iii) assist in the commissioning phase of installed calibration systems (iv) verify declared level of calibration accuracy provided by the SSDL of Myanmar through its participation in the IAEA dosimetry comparison programs organized for SSDL network members (v) support establishment of calibration services for end users in Myanmar according to the ISO17025.

Food and Agriculture: As a traditionally agricultural nation, rice production remains the main priority for Myanmar, with several projects involving rice production implemented during past several TC cycles. Other important cash crops are oilseeds and there is a need for better nutrient-water application to ensure higher yields.

▪ Soil And Water Management

An important priority for Myanmar is the preservation of the Inle Lake. Agricultural production and various economic activities have affected the erosion and sedimentation of the lake shores. More effective soil and water management practices using isotopic techniques will enhance agricultural production. The severe floods in Myanmar in 2015 washed away the top 0 to 20 cm of surface soil resulting in loss of essential plant nutrients and organic carbon, destruction of soil structure and tilth. This land degradation by water made it practically impossible for farmers to use the eroded land for sustainable agricultural production. Similarly, the intrusion of sea water into cropping land resulted in salinization of productive cropping land. Utilization of lands for agriculture in term of nutrient inputs, salinity, crop productivity and land use planning for environment sustainability in farming system should be examined. Capacity building in restoring degraded land for productive agriculture is needed. In such scenario, nuclear techniques such as N-

15 and C-13 and fallout radionuclides (FRN) techniques help to assess soil fertility and quality and to evaluate the loss-deposition of sediments and plant nutrients from cropping land. Capacity building in providing two national training to restore degraded land back to cropping and minimize the impact of salinity due to seawater intrusion into cropping land is urgently needed.

- **Livestock Production:** Agency has helped Myanmar in the past for controlling animal diseases like FMD and rinderpest, etc. In order to stimulate sector productivity and improve food security and nutrition at the household level, the IAEA's technical assistance is needed in the near term. The other three areas of growing importance are livestock reproduction and breeding, animal nutrition and the sterile insect techniques.

Radiation Technologies Applications: The industrial sector in Myanmar lacks facilities for testing of a variety of components for quality control, quality assurance, and monitoring of plant integrity during construction, operation and maintenance. Support from the IAEA is required to build national capacity in radiotracer and NDE techniques for industrial applications.

- **Irradiation technologies**

- **Electron beam:** Radiation Technologies today are playing a key role world over in enhancing the socio-economic conditions by providing radiation sterilized lifesaving equipment for better healthcare as well as for improving the safety and quality of food and agriculture products so as to provide enhanced trade opportunities. Presently, Myanmar lacks the radiation facilities for treatment of such industrial products. Establishment of an appropriate electron beam facility will enable meeting the needs of a large variety of end-users, such as food and agriculture sectors, healthcare industry for medical products sterilization production, and for conducting studies related to environmental remediation and other areas for research and developments.

- **Radiation Technologies for Measurement:**

- **Radiotracers and sealed sources applications:**

The focus will be on radiotracers and nucleonic measurement systems applications for sediment transport investigation. The needs for such applications and related qualification of personnel will be growing during future years. The qualification and certification of personnel under the ISTRA certification system will be a key priority to ensure the sustainability of the technologies.

- **Non Destructive Testing:**

The establishment of the full NDT structure for qualification and certification of NDT personnel is a long process including the creation of an NDT society with all stakeholders, training center(s) and national certification body will remain a key priority during many years. The last step will be the international accreditation and recognition of the certification body.

Water Resources Management: Myanmar plans to initiate a project on enhancing water resources management through infrastructure development and isotope hydrology applications for which the IAEA's technical assistance would be requested.

Radiation Safety: Myanmar will continue capacity-building of its national radiation safety infrastructure through regional and/or directly with the IAEA Department of Nuclear Safety and Security.

Environmental Protection and Monitoring: Marine environment is subject to contamination by disposal of industrial and municipal sewage, dumping of industrial wastes, oil from ships and boats etc, radiation technologies strengthening environmental radio activity monitoring laboratory is important in addressing uncontrolled release of radionuclides.

V.1.1 Human Health

Non-communicable disease including coronary artery diseases and cancer are common health problems in Myanmar where the prevalence of risk factors such as hypertension, diabetes, hypercholesterolemia, and smoking habits are common and very high due to change of life style. Cancer constitutes a significant portion in the overall mortality and morbidity. According to the hospital-based data, there are four common malignancies in Myanmar, namely cervical, breast, head and neck and gastrointestinal tract cancer. Annually, approximately more than 7500 new patients are registered in all four radiotherapy centers. Radiotherapy is offered to cancer patients for curative and palliative treatment free of charge in the available facilities. Chemotherapy treatment is very expensive and the majority of patients rely on radiation treatment only. Diagnostic facilities to support clinical management of cancer are lacking.

Radiation Oncology in Myanmar is still in infancy stage, apart from radioiodine therapy for thyroid cancer. This problem is compounded by various factors including a lack of trained physicians and technologists, and medical physicists for dosimetry, radiochemistry, and a very limited availability of radioisotopes, kits and radiopharmaceuticals. Some machines are not fully functional and a radioactive source needs replacement. As such, the patients are deprived of getting a better clinical management for both diagnosis and therapy in the field of oncology and cardiology. In addition, The recent establishment of the Cyclotron and PET/CT facility will require continuous support in training professionals in the field, such as Nuclear Medicine physician, technologist, nurse, radiopharmacist/chemist and medical physicist (and operators), in order to provide optimal clinical services to the people.

In Myanmar, there are currently four public radiotherapy centers. In Yangon, Mandalay, Taunggyi and Nay Pyi Taw, linear accelerators and HDR brachytherapy machine have already been installed. The new linear accelerator radiotherapy machines were used for the first time and transitioning from 2D to 3D-Conformal radiotherapy is in progress. The technical assistance of IAEA is required to strengthen human resource capacity and services in nuclear medicine and radiotherapy for improving the diagnosis and treatment of cancer patients. In addition, training of a maintenance engineer for the radiotherapy equipment is needed. Specialized training of radiation oncologists, medical physicists and radiation therapy technologists, and expert advice on the state-of-the-art treatment techniques and QA/QC of the facilities and services will enable extending health care facilities to the patients according to international standards.

Quality management initiatives should be in place in order to provide optimal clinical services, while adhering to international practice standards of quality (ie QUANUM, QUATRO).

The applications of radiation and radioisotopes have benefited people in agriculture, human health, industry and environmental conservation. As accuracy in radiation dosimetry is required in every application of radiation technology, Myanmar needs the Agency's assistance to establish a National Secondary Standard Dosimetry Laboratory in order to provide calibration services, improve dosimetric accuracy and provide training in radiation measurement and calibration techniques. The project will be of immense benefit to radiation workers and the general public in view of the availability of high quality control in radiation processing, more accurate calibration services for radiation measurement instruments and personal dosimetry services.

V.1.1.1 Nuclear Medicine and Radiotherapy

The ongoing 2016-2017 Myanmar TC Programme addresses the following:

MYA6032 (2016-2017)

Title: Strengthening Human Resource Capacity in Nuclear Medicine and Radiotherapy Services for Improving the Diagnosis and Treatment of Cancer Patients.

FOA: Radiation oncology in cancer management

Objective: *To strengthen human resource capacity in PET-CT, Cyclotron, and Linear Accelerator and HDR Brachytherapy services in Myanmar.*

V.1.1.2 Secondary Standard Dosimetry Laboratory

The ongoing 2016-2017 Myanmar TC Programme addresses the following:

MYA6033 (2016-2017)

Title: Establishing a National Secondary Standard Dosimetry Laboratory (Phase II)

FOA: Dosimetry and medical physics

Objective: *To improve dosimetric accuracy in various fields of radiation dosimetry and to foster the safe use of every application of radiation technology in Myanmar through the establishment of a National Secondary Standard Dosimetry Laboratory in accordance with relevant IAEA Safety Standards and guidance.*

V.1.2 Food and Agriculture

V.1.2.1 Soil and Water Management

In soil and water management, the focus of national technical cooperation activities, have been on agricultural production and the associated soil erosion on the watersheds of the Inle Lake. Efforts will be continued in monitoring and assessing watershed management practices so as to derive better water quality and have an accurate measurement of the sedimentation rate of Inle Lake.

