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The Role of Technical Cooperation Programs of International Atomic Energy Agency In Enhancing Socioeconomic Development In Sudan

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DEDICATION

TO

My family whom I love very much,

And

To all my friends,

I dedicate this effort

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ABSTRACT

This study has been designed to highlight the impact of the International Atomic Energy Agency (IAEA) Technical Cooperation Programmes in Enhancing Socio-economic Development in Sudan.

The main objective of this study is to reflect the role of Nuclear Techniques in development through the IAEA provision of the Technical Cooperation (TC) projects in Sudan; and to show their impact on socio-economic activities, technology transfer, and whether the targeted institutes become economically self-reliant.

This study as an analytical study uses secondary sources, namely reports from IAEA and coordinators of the projects, also uses primary data through conducting interviews. The study has come out with some main findings: that the IAEA technical assistances played a major role in addressing pressing issues such as socio-economic development, sustainable development and management of different fields related to application of nuclear technology. Sudan Atomic Energy Commission (SAEC) in its capacity as the national coordinating body with respect to Technical Cooperation (TC) is highly appreciated and the projects had achieved a high implementation rate, the management of TC projects activated at the national level were successful and have significant impact particularly in human health, agriculture, and NDT. The total number of projects increased rapidly from 16 projects in 1995 to 55 projects in 2005, and where most of the projects attained their objectives; showing good results in socio-economic and infrastructural indicators, are continuous sustainable and they continue to provide services to the end-users. But some projects were not able to fulfill their objectives due to lack of some local component and other constraints, besides that the local Government component is very weak. From the results some recommendations can be advanced and summarized as follows:-

- Convince the decision makers and end-users with the importance of new nuclear techniques, and their contribution to national development

- Increase the local government inputs (local component), provide sufficient financial support to the projects, and collaboration with other organizations
- There must be good connection with the counterparts of the projects, and technical officer at SAEC and IAEA,
- Strengthening communication with institutes outside of Khartoum

بسم الله الرحمن الرحيم

ملخص الدراســـــــــة

وضعت هذه الدراسة لتوضيح أثر العون الفني المقدم من قبل الوكالة الدولية للطاقة الذرية (IAEA) و مساهمتها في تحفيز التنمية الإقتصاديه و الاجتماعيه في السودان.
تلخصت الأهداف الأساسية لهذه الدراسة في: توضيح دور التقانة النووية في التنمية من خلال مشاريع العون الفني المقدم من IAEA للسودان، كذلك توضيح أثرها في تطوير البنية التحتية، عكس التقانه المنقولة، و توضيح الاثر الاقتصادي و الاجتماعي لهذه الموسسات وقدرتها علي تحقيق الاعتماد علي الذات اقتصادياً.

هذه الدراسة دراسة تحليلية استخدمت المصادر الثانوية خاصة التقارير الصادرة من IAEA و منسقي المشاريع، وكذلك استخدمت المصادرالأولية عن طريق المقابلات الشخصيه مع المسؤلين. من أهم نتائج الدراسه أنها كشفت أن المساعدات الفنية المقدمة من قبل الوكالة الدولية IAEA لعبت دوراً أساسياً في بعض المحاور مثل تنميه الاقتصاد و المجتمع، التنمية المستدامة في المجالات المختلفة المتعلقة بالتطبيقات النووية. كما كشفت الدور المهم لهيئة الطاقة الذرية السودانية في إدارة هذه المشاريع حيث تعتبر المنسق القومي للمشاريع بالسودان كما نجد أن هذه المشاريع علي المستوي القومي قد نجحت في إحداث الأثر الإيجابي خاصة في مجال الطب، الزراعة، و الاختبارات الغير إتلافية في الصناعة. حيث تزايد عدد المشاريع المدعومة (قومية، إقليمية) من 16 مشروعاً في 1995 إلي 55 مشروعا في 2005. و كانت نسبة تنفيذ هذه المشاريع عالية، و حققت أهدافها، وتحصلت علي نتائج جيده في مؤشراتها الاقتصادية و الاجتماعية، تحسين البنية التحتية وهي ما زالت مستمرة في تقديم الخدمات للمستفيدين. ولكن هناك بعض المشاريع فشلت في انجاز أهدافها مع نسبة تنفيذ ضعيفة وذلك نسبة لعدم توفر المكون المحلي بواسطة الدولة و معوقات أخري بالاضافة الي أن الدعم المحلي المقدم من الدولة يعتبر ضعيفا.