MYA5025 (2015-2017)

Title: Monitoring and Assessment of Watershed Management Practices on Water Quality and Sedimentation Rate of Inle Lake

FOA: Agricultural water and soil management

Objective: *To support environmental conservation of Inle Lake through improved monitoring, reporting and verification on water quality and sedimentation rate.*

V.1.2.2 Livestock Production

Although the livestock sector in Myanmar offers tremendous potential towards contributing to more inclusive and poverty alleviating growth, the sector is not playing its full potential due to poor technology adoption and absence of a policy and institutional structure that can promote provision of good advice to livestock farmers. The productive potential of animals depends crucially on adoption of proper feeding and husbandry practices and utilization of locally available feed and fodder resources. In Myanmar however the farmers, especially small farmers, continue to follow traditional instinctive practices with little attention to their impact on production potential. There is also poor awareness about nutritional composition of locally available resources and to use this information to form and feed balanced diets and also relationship between associative effects of feeds (roughages and concentrates used for animals) and methane emission. In addition, there is poor technical capacity within Myanmar to acquire, assimilate and transfer good practices within the production, marketing and agro-ecological context.

The stakeholders (both in public and private sectors) appreciate these limitations, and therefore, eager to learn new practices that can stimulate sector productivity and improve food security and nutrition at the household level. Myanmar is conscious of these limitations and needs IAEA's assistance in this field. This project will provide support to development of policy and regulatory environment for more inclusive sector development and will provide focused support on development of animal feeding strategies linked specifically to capacity development of relevant stakeholders in the public and private sector. This will lay the foundation for long term future development of appropriate technical capacity and regulatory environment in support of balanced and equitable livestock sector development.

The ongoing 2016-2017 Myanmar TC Program is addressing the following:

MYA5026(2016-2017)

Title: Improving the Livelihoods of Smallholder Livestock Farmers by Developing Animal Feeding Strategies for Enhanced Food Security

FOA: Livestock production

Objective: *Improving the livelihoods of smallholder livestock farmers by the development of animal feeding strategies for enhancing food security, balancing ration and environment through research.*

V.1.3 Radiation Technologies Applications

Non-destructive testing and evaluation (NDT/NDE) is an important non-power application widely used by industry for testing of a variety of components for quality control, quality assurance, and monitoring of plant integrity during construction, operation and maintenance. Major users of NDT like power generation and processing industries are governed by regulatory requirements for periodic plant shutdowns for maintenance and testing. NDE is one of the powerful tools to minimize these forced outage periods resulting in huge economic saving to the industrial sector. New methods such as digital radiography that are becoming more and more common would necessitate the development of capability in that area as well as the establishment of new protocols. With the rapid growth of the industrial sector, there has been a manifold increase in the applications of the established radiation based conventional radiography techniques for non-destructive testing and examination for quality assurance and sustainability. In Myanmar, even the conventional NDE is at beginning stages. As Myanmar joined the IAEA/RCA technical cooperation project in this field at a later stage, there is a need to catch up with other participating RCA Member States in order to fully benefit from the joint training programs. Support from IAEA is required to build national capacity in radiotracer and NDE techniques in industry. The positive outcomes of this technical assistance will greatly contribute towards industrial development through capacity-building in radiotracer and sealed source techniques as well as conventional and advanced NDE techniques in the country.

The ongoing 2016-2017 Myanmar TC Program is addressing the following:

MYA1016 (2016-2017)

Title: Building National Capacity in Radiotracer and Non Destructive Evaluation Techniques in Industry

FOA: Radioisotopes and radiation technology for industrial applications

Objective: *To contribute towards industrial development through capacity-building in radiotracer and sealed source techniques as well as conventional and advanced Non-Destructive Evaluation (NDE) techniques.*

V.1.3.1 Irradiation Technologies

V.1.3.1.1 Electron beam

Radiation processing technologies based on gamma, electron beam or X radiations have been applied in last few decades in diverse industries to enhance the properties of materials and to reduce undesirable contaminants, such as pathogens or toxic by-products. The use of electron

beam machines in radiation processing has been expanded to include sterilization of medical products, food processing and others like value addition of precious and semi-precious gem stones, offering decisive economic and environmental advantages over conventional technologies. The applications of electron beam technologies have been extensively deployed in food and agricultural products as well as industrial processes such as sterilization of medical products. Developing countries can particularly benefit by applying such technologies to meet their specific societal needs in these areas. Efforts are underway to establish an electron beam facility in Myanmar. Lack of the technology of the electron beam application, has led to dependence on primary products only and limiting value addition to the products. Myanmar needs the Agency's assistance to establish an Electron Beam Irradiation Facility in order to establish radiation sterilization industry and also to enhance opportunities related to trade of food and agricultural commodities by improving the safety and the quality of food and agricultural products and enhance the quality and durability of many other industrial products. It will enable meeting the needs of a large variety of end-users, such as food and agriculture sectors, industry, medical products sterilization and production, gem stone industry besides providing opportunities to explore environmental remediation and other areas for research and developments. This facility is intended to be used for studies and scale-up from research and development stage to semi-commercial scale for processing of raw material primary products to value added secondary products. However, bringing in a new technology that is different from the conventional technologies is a challenging task that requires sustained effort and providing adequate scientific and technical information to the technologists in the industries. In the near term, therefore, Myanmar will focus on gaining an understanding and experience in various aspects related to establishment, operation and utilization of such facilities and generating an awareness of the use of this technology among the stakeholders.

The ongoing 2016-2017 Myanmar TC Program is addressing the following:

MYA1015 (2016-2017)

Title: Establishing an Electron Beam Irradiation Facility (Phase I)

FOA: Radioisotopes and radiation technology for industrial applications

Objective: *To establish an Electron Beam Irradiation Facility for improving the quality of products from the agriculture, livestock and industrial sectors.*

V.1.3.2 Radiation Technologies for Measurement

V.1.3.2.1 Radiotracers and Sealed Sources Applications:

Stimulated by an ever increasing demand from production plants, many radioisotope techniques have been evolved to provide fast and effective solutions to plant and process problems. Relevant target areas for radioisotope applications are well defined. Though the technology is applicable across a broad industrial spectrum, the petroleum and petrochemical industries, mineral processing and wastewater treatment sectors are identified as the most appropriate target beneficiaries of radioisotope applications: these industries are widespread internationally and are of considerable economic and environmental importance.

Radiotracer technology is used to diagnose specific causes of inefficiency in plant or process operation. The troubleshooting derives benefits in the form of savings associated with plant shutdown minimization and loss prevention. While a troubleshooting project results in a "one-off" economic benefit, often realized as savings, an optimization exercise results in a permanent and ongoing increase in productivity and/or product quality, leading in turn to a continuing increase in profit. Thus, the cost: benefit ratio from process optimization application is likely to be considerably greater than for troubleshooting.

Nucleonic control systems (NCS) or Nucleonic gauges are nuclear instruments for measurement and analysis based on the interaction between ionizing radiation and matter. NCS technology is

by far one of the most requested among other industrial radioisotope techniques. NCS have been widely used by various industries to improve the quality of product, optimize processes, and save energy and materials. The magnitude of the benefit obviously varies from one application to another, but is always considerably greater than the costs of purchasing, installing and maintaining the instrument.

Industrial process gamma tomography is being developed for the study of multiphase processes. Multiphase reactor technology is the basis of petroleum refining, synthesis gas conversion to fuels and chemicals, bulk commodity chemicals production, manufacture of specially chemicals and polymers, and conversion of undesired products into recyclable materials. While progress has been made in understanding fundamental reaction mechanisms and in computing the effect of mass transfer on the reaction rate locally, the description of the reactor scale flow pattern and mixing is in general primitive and rests on the assumption of ideal flow patterns. Radioisotope techniques help optimising multiphase reactors saving billions of US dollars annually in world scale.

V.1.3.2.2 Non Destructive Testing:

The need for NDT is increasing in Myanmar as the economy is growing and infrastructures being built. NDT is a tool for quality. It has played a significant role in improving product quality, safety and reliability. NDT organization shall be subjected to a quality system to ensure the quality of services provided to the client. Most NDT end users adopted some form of a quality system in their organization, e.g. ISO 9001. The qualification and certification of NDT personnel is performed according to ISO 9712 standard. An important effort has to be conducted to develop the qualification and certification of NDT personnel in Myanmar to ensure sustainability of the technology and independence of the country in this field.

V.1.4 Water Resources Management

The investigation of water resources under changing climate conditions is the need of the day as a national programme with high priority. The sources of groundwater, its recharge mechanism, mixing of aquifers, surface water/groundwater interrelationship, contamination of the groundwater and residence time distribution are the major factors which play an important role in the management of groundwater resources. The problems can be addressed more effectively when isotopic techniques are integrated with conventional hydrological methods. Myanmar is participating in the regional projects for human resource development in this field, but the analytical facilities are not adequate within the country. There is a great need to establish a state-of-the-art isotope hydrology laboratory to address these problems for sustainable management of groundwater resources. Myanmar plans to initiate a project on enhancing water resources management through infrastructure development and isotope hydrology applications for which the IAEA's technical assistance would be requested.

The ongoing 2016-2017 Myanmar TC Program is addressing the following:

MYA7006 (2016-2017)

Title: Establishing Infrastructure for the Application of Isotope Hydrology in Water Resources Management

FOA: Water resources management

Objective: *To enhance water resources management in Myanmar through infrastructure development and isotope hydrology applications.*

V.1.5 Radiation Safety

In the 2016-2017 TC Cycle, Myanmar will continue to utilize technical cooperation through the relevant regional projects that address each relevant thematic safety area. Further capacity-building in Myanmar's radiation safety and radiation protection will also be provided directly with the Department of Nuclear Safety

and Security where relevant. A top priority will be to further develop its radiation safety infrastructure, and its competencies in radiation protection and safety, especially in its human resources

V.1.6 Environmental Protection and Monitoring

Myanmar has about 2400 kilometer long coastal line and fish and shrimp have been an important export items. The fishery sector is of major importance to Myanmar as the fifth largest foreign currency earner for the country. Sustainable management of the ecosystems is vital for national development. Marine environment is subject to contamination by disposal of sewage, dumping of industrial wastes, oil from ships and boats, municipal waste and also uncontrolled release of radioactivity following the nuclear events in the region. Increased marine pollution could affect marine resources and development of tourism industry.

The studies on seawater, sediment, aqua products and other biota to identify pollutants, estimate radioactivity of main effluent in coastal and in marine environment and the establishment of marine baseline data are needed for the sustainability of marine eco-system. Similarly, measurement of particulate matter in air using nuclear techniques is also important in environmental pollution. The Department of Atomic Energy (DAE) is conducting the radioactivity monitoring and certification of imported dairy products and exported agricultural product other than measurement of various radioisotopes in marine samples. Myanmar plans to initiate marine environmental radiation monitoring for which Agency's technical assistance will be required. Environmental radiation monitoring will be carried out in high priority areas such as seawater, sediment, aqua products and other biota. It will enable identifying pollutants, estimate radioactivity of main effluent in coastal and in marine environment and the establishment of marine baseline data other than investigation and monitoring of air particulate matter pollution and investigation and study on natural radiations. The environmental radiation monitoring laboratory established at the DAE needs to be strengthened and upgraded to enhance the capacity for assessment of risks associated with consumption of radioactively contaminated sea foods, and for analysis of a broader range of radionuclide potentially associated with various nuclear accident scenarios. To add non-nuclear pollutants of concern (toxic trace elements, pesticides and petroleum hydrocarbons)

V.2. Medium-Term Programme

The strategic areas of priority for the IAEA cooperation in Myanmar for the medium term are mostly a continuation from the short term priorities outlined below:

- **Human Health:** In continuation of the ongoing capacity-building efforts in Myanmar, the focus of IAEA's technical cooperation programme will continue to be to enhance nuclear medicine and radiotherapy infrastructure: training of professional and assistance to improve QA/QC and safety of the patients and the staff at the workplace. Furthermore, there is a commitment to have a fully functional National Secondary Standards Dosimetry Laboratory in place and operation by the medium-term.
- **Nutrition:** The IAEA's technical cooperation programme will continue to support the use of stable isotope techniques in nutritional assessment through training of nutrition and public health researchers and technicians, procurement of the necessary instruments and supplements and assistance to analyze and interpret the results to provide the evidence-base to policy makers in Myanmar that can help them assess the success of the current strategies and adjust/modify them as necessary.
- **Food and Agriculture:**
 - **Plant Mutation Breeding**

Crops (rice, food legumes, maize, and oil seed crops) have to be improved to mitigate the effects of the climate change, to be improved tolerance to abiotic stresses (floats, submergence, salinity, droughts) and biotic stresses (diseases, pests, and weeds). Rice, as a staple crop in Myanmar, needs to be improved through mutation breeding technologies and other related technologies.
 - **Soil and Water Management**

Improving soil fertility and productivity and climate resiliency of rice is a priority. Enhancing rice productivity and other crops such as sunflower, chickpeas and legumes in rice-based farming systems is possible by combining intensive rice production technologies with conservation agriculture (CA) practices and other resource-conserving technologies that reduce environmental impacts, such as minimum tillage and direct/drill seeding, precise water management, crop diversification, and site-specific and crop need-based plant nutrient management. Such eco-efficient practices are expected to raise land and water productivity, improve resource use efficiency, reduce risks and vulnerability of cropping systems to climate change, diversify farm income, and improve family nutrition and livelihood. Optimizing mineral nutrition through co-application of chemical/organic fertilizers, natural' (plant-produced) hormones, additives and bio-fertilizer (a suit of beneficial microorganisms) have the most potential to gain appreciable yield increases, decrease emissions of greenhouse gases, reduce the use of N-based fertilizers and/or an increased assimilation efficiency of applied N in a wide range of field crops including rice which also lead to improving soil fertility. The use of nuclear techniques including N-15, C-13, O-18 and H-2 provide critical information on most strategically important issues of soil/land, nutrient and water management, and conservation in agro-ecosystems.
 - **Insect Pest Control**

The use of SIT should be explored on the suppression of fruit flies, moths and control of disease vector mosquitoes. In the area of insect pest control, increasing awareness and knowledge of decision-makers in the public and private sectors on the role of integrated area-wide management of major fruit fly pests and the use of environment-friendlier suppression techniques, with the objective to increase food security, to meet international standards by integrating a series of newly validated biotechnologies and promoting sustainable commercialization for area-wide pest management programmes and promote international trade. Also the objective to explore the use of SIT as a novel technique for control of disease vector mosquitoes *Aedes albopictus* and *Aedes aegypti*.

▪ **Livestock Production**

The contribution of the livestock sector to the livelihoods of subsistence farmers should be supported. An integrated approach to identify alternative feed resources (whilst protecting the environment), synchronized reproduction and breeding actions to optimize birthing of livestock with selected genotypes and phenotypes, and the timely diagnoses of animal and zoonotic diseases such as Foot-and-Mouth disease, Avian Flu needs to be further explored. For livestock, the optimal use of available feed resources to improve animal nutrition (selection of feed that supports energy conversion with less cfc gas production) to provide better nutritioned animals; the phenotypic and genotypic selection of genetic traits to allow for animals that provide more and of better quality milk and meat as well as their adaptation to local conditions (ie heat tolerance, disease resistance, draught power); and the quality assured diagnoses and control of transboundary animal and zoonotic diseases, are important. The quality assured practises to improve livestock production should be enhanced. The enhanced high quality livestock production to satisfy own consumption and the export market is a priority and should be the main outcome target.

• **Radiation Technologies Applications:**

▪ **Irradiation Technologies**

- **Electron Beam:** Establishing radiation processing with electron beam machines for applications like sterilization of medical products, food processing and others like value addition of precious and semi-precious gem stones to derive decisive economic and environmental advantages will be the focus of Myanmar for meeting the needs of end-users in food and agriculture sectors, industry, medical products sterilization and production, gem stone industry. Myanmar will seek techno-financial assistance from the IAEA to establish an Electron Beam Irradiation Facility in the country This facility will aim to provide irradiation services to the end users for various commercial application as well as will be used for studies and scale-up from research and development stage to semi-commercial scale for processing of raw material primary products to value added secondary products. Myanmar will utilize the experience gained in the current TC project 2016-17 that focus on gaining an understanding and experience in various aspects related to establishment, operation and utilization of such facilities and generating an awareness of the use of this technology among the stakeholders.
- **Gamma Irradiation Facility:** The existing gamma irradiation facility is more than three half-life (15 years) old, resulting in a low dose unsuitable for some research and development work. Therefore upgrading of current gamma irradiation facility is required. Myanmar would like to further promote the use of radiation application technologies in medicine, food and agriculture, industry, environmental remediation and other research areas.