من النتائج السابقة خلصت الدراسة إلي بعض التوصيات تلخصت في الآتي: -

- إقناع متخذي القرار و المستفدين بأهمية التقنية النووية و أسهاماتها في التنمية القومية.
- زيادة مدخلات الحكومات المحلية(المكون المحلي)، وحث الدولة علي تحديث و إكمال المنشأت والمعامل و توفير الكفاءات.
- زيادة الميزانية الكليه للمشروع و التعاون مع المنظمات الأخري لجلب دعم إضافي.
- علي منسقي المشاريع الاتصال مع إدارة التعاون الفني بالهيئة، و المكتب الفني بالوكاله الدولية.
- دعم الروابط مع المؤسسات خارج ولاية الخرطوم.

CONTENTS

Chapter Two:

Chapter Three:

List of Appendices

List of Tables

List of Abbreviation

- IAEA: International Atomic Energy Agency
- TC: Technical Cooperation
- TCP: Technical Cooperation Programme
- AFRA: - Africa Regional Cooperation Agreement for Research Development and Training Related to Nuclear Science and Techniology
- RAF: Regional Projects (African Countries)
- SUD: Country or National Project (Sudan)
- NGOs: - Non-government Organizations
- UN: - United Nation
- UNDP: - United Nation for Development Programme
- SAEC: Sudan Atomic Energy Commission
- AAEA: Arab Atomic Energy Agency
- RIA: Radioimminioassy
- AI: Artificial Insemination
- IFAD: - International Fund for the Agriculture Development
- WHO: - World Health Organization
- FAO:- the Food and Agriculture Organization
- NDT: - Non Destructive Tasting
- CRR: - Commission for Relief and Rehabilitation
- IDA : - International Desalination Association
- UNICEF: United Nation Infants Care
- WFP: World Food Programme
- CPF: - Country Programmes Framework

- PC: - Project Coordination or Counterpart
- SSDLs: Secondary Standard Dosimetry Laboratories
- MOH: Ministry of Health
- CRR: Commission for Relief and Rehabilitation
- CR: Committee of Refugees
- GDP: Gross Domestic Production
- RICK: Radiation and Isotope Centre, Khartoum
- INMO: Institute of Nuclear Medicine and Molecular Biology
- ICT: Information Communication Techniques
- CVRL: Central Veterinary Research Laboratories
- LDCs: Less Development Countries
- GLP**:** Good Laboratory Practice
- SOP: Standard Operating Programme
- ISO: International Organization for Standardization
- NSAS: Nubian Sandstone Aquifer System
- TUB: Technishe University of Braunschweig in Germany
- GEF: Global Environmental Facility
- ODA: Overseas Development Association
- AAAID: Arab Authority for Agriculture Investment Development
- LN_2: Liquid Nitrogen
- SPECT: Single-Photon Emission Computed Tomography
- LDR: Low Dose Rate
- CNS : Central Nervous System
- GCR: Gas Cooled Reactors

1. INTRODUCTION

1.1. Energy for Sustainable Development

Energy plays a crucial role in our society; it is an essential input for economic and social development and improved quality of life. Energy is not only a provider of basic needs and services in our every-day life, but it is also a production factor of prime importance in virtually all sectors of the industry, (Khan, 2000).

The overall energy supply is characterized by the dominance of traditional biomass fuels (wood, charcoal). Since the Second World War the production of Petroleum has been increasing; the contribution of it is estimated to be more than 50% of the total energy resources. Other resources of energy include national gases, fossil fuel, electricity with lower and different percentages, (ELromi, 1994).