▪ **Radiation Technologies for Measurement**

- **Radiotracers and Sealed Sources Applications:** The needs for such applications and related qualification of personnel will be growing during future years. The qualification and certification of personnel under ISTRA certification system will be a key priority to ensure the sustainability of the technologies.
- **Non Destructive Testing:** The establishment of the full NDT structure for qualification and certification of NDT personnel is a long process including the creation of an NDT society with all stakeholders, training center (s) and national certification body will remain a key priority during many years. The last step will be the international accreditation and recognition of the certification body.

- **Water Management:** The IAEA has already provided assistance to Myanmar in this field and additional support is still needed in the near and medium term, in view of the extent of issues affecting the water sector nationwide. In particular, facilities will be established for application of isotope hydrology techniques for water quality survey and water resources management in the country.
- **Radiation Safety:** With the continued capacity-building activities that Myanmar will have absorbed in radiation safety and radiation protection, steady improvements can be expected in the medium term, particularly in Myanmar's efforts to update its Nuclear Law, further develop its core radiation safety infrastructure and regulatory functions, improved capacities in occupational exposure, emergency preparedness and response, and infrastructure for the safe management of radioactive waste.
- **Nuclear Science and Technology Education:** Nuclear science curriculum is old and most of the related laboratory equipment at the teaching institutions is out-of-order. It is necessary to refurbish the laboratory facilities and also to develop the nuclear science curriculum on modern lines.

More specific details for the medium term are provided below:

V.2.1 Human Health

In the field of human health, use of modern technology leads to improved precision of cancer diagnosis and an increased quality of cancer therapy. The focus of the IAEA's technical cooperation programme will continue to be on building capacities in nuclear medicine and radiotherapy infrastructure, including training of professionals and assistance to improve quality management processes for safety of the patients and the staff.

V.2.1.1 Nuclear Medicine

The recent establishment of the Cyclotron and PET/CT facility would require continuous support in training professionals in the field, such as Nuclear Medicine physician, technologist, nurse, radiopharmacist/chemist and medical physicist (and operators), in order to provide optimal clinical services to the people. Activities geared towards extending the clinical application of hybrid imaging modalities in the management of patients with non-communicable diseases (Cardiovascular diseases, cancer, pediatric population, etc) should be in place. Therapeutic nuclear medicine services should be strengthened in order to provide holistic services to patient management.

V.2.1.2 Radiotherapy

Myanmar's four radiotherapy centers are now equipped with Linear accelerators and CT simulators. Training and support will be provided for oncologists, medical physicists and RTTs for the transition from 2D to 3D conformal radiotherapy. Further activities will focus on quality control in 3D planning and strengthening local training schemes in the radiation medicine disciplines.

V.2.1.3 Secondary Standard Dosimetry Laboratory

A new irradiation room dedicated for therapy level calibrations has been already included in the construction of new SSDL premises, established under MYA6028 during 2014-2015, as provision for therapy level calibration services planned in the future, taking into account future needs associated with planned upgrade of existing radiotherapy infrastructure in Myanmar. As discussed and preliminary agreed with NLO, the new therapy level irradiation room could be adequately equipped (therapy level Co-60 irradiator, ancillary items, dosimetry tools) within few years, most likely through a new national IAEA TC project during 2018-2019. Agency support will be needed to assist in further extension of calibration services provided by the SSDL of Myanmar for end-users in the field of radiation therapy dosimetry. In addition, international recognition of the SSDL will be supported through (i) implementation of a Quality Management System (QMS) accredited in accordance to the ISO17025 (ii) membership of the SSDL of Myanmar in the IAEA/WHO network of SSDLs.

V.2.2 Nutrition

During the previous years, there was an increase in awareness of the importance of nutrition in the national development among policy makers, government institutions and the civil society. The government has increased its expenditures on health and nutrition; it has upgraded the Department of Public Health and the National Nutrition Council to Directorate level. To improve nutrition among the Myanmar population, especially among children and women of reproductive age, Myanmar has previously implemented national programmes to control/eliminate macro- and micronutrient deficiencies including: Protein and Energy Malnutrition; Iron Deficiency Anemia; Iodine Deficiency Disorders; Vitamin A Deficiency; Vitamin B1 Deficiency. Activities under TC can support decision makers in Myanmar in the development of new policies that target emerging or unsolved nutrition problems, such as stunting and suboptimal infant and young child feeding practices.

Stable isotope techniques can be used to measure human nutritional status and can give an objective picture of the situation in Myanmar. They can help policy makers to assess the success of the current strategies programmes and adjust/modify them as necessary. The role of the IAEA's TC programme is to support the use of stable isotope techniques in nutritional assessment through training of nutrition and public health researchers and technicians, procurement of the necessary instruments and supplies and assistance to analyze samples and interpret the results to provide the evidence-base.

V.2.2.1 Exclusive breastfeeding

According to UNICEF, between 2007-2011 only 24% of infants under six months of age were exclusively breastfed and 65% were reportedly breastfed up to 2 years of age. During the important transition to complementary feeding between 6 and 9 months of age, one fifth of young children were not introduced to other solid foods. Breastfeeding and complementary feeding are key contributors to children's nutrition and health during the first two years of life. Almost all the countries in the world have implemented programmes to promote infant and young child practices. Myanmar aims at increasing the rate of exclusive breastfeeding to 60%. Evaluation of these programmes are very important, but are based on reported data that can be biased and unreliable.

Under a previous Technical Cooperation project, the Department of Medical Research of Myanmar was equipped with the Fourier transform infrared spectroscopy (FTIR) that can be used to assess breastfeeding practices after appropriate training.

V.2.2.2 Vitamin A

More than 30% of children under 5 years of age had subclinical vitamin A deficiency in 2003. Under its national nutrition programme, vitamin A supplementation is one of the strategies that Myanmar has implemented to eliminate vitamin A deficiency. This strategy aims to improve the health and nutritional status of children through biannual universal distribution of high dose vitamin A capsules (100,000 to 200,000 IU) to 6-59 months of age children. In the context of fortification (large scale or home-based), infants and children will benefit from additional intake of vitamin A through breast-milk or family food.

V.2.2.3 Body Composition and Physical Activity

The post 2015 framework includes reducing rates of childhood overweight, and one of the opportunities to address this is the intensification of school-based nutrition activities. Although obesity does not constitute a problem at this time in Myanmar (only 2% of children under 5 years of age were overweight in 2009), the early introduction of programmes that can promote nutrition and physical activity, among others, can prevent the occurrence/the increase of overweight and obesity among children and will help the country to avoid the double burden of malnutrition. The IAEA supports the application of stable isotopes to assess total body water for the measurement of body composition (lean mass and fat mass) and total energy expenditure to validate the measurement of physical activity. Capacity to measure body composition using the deuterium dilution technique was already built.

V.2.3 Food and Agriculture

Rice is the staple food of Myanmar people. Paddy is grown on 16 million acre in monsoon and on 3 million acre in summer. Once the top exporter of rice in the world, Myanmar's rice exports now account for a negligible share of the world market.

Rice bacterial blight (BB) caused by *Xanthomonas oryzae* pv *oryzae* (Xoo) is one of the most destructive diseases of rice throughout the world. Yield losses due to bacterial blight disease are thought to be higher in tropical Asian countries including Myanmar than in temperate area countries because virulent populations of this pathogen become prevalent in the tropical area. Producing improved rice plants for bacterial blight resistance requires rigorous application of mutation breeding like gamma radiation and EMS (ethyl methanesulfonate). Department of Biotechnology, Mandalay Technological University, Ministry of Science and Technology*, plans to initiate a project on Bacterial Blight Resistant Mutants in Rice by Induced Mutagenesis for which the IAEA would provide much assistance. A bacterial blight-resistant rice variety obtained from this project will lead to a reduced use of chemicals and an improved yield leading to an increased income of the farmers.