The doubling of the world's population in the 21st Century, suggest that global energy consumption will surely continue to increase. Growth will be driven principally by the demand in developing countries; they consume only 31% of all energy produced world wide. The growth of energy demand will be anywhere between 50% and 300% over the next five decade, (Mourogov, 1997).

The alternative sources of energy are bound to grow to cover the high consumption of the un-renewable sources which will be depleted by time. Energy consuming countries are looking for alternative sources to petroleum due to the sharp increase in petroleum prices, greater demand for electricity, and increased economic activity. The new alternative sources of energy, like solar energy, wind, hydropower, tides & ocean

thermal, geothermal, organic, and nuclear energy are expected to play a leading role in the energy pattern.

Nuclear power has a clear advantage in contributing to the global sustainable development. It is considered as an important and more concentrated form of energy due to its heavy and large energy generated by either fission and fusion processes, (Elromi, 1994). Nuclear energy can contribute substantially to the security of energy supply, and it has the potential to be an almost inexhaustable long-term energy source through the use of breeder reactors. Nuclear power currently provides about 6% of the global energy and 17% of global electricity supply. The world has been interested in this kind of energy after establishing the first nuclear reactor in 1950 to generate electricity. After that nearly 480 nuclear plants were operating or being built in 32 countries for peaceful purpose. Nuclear energy, although a non renewable resource, has the potential of supplying very large amounts of energy for practically unlimited period of time, they are expected to have useful working lives of 30 – 40 years for same hydropower generated. In addition to that, they have limited emission of greenhouse gases and other pollutants.

The challenge for the nuclear community is to assure that nuclear power remains a viable option to meet the energy requirements of this Century. It could be a major provider of electricity-based load, play a role in non electric applications, district heating process industries, maritime transport, water desalination, hydrogen production, for applications in remote areas, nuclear medicine application and diagnoses, (Mourogov, 1997).

In view of limited energy resources in many developing countries, they have launched programmes to rely on and introduce nuclear power and urgently desire to carry out these programmes, (Semenor & etal, 1989).

1. 2. Organizations Providing Assistance to Nuclear Energy

Over the last two decades many organizations started to provide technical assistance to developing countries for scientific and technical cooperation in the peaceful uses of atomic energy. Most of these organizations are sponsored by the United Nations.

According to Fischer (1997) a total of 191 countries belong to UN membership, taking benefit from the UN primary function; to cooperate in solving international problems. IAEA is one of the main organs of the UN as economic and social conical parts. The establishment of UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was a step to ensure that the UN would play a role in the fields of nuclear safety, monitoring of fallout from military activities and waste management practices.

According to Gururaja (1995) and Charpentier (1990), the United Nations Development Program UNDP initiated a technical assistance project in nuclear energy in 1987. It was designed to stimulate the exchange and flow of knowledge and experience among countries of Europe and the Arab States. The UNDP is an organization with offices located in 166 countries, working in collaboration with them to meet both global and national development challenges. It helps developing countries attract and use aid effectively. The UNDP began to receive request from developing countries, for technical assistance in energy planning, energy efficiency and conservation of energy supply, and enhancement and development of new renewable energy. The UNDP responded by providing funds for over 900 projects in Africa in energy planning and other relevant sectors; with a total of 68 projects in nuclear energy on regional, interregional, and national levels. The World Bank is one of the most important official sources of external capital for energy development in the developing countries. The Bank's energy lending

amounts to more than 30% of its total annual lending programme. It diversifies its activities and has increased its energy policy and advisory role through advising on energy sector strategies and comprehensive technical assistance projects, and IAEA is regarded as an active participant in these projects through the provision of technical advice, planning and training programmes.