Myanmar is on the list of 25 countries worldwide that will be most affected by climate change according to the Notre Dame Global Adaptation. Impact of climate change in Myanmar is evidenced by a shortening of the monsoon period with extreme rain and high temperature. As a consequence, lesser inflows into the reservoirs result in the irrigation water shortage particularly in the dry season. Moreover, flooding has been a yearly occurrence in lower Myanmar. Salinity is one of the major stresses in the delta and coastal area of lower Myanmar. Salt stress is also a worsening problem in inland area because of the buildup of salinity as a consequence of excessive use of irrigation water with improper drainage coupled with the use of poor quality irrigation water. Biotechnology Research Department, Mandalay Technological University, is carrying out research on rice improvement through radiation mutation breeding technique for sustainable agricultural development using Co-60 gamma facility at DAE. The IAEA's technical assistance will be sought for human resource development and expert advice on the improvement of climate proofing rice varieties using radiation induced mutation breeding techniques.

The total global emission of CO₂ from soils is recognized as one of the largest fluxes in the global carbon cycle and small changes in the magnitude of soil respiration could have a large effect on the concentration of CO₂ in the atmosphere. Concern for soil erosion and environmental quality has evolved from the link between global warming and atmospheric carbon dioxide (CO₂) which has led to a focus on soil carbon (C) storage in cultivated slopes. In dry zone area of Myanmar, there are a lot of soil erosion problems. Myanmar has participated in the regional project RAS 5055 and analysis of fallout radionuclides (FRNs), soil organic carbon (analysed in China with support of the IAEA), soil nutrient (N,P,K) etc., are ongoing. Department of Biotechnology, Mandalay Technological University, plans to initiate the project on improving farming practices under different land uses in Myanmar, based on the relationship of soil organic carbon and soil nutrients. IAEA's assistance would be required to develop laboratory facilities for Gamma Spectrometry to measure FRNs (fallout radionuclides), soil hydrometer to measure soil texture, and measuring soil nutrients (N,P,K). The project, focused on relationship between soil erosion rate and carbon sequestration on dry zone area, will be beneficial for the development of agriculture in Myanmar, and also augment the ongoing efforts in reducing global warming around the world.

V.2.3.1 Plant Mutation Breeding

Mutation breeding offers a fast and environmentally safe way for improvement of crop varieties that can yield under adverse conditions, such as saline soils, or are resistant to certain diseases. Capacity building is needed to strengthen the use of mutation breeding, in particular the use of biotechnologies that speed up the development of new mutant varieties, as well as the molecular discovery of mutation that will lead to the development of molecular markers.

Rice bacterial blight (BB) is one of the most destructive diseases of rice resulting in yield losses. Moreover, to mitigate the affects of the climate change, flooding and salt stress on rice yields, there is

a need for improvement of rice varieties to make them resistant to diseases and tolerant to abiotic stresses. Mutation breeding using irradiation of seeds with ionizing radiation such as gamma rays has shown to have an enormous potential to develop improved crop varieties in short time and environmentally safely manner. Mutation breeding will be used to address the yield reductions caused by rice bacterial blight and climate change. The mutation breeding activities are expected to continue on the basis of results and achievements of the previous projects.

V.2.3.2 Soil and Water Management

Improving soil fertility and productivity and climate resiliency of rice is a priority. Enhancing rice productivity and other crops such as sunflower, chickpeas and legumes in rice-based farming systems is possible by combining intensive rice production technologies with conservation agriculture (CA) practices and other resource-conserving technologies that reduce environmental impacts, such as minimum tillage and direct/drill seeding, precise water management, crop diversification, and site-specific and crop need-based plant nutrient management. Such eco-efficient practices are expected to raise land and water productivity, improve resource use efficiency, reduce risks and vulnerability of cropping systems to climate change, diversify farm income, and improve family nutrition and livelihood. Optimizing mineral nutrition through co-application of chemical/organic fertilizers, natural (plant-produced) hormones, additives and bio-fertilizer (a suit of beneficial microorganisms) have the most potential to gain appreciable yield increases, decrease emissions of greenhouse gases, reduce the use of N-based fertilizers and/or an increased assimilation efficiency of applied N in a wide range of field crops including rice which also lead to improving soil fertility. The use of nuclear techniques including N-15, C-13, O-18 and H-2 provide critical information on most strategically important issues of soil/land, nutrient and water management, and conservation in agro-ecosystems.

V.2.3.3 Insect Pest Control

The use of SIT should be explored on the suppression of fruit flies, moths and control of disease vector mosquitoes. In the area of insect pest control, increasing awareness and knowledge of decision-makers in the public and private sectors on the role of integrated area-wide management of major fruit fly pests and the use of environment-friendlier suppression techniques, with the objective to increase food security, to meet international standards by integrating a series of newly validated biotechnologies and promoting sustainable commercialization for area-wide pest management programmes and promote international trade. Also the objective to explore the use of SIT as a novel technique for control of disease vector mosquitoes *Aedes albopictus* and *Aedes aegypti*.

V.2.3.4 Livestock Production

The use of nuclear, nuclear related and nuclear derived immunological, molecular, tracing and labeling technologies should be explored to provide livestock able of consuming feed in an optimal way, to give more and of better quality milk and meat as well as their adaptation to local conditions (ie heat tolerance, disease resistance, draught power); to have the technologies in place to diagnose and control of transboundary animal and zoonotic diseases. A database of alternative local feeds should be developed in support and implement a nutrition programme. The phenotypic and genotypic library should be enhanced to form the basis of a progressive reproduction and breeding programme to select for favourable traits such as heat tolerance, disease resistance, milk and meat production and draught power. The selected animals should be protected from infections and production diseases and where possible these diseases should be eliminated.

V.2.4 Radiation Technologies Applications

V.2.4.1 Irradiation Technologies

V.2.4.1.1 Electron Beam

Myanmar would like to further promote the use of electron beam application technologies in medicine, food and agriculture, industry, environmental remediation and other research areas. In this respect, the experience gained in establishing and operating the established electron beam facility will be utilized to act as a catalyst to support its enhanced utilization in the local industries to produce value added materials and services and setting up of many such facilities in private sector or through private-public partnerships

V.2.4.1.2 Gamma Irradiation Facility

Gamma radiation technology applications in the areas of sterilization of medical products and food irradiation are also well established worldwide. Myanmar will strive to derive socio-economic benefits from radiation technology in the long term by establishing a service center equipped with complimentary techniques of electron beam and gamma radiation facility for which the necessary infrastructure both for human capacity as well as laboratories would need to be developed.

V.2.4.2 Radiation Technologies for Measurement

Myanmar would like to further promote the use of radiation application technologies in medicine, food and agriculture, industry, environmental remediation and other research areas. In this respect, there are plans to establish gamma irradiation facility, X-ray facility and an Electron beam facility for applied research and development.

Being an agricultural based country, improving agricultural productivity is necessary by using suitable fertilizers. Natural fertilizer such as plant growth promoter can help in increasing productivity in an environment-safe manner. Moreover, Upper Myanmar is dry zone, and this region needs the material to maintain water for longer period. There is a need to produce both plant growth promoter and super water absorbent using natural polysaccharide using radiation technology. The application of radiation technology in industry sector is also very important. To upgrade the property of rubber product, gamma radiation can be applied for rubber vulcanization. The existing gamma irradiation facility is more than three half-life old, resulting in a low dose unsuitable for some research and development work. Therefore upgrading of current gamma irradiation facility is required for which IAEA's help would be sought.

Various cross-linking techniques have been extensively used to natural polymers to produce biomaterials. These may include the harmful chemical additives. Further there is always the possibility of the presence of impurities in the final product which may lead to unwanted side effects. As a solution to this problem, radiation cross-linking for developing biomaterials has been studied in other countries. Both sterilization and cross-linking can be done in one step. No additional heat is necessary for heat sensitive conditions. On the other hand, tissue engineering is one of the most exciting interdisciplinary and multidisciplinary research areas and is growing exponentially over time. According to the WHO, the deaths caused by burns occur mostly in low and middle income countries. This is just one area where tissue engineering can solve the problems. There is a need for the production of effective and inexpensive biomaterials in biomedical field. Effective biopolymer based scaffolds which promote the tissue regeneration process will be created from the naturally abundant biopolymer by using the radiation technology and tissue engineering approach. As the IAEA is facilitating the Member States to use tissue engineering technology to develop the new tissue created either from stem cells or synthetically produced biomaterials including natural biopolymers, the proposed project will combine the advantages of radiation technology and tissue engineering

technology. The project proposed by Biotechnology Research Department, Kyaukse, on the Use of Radiation Technology for the Preparation of Chitosan Hydrogel Scaffolds in Potential Biomedical Application will hold the promises for the patients with the tissue damage after surgery or traumatic injury.

V.2.4.2.1 Radiotracers and Sealed Sources Applications:

The needs for such applications and related qualification of personnel will be growing during future years. The qualification and certification of personnel under ISTRA certification system will be a key priority to ensure the sustainability of the technologies.

V.2.4.2.2 Non Destructive Testing

The establishment of the full NDT structure for qualification and certification of NDT personnel is a long process including the creation of an NDT society with all stakeholders, training center(s) and national certification body will remain a key priority during many years. The last step will be the international accreditation and recognition of the certification body.

V.2.5 Water Resources Management

Water assessment studies are needed to project the demand for water of different quality for different purposes in the medium to long-term. Nuclear techniques have the potential to contribute significantly to sustainable water resource management by providing basic data and information required to plan, develop and rationally exploit ground and surface water resources. The IAEA has already provided assistance to Myanmar in this field and additional support is still needed in the medium term, in view of the extent of issues affecting the water sector nationwide. In particular, facilities for isotope analysis will be established and isotope hydrology techniques will be applied in water quality survey and water resources management in the country. Efforts will be made to apply the isotopic methods to identify safe water supplies. The IAEA's assistance would be requested for the needed inputs to these activities through provision of analytical tools and specialised training and expert advice.

V.2.6 Radiation Safety

The continued capacity-building of Myanmar's national radiation safety infrastructure is the key factor for the sustainable promotion of peaceful applications of nuclear science and technology. The Agency's support will continue in assisting the Government in establishing key elements of the national infrastructure including training of more qualified staff in radiation protection, in particular occupational and public radiation protection. Myanmar will need to continue human resource development for its regulatory framework and its emergency planning and response preparedness, and all the relevant Thematic Safety Areas designated by the IAEA, in order to effectively work with nuclear applications.

V.2.7 Environmental Protection and Monitoring

Based on country conditions, there should be a reasonable and efficient approach to the use of natural resources to ensure that the balance is maintained between socio-economic developments and environmental protection. Protection from the impact of climate change, and ensuring protection of forests, land, mineral resources will remain a challenge of the government.

There is a need to develop both the infrastructure and human capabilities to strengthen the national environmental management system, as well as to improve laws and regulations on environmental conservation and pollution control. There is also need for the effective monitoring, inspection and evaluation of the environmental management system for the promotion of scientific research, the construction of library network and raising awareness about the environment in the society.

The priority areas to be focused on:

- Environmental radioactivity monitoring;

- Application of nuclear techniques for controlling microbial hazards in water environments;
- Treatment of industrial effluents by nuclear and related techniques;
- Biodegradation of chemical pollutants, using potential microbial strains along with nuclear approaches;
- Development of nuclear analytical techniques in environmental monitoring, food and quality control in view of nuclear power programme pursued in the region;
- Establishment of a stationary national air monitoring network and an early notification air pollution network.

V.2.8 Nuclear Science and Technology Education

Nuclear Physics and Chemistry Laboratories at University of Yangon were established under IAEA technical assistance programme several decades ago. Since then, it has been involved in teaching Nuclear Physics and Chemistry experimental techniques to undergraduate students and carrying out research projects. However, nuclear science curriculum is old and most of the nuclear equipment are out-of-order. It is necessary to refurbish the laboratory facilities and also to develop the nuclear science curriculum on modern lines. Myanmar would need Agency's help and assistance in developing nuclear science curriculum and refurbishing nuclear science laboratories for undergraduate and post-graduate students.

V.3 General Support Activities

In view of the pressing need to build a sustainable human capacity in all high priority nuclear techniques, particular efforts will be made to tackle this cross-cutting priority area, mostly through, specific and general training and scientific visits as well as support to the national education and training institutions. The proposed programme will further consolidate the momentum achieved so far in this important sector of socio-economic development.

Under an RCA project, Myanmar received technical assistance for the formulation of sustainable energy development strategies in the context of climate change. Assistance is still needed to initiate activities for energy planning studies in the country in which the IAEA can provide input in terms of provision of analytical tools and energy planning models, specialized training and expert support to help carrying out and evaluating these studies.

Regional Projects

In addition to the national TC programme, Myanmar gives importance to its participation in the RCA and non-RCA regional projects. This additional support will complement/supplement the assistance foreseen under the national projects with the particular aim to maximize the utilization of the national nuclear institutions and expertise, enhance the quality of nuclear services provided by these institutions and pave the way to accreditation.

Myanmar Government's active commitment in the projects implemented under the technical cooperation programme of IAEA, has made strategic contribution where distinct benefits can be derived through cooperative activities, including introducing nuclear technologies in various sectors of national economy, in-depth nuclear research advancement, implementing and harmonizing regulatory requirements and guidance on radiation protection and safety of nuclear technology applications, together with training of personnel involved in these activities. The agreed Country Programme Framework will promote the maximum utilization of the available nuclear infrastructure and the integration of nuclear techniques into national development programme for the socio-economic development of the country. It is expected that scope of the cooperation between Myanmar and the IAEA will continue to grow in conformity with the state policies and national development programmes.

ANNEX-I Compilation of Treaties under the Auspices of the International Atomic Energy Agency signed by the Member State

Multilateral Agreements

Acronym	Title	In Force	Status
P&I	Agreement on the Privileges and Immunities of the IAEA		Non-Party
VC	Vienna Convention on Civil Liability for Nuclear Damage		Non-Party
VC/OP	Optional Protocol Concerning the Compulsory Settlement of Disputes		Non-Party
CPPNM	Convention on the Physical Protection of Nuclear Material		Non-Party
CPPNME	Amendment to the Convention on the Physical Protection of Nuclear Material		Non-Party
NOT	Convention on Early Notification of a Nuclear Accident	1998-01-18	accession: 1997-12-18
ASSIST	Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency		Non-Party
JP	Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention		Non-Party
NS	Convention on Nuclear Safety		Non-Party
RADW	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management		Non-Party
PVC	Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage		Non-Party
SUPP	Convention on Supplementary Compensation for Nuclear Damage		Non-Party
RSA	Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA)	1991-03-19	Signature: 1991-03-19
RCA	Fifth Agreement to Extend the 1987 Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (RCA)		RCA Government Party
AFRA	African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) - Fourth Extension		Non-Party
ARCAL	Co-operative Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL)		Non-Party
ARASIA	Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) - First Extension		Non-Party

Safeguards Agreements

Reg.No	Title	In Force	Status
1662	Agreement between the Union of Myanmar and the IAEA for the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (with Protocol)	1995-04-20	Signature: 1995-04-20

ANNEX II – Myanmar TC Projects Implemented from 2012-2013 TC Cycle to current

1. Project Title / Objective / Primary Field of Activity

Myanmar				
Project	Years	Title	Objective	Primary FOA
MYA0009	2012-2014	Establishing an Information Communication Technology (ICT) Based National Training Centre for Nuclear Instrumentation	To strengthen and expand the national capacity for sustainable human resource development in the field of nuclear instrumentation.	01 - Capacity building, human resource development and knowledge management
MYA1014	2012-2015	Building National Capability to Use Radiotracer and Sealed Source Techniques in Industry	To build up national capability in radiotracer and sealed source techniques for industrial applications including for the provision of services to national industries	18 - Radioisotopes and radiation technology for industrial applications
MYA5020	2012-2015	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	To strengthen food security and to help local farmers and consumers through the development of new high yielding rice varieties with good eating quality.	20 - Crop production
MYA5021	2012-2013	Integrating Sterile Insect Technique with Other Biocontrol Tactics to Improve Diamondback Moth Control	To integrate SIT into other biocontrol techniques for DBM control in promoting the crop protection system.	23 - Insect pest control
MYA5022	2012-2015	Improving Animal Productivity through the Use of DNA-Based Technology and Artificial Insemination	To improve livestock productivity through the selection of superior breeding stock and to improve capacity in the use of molecular and related technologies for raising the genetic quality of local and adapted livestock breeds.	22 - Livestock production
MYA5023	2014-2016	Evaluating Nitrogen Use Efficiency Using Low Nitrogen Tolerant Rice Varieties	To determine the nitrogen (N) use efficiency of low N tolerant rice varieties screened in Myanmar through nitrogen-15 dilution method, and to demonstrate the effectiveness of these varieties in the farmers's fields.	21 - Agricultural water and soil management
MYA5024	2014-2017	Supporting the National Foot-and-Mouth Disease Control Programme	To increase productivity of the livestock sector by implementing sustainable strategies to control and eradicate Foot-and-Mouth Disease.	22 - Livestock production
MYA5025	2015-2017	Monitoring and Assessment of Watershed Management Practices on Water Quality and Sedimentation Rate of Inle Lake	To support environmental conservation of Inle Lake through improved monitoring, reporting and verification on water quality and sedimentation rate.	21 - Agricultural water and soil management
MYA6028	2014-2015	Establishing a National Secondary Standards Dosimetry Laboratory (Phase I)	To improve dosimetric accuracy in various fields of radiation dosimetry and to foster the safe use of every application of radiation technology in Myanmar through establishment of a National Secondary Standard Dosimetry Laboratory in accordance with relevant IAEA Safety Standards and guidance and following the methodology and essential elements of Thematic Safety Area (TSA-1).	29 - Dosimetry and medical physics
MYA6029	2014-2016	Strengthening Human Resource Capacity in Nuclear Medicine for Improving Diagnostic Procedures in Cardiology and Oncology	To improve human resource capacity in nuclear medicine services of Myanmar.	27 - Nuclear medicine and diagnostic imaging
MYA6030	2014	Support for Radiotherapy Capacity Building in Myanmar	To improve radiotherapy treatment in Myanmar, including a QA/QC programme of radiotherapy practice and staff training.	26 - Radiation oncology in cancer management
MYA6031	2015	Improving Radiotherapy Services in Myanmar	To improve radiotherapy treatment in Myanmar, including staff training in treatment techniques and QA/QC programme of radiotherapy practice.	26 - Radiation oncology in cancer management

2. Project Title / Budget by Year

Myanmar								
TC Project	Title	2012	2013	2014	2015	2016	2017	CORE TOTAL
MYA0009	Establishing an Information Communication Technology (ICT) Based National Training Centre for Nuclear Instrumentation	48 710	59 820	83 275	-	-	-	191 805
MYA1014	Building National Capability to Use Radiotracer and Sealed Source Techniques in Industry	53 610	50 910	41 790	43 965	-	-	190 275
MYA5020	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	29 710	35 530	55 745	35 615	-	-	156 600
MYA5021	Integrating Sterile Insect Technique with Other Biocontrol Tactics to Improve Diamondback Moth Control	49 355	45 610	-	-	-	-	94 965
MYA5022	Improving Animal Productivity through the Use of DNA-Based Technology and Artificial Insemination	48 065	48 365	49 655	57 625	-	-	203 710
MYA5023* (Footnote-A)	Evaluating Nitrogen Use Efficiency Using Low Nitrogen Tolerant Rice Varieties (Footnote-A)	-	-	-	-	-	-	0
MYA5024	Supporting the National Foot-and-Mouth Disease Control Programme	-	-	31 600	31 800	71 600	35 000	170 000
MYA5025	Monitoring and Assessment of Watershed Management Practices on Water Quality and Sedimentation Rate of Inle Lake	-	-	-	41 660	53 400	21 200	116 260
MYA6028	Establishing a National Secondary Standards Dosimetry Laboratory (Phase I)	-	-	19 000	29 600	-	-	48 600
MYA6029	Strengthening Human Resource Capacity in Nuclear Medicine for Improving Diagnostic Procedures in Cardiology and Oncology	-	-	38 200	56 800	104 800	-	199 800
MYA6030*	Support for Radiotherapy Capacity Building in Myanmar. [Deputy Director General (DDG) TC Reserve Funds]	-	-	40 000	-	-	-	0
MYA6031*	Improving Radiotherapy Services in Myanmar. [Deputy Director General (DDG) TC Reserve Funds]	-	-	-	40 000	-	-	0
SUB TOTAL		229 450	243 235	319 265	297 065	229 800	56 200	1 372 015
TC Cycle Total		469 685		616 330		286 000		

ANNEX III – Myanmar Near-Term Programme (2016-2017 TC Cycle)

1. 2016-2017 TC Projects with Project Title / Objective / Primary Field of Activity

Myanmar				
Project	Years	Title	Objective	Primary FOA
MYA1015	2016-2017	Establishing an Electron Beam Irradiation Facility (Phase I)	Establishing of an Electron Beam Irradiation Facility in Myanmar (Phase I)	18 Radioisotopes and radiation technology for industrial applications
MYA6033	2016-2017	Establishing a National Secondary Standard Dosimetry Laboratory (Phase II)	Establishment of A National Secondary Standard Dosimetry Laboratory (phase II)	29 Dosimetry and medical physics
MYA6032	2016-2018	Strengthening Human Resource Capacity in Nuclear Medicine and Radiotherapy Services for Improving the Diagnosis and Treatment of Cancer Patients	Strengthening human resource capacity in Nuclear Medicine and Radiotherapy services for improving the diagnosis and treatment of Cancer patients	26 Radiation oncology in cancer management
MYA5026	2016-2019	Improving the Livelihoods of Smallholder Livestock Farmers by Developing Animal Feeding Strategies for Enhanced Food Security	Improving the Livelihoods of Smallholder Livestock Farmers by the Development of Animal Feeding Strategies for Enhancing Food Security, Balancing Ration and Environment through Research	22 Livestock production
MYA1016	2016-2019	Building National Capacity in Radiotracer and Non Destructive Evaluation Techniques in Industry	Building National Capacity in Radiotracer and Non Destructive Evaluation Techniques in Industry	18 Radioisotopes and radiation technology for industrial applications
MYA7006 (Footnote-A)	2016-2017	Establishing Infrastructure for the Application of Isotope Hydrology in Water Resources Management	Establishment of Infrastructure for Application of Isotope Hydrology in Water Resources Management	15 Water resources management

2. 2016-2017 TC Projects with Project Title / Budget by Year

Myanmar								
TC Project	Title	2016	2017	2018	2019	CORE TOTAL	FNA	TOTAL with FNA
MYA1015	Establishing of an Electron Beam Irradiation Facility in Myanmar (Phase I)	53 240	53 360	-	-	106 600	0	106 600
MYA6033	Establishment of A National Secondary Standard Dosimetry Laboratory (phase II)	48 200	36 200	-	-	84 400	0	84 400
MYA6032	Strengthening human resource capacity in Nuclear Medicine and Radiotherapy services for improving the diagnosis and treatment of Cancer patients	78 240	111 640	118 720	-	308 600	0	308 600
MYA5026	Improving the Livelihoods of Smallholder Livestock Farmers by the Development of Animal Feeding Strategies for Enhancing Food Security, Balancing Ration and Environment through Research	61 000	46 320	46 240	5 000	158 560	0	158 560
MYA1016	Building National Capacity in Radiotracer and Non Destructive Evaluation Techniques in Industry	80 520	45 280	45 120	30 160	201 080	0	201 080
MYA7006 (Footnote-A)	Establishment of Infrastructure for Application of Isotope Hydrology in Water Resources Management	-	-	-	-	0	250 200	250 200
SUB TOTAL		321 200	292 800	210 080	35 160	859 240	536 900	1 396 140
TC Cycle Total		614 000		245 240				

Annex IV – Plan of Action

CPF Referenced Thematic Area	Proposed Action	Action Party	Expected Output	Time Frame	Project Number
Human Health	Nuclear Medicine To improve existing Capabilities to Provide distinct professionals support in the field, such as Nuclear Medicine physician, technologist, nurse, radiopharmacist /chemist and medical physicist (and operators), in order to provide optimal clinical services.	Ministry of Health* Yangon General Hospital including regional hospitals	<ul style="list-style-type: none"> • QA/QC programme of the PET-CT improved • CYLOTRON operations improved • In nuclear medicine: Radiochemistry Lab improved 	2016-2018	MYA6029 MYA6032
	Radiotherapy To strengthen human resource capacity in PET-CT, Cyclotron, and Linear Accelerator and HDR Brachytherapy services in Myanmar.		<ul style="list-style-type: none"> • Teletherapy with LINAC (2-D, 3-D) established • HDR Brachytherapy established 	2016-2018	MYA6032
	Secondary Standards Dosimetry Laboratory To improve dosimetric accuracy in various fields of radiation dosimetry and to foster the safe use of every application of radiation technology in Myanmar	Ministry of Science and Technology* Department of Atomic Energy	<ul style="list-style-type: none"> • Operational SSDL upgraded. • Accredited calibration services provided to end users. • Membership in IAEA/ WHO network of SSDLs gained. 	2016-2017	MYA6033
Food and Agriculture	Soil and Water Management To improve productivity of crops in rice-based farming systems is possible by combining intensive rice production technologies with conservation agriculture (CA) practices and other resource-conserving technologies that reduce environmental impacts.	Department of Agricultural Research	<ul style="list-style-type: none"> • Human Resource Development on isotopic techniques • Guidelines for improved water quality monitoring reporting and verification process of Inle Lake • Assessment Model validated 	2015-2017	MYA5025
	Livestock Production To enhance food security through the utilization of nuclear related and nuclear derived immunological, molecular, tracing and labeling technologies to develop the potential in local feed resources.	The Ministry of Livestock, Fisheries and Rural Development * National FMD Laboratory, Livestock Breeding and Veterinary Department	<ul style="list-style-type: none"> • Promote FMD vaccine production • Improve quality of FMD vaccine • Strengthening FMD diagnostic capacity • Establishment of FMD eradication zone starting in one region and gradually extending to other regions of the country • Increased awareness of farmers in feed balance diet to generate higher impact of feeding • Increased laboratory capacity building and trained personnel for research in field survey and laboratory for ruminant nutrition • Improved feed resources base for the condition of feed shortage 	2016-2019	MYA5024 MYA5026

Radiation Technologies Applications	Electron beam facility To establish an Electron Beam Irradiation Facility for improving the quality of products from the agriculture, livestock and industrial sectors.	Ministry of Science and Technology* Department of Atomic Energy	<ul style="list-style-type: none"> Human resource capacity building for electron beam application technologies completed 	2016-2017	MYA1015
	Radiotracers and Sealed Sources Applications The focus will be on radiotracers and nucleonic measurement systems applications for sediment transport investigation		<ul style="list-style-type: none"> Team in charge of radiotracers and nucleonic (sealed sources) techniques in sediment transport studies for applications in harbors and dams management in place coastal protection and oil and gas established and operational 		MYA1016
	Non Destructive Testing To contribute towards industrial development through capacity-building in radiotracer and sealed source techniques as well as conventional and advanced Non-Destructive Evaluation (NDE) techniques.		<ul style="list-style-type: none"> NDT team established and operational with special focus on oil and gas industry. 	2016-2019	MYA1016
Water Resources Management	To enhance water resources management in Myanmar through infrastructure development and isotope hydrology applications.	Ministry of Science and Technology* Department of Atomic Energy	<ul style="list-style-type: none"> Operational isotope hydrology equipment for groundwater mapping. Human Resource developed in isotope hydrology applications Information on groundwater recharge sources and dynamics gained, interaction between surface water and groundwater established, and aquifer vulnerability to pollution in the selected areas for sustainable development gauged. 	2016-2017	MYA7006

Annex-VI Counterpart Organizations/Departments/ Institutions

Counterpart	Activity	Contact / Address
<p>Ministry of Science and Technology (MOST)*</p> <p>Department of Atomic Energy (DAE)</p>	<p>The Ministry of Science and Technology (MOST) *is the focal point for all IAEA matters. Any work or business involving the IAEA must go through MOST and more specifically through the Department of Atomic Energy (DAE).</p> <p>The Union of Burma Atomic Energy Centre (UBAEC) was established in 1956 as a division under the Union of Burma Applied Research Institute (UBARI). The UBARI was reorganized as the Central Research Organization (CRO) which again changed to the new name of Myanmar Scientific and Technological Research Department (MSTRD). Until 1997, the AEC existed all along as a division under UBARI, CRO and MSTRD. The main objectives of DAE include carrying out research works for the development of nuclear technology in the country, implementing nuclear radiation protection, and to coordinate with government and private sector for nuclear technology applications and promotion</p> <p>The DAE comprises departments of Radiation Application, Radiation Protection, Reactor and Isotope, and Administration and Finance. Radiation Protection Department is responsible for Food & Environmental Monitoring, Occupational & Medical Exposure, Waste Management & Transport and Regulatory Control. Radiation Application Department comprises Divisions for Nuclear Technique, Irradiation, Radiation Biology, Research and Health Physics. Although Myanmar has.</p> <p>The current activities of DAE include providing services for monitoring of radioactivity; preparing Atomic Energy Regulation in order to accomplish the provisions of Atomic Energy Laws; Issuance of licenses for importing and re-exporting of radiation sources; Radiation Dosimetry Services for radiation workers in the country; Inspection of used radioactive sources and enforcement of regulatory compliance; Maintenance of nuclear instruments, calibration, and testing of nuclear and testing of instruments from various governments; Sterilization of tissue grafts; Study of radiation effects on various materials using Co-60 Gamma sources. All regulatory and technical cooperation matters are dealt with by the DAE.</p>	<p>Dr. Khin Maung Latt Director General (DAE) and NLO Ministry of Education Ph: +95 67 404277 Fax:+95 67 404288 Email: Sayarkyee9@gmail.com</p> <p>Building-21 Ministry of Education Nay Pyi Taw, Myanmar</p> <p>Dr. Theingi Maung Manug Director (DAE) and NLA Ministry of Education Ph: +95 67 404460/404462 Fax:+95 67 404461 Email: theingim@gmail.com Most18@myanmar.com.mm</p> <p>Building-21 Ministry of Education Nay Pyi Taw, Myanmar</p>
<p>Ministry of Environmental Conservation and Forestry (MOECAF)*</p>	<p>Ministry of Environmental Conservation and Forestry (MOECAF)* is mainly responsible for conservation and harvesting of Myanmar's forest resources in sustainable manner, and environmental protection. Previously from 1948 to 1992, Ministry of Environmental Conservation and Forestry and Ministry of Agriculture and Irrigation were under the same Ministry as Ministry of Agriculture and Forestry.</p>	<p>Mr. Kyaw Zaw (Director) Union Minister's Office Ministry of Natural Resource and Environmental Conservation Ph: +95 67405009, +95 67 405388 Fax: +95 67 405404 Email: kyawzaw.fd@gmail.com Building No.28 Nay Pyi Taw, Myanmar</p>
<p>Ministry of Agriculture and Irrigation*</p>	<p>The Ministry of Agriculture was renamed as Ministry of Agriculture and Irrigation* on 8 August 1996 to acknowledge the importance of irrigation in agriculture. The main objective of the MOAI is increasing of crop production In the last 4 TC cycles since 2003, the lion's share of the TCP in Myanmar has been in agriculture (crop management and mutation breeding; livestock breeding; sterile insect techniques) i.e. a rice-related project has always been prioritized, submitted and approved.</p>	<p>Dr. Ye Tint Tun Director General Ministry of Agriculture and Irrigation* Ph: +95 67 416533 Fax: +95 67 416535 Email: dgdar.moai@gmail.com</p> <p>Ministry of Agriculture and Irrigation Department of Agricultural Research (DAR) Nay Pyi Taw, Myanmar</p> <p>Dr. Su Su Win Director Soil, Water Utilization and Agricultural Engineering Division Department of Agricultural Research (DAR) Ph: +95 9 2024052 Fax: +95 67 416 535 Email: susuwinmyanmar@gmail.com</p> <p>Department of Agricultural Research (DAR) Yezin, Nay Pyi Taw, Myanmar</p>