Under these issues Eisenlohr (1989), reported that IAEA and Word Health Organization (WHO) concentrate on the work of radiation in medical uses of radioisotopes and radiation; with WHO assigning higher priority to the major health problems of the developing world and medical use of nuclear techniques. These combined efforts resulted in the establishment of a world-wide networks of Secondary Standard Dosimetry Laboratories (SSDLs), to perform tasks of setting up basic functions with respect to radiation measurements in medicine.

FAO (1989) has pointed out that Food & Agriculture Organization of United Nations (FAO) is the leading organization of the United Nations in agriculture forestry, fisheries, and natural resources development. FAO/IAEA serves the UN family as the global forum for scientific & technical assistance in the peaceful use of nuclear energy; its aim is to accelerate and expand the use of atomic energy and assist research and development. Fischer (1997) reviewed the joint work of FAO/IAEA in establishing the agriculture and biology laboratory.

1.3. Application of Nuclear Technology

The potential application of nuclear technologies has greatly expanded, as have the associated benefits for economic and social development, and there is a rapidly growing demand for nuclear energy by the developing countries. The International Atomic Energy Agency (IAEA) is the main body which provides this capability to a number of developing countries.

A complete catalogue of the nuclear applications that have been transferred to routine use in developing countries would be very large, (Gottstein, 1980).

IAEA was created in 1957, in response to the deep fears and expectations resulting from the discovery of nuclear energy. The development of three of the Agency's main programmes, nuclear power, nuclear safety, and safeguards, has been largely shaped by events beyond IAEA's control. Another major part of IAEA's work has been to help transfer the practical applications of nuclear science to the developing world; this consisted of the transfer of the numerous and varied uses of Radioisotopes and Radiation aboard stream of diverse and relatively small technical assistance projects, (Semenor & etal, 1989). The IAEA works to ensure safe, secure, and peaceful uses of nuclear science and technology. Its key role is to contribute to international peace and security, and to the world's millennium goals for social, economic and environmental development.

AIEA promotes the peaceful uses of nuclear energy and seeks to ensure that it was not used to further any military purpose. It is empowered to:-

1. Promote practical applications of nuclear energy for peaceful purposes, provide materials, services, equipment, and facilities for such research and development, and for the practical application of atomic energy with due consideration for the needs of the underdeveloped areas of the world;
2. Establish and apply safeguards to ensure that any nuclear assistance or supplies with which IAEA was associated should not be used to further any military purpose;
3. Establish or adopt nuclear safety standards.

Hence, IAEA is the world's focal point for scientific and technical cooperation in nuclear fields. The work contributes to fighting poverty,

sickness and pollution of the earths environment, and to other global "Millennium Goals" for safer and better future.

1.3.1. IAEA Technical Cooperation (TC)

Technical Cooperation (TC) is one of the IAEA departments, a specialized organization within the United Nation (UN) System; it helps to transfer nuclear and related technology for peaceful uses to countries throughout the world. In addition, TC collaborates with the World Bank, and other organizations to plan and execute projects in collaboration with member countries.

TC provides training courses, expert missions, fellowships, scientific visits and equipment. Its programme provides the necessary skills and equipment to establish sustainable technology in the counterpart country or region with more than 800 ongoing projects. It was foreseen that the normal arrangement by which the IAEA would provide assistance to member states would be "Agency Project". The most frequently used channel for providing the services of experts, training and equipment became the IAEA Technical Assistance programme or Technical Cooperation programme. The major fields of activity of projects include: -

1. General Atomic Energy Development.
2. Nuclear Physics;
3. Nuclear Chemistry;
4. Nuclear Energy and Technology
5. Prospecting, Mining and Processing Nuclear Materials;
6. Application of Isotopes and Radiation in Agriculture.
7. Application of Isotopes and Radiation in Medicine.

8. Application of Isotopes and Radiation in Biology.

9. Application of Isotopes and Radiation in Industry and Hydrology.

10. Safety in Nuclear Energy.

IAEA Technical Cooperation projects are classified according to Member State and contemporary TC project management views, as follows: -

1. Country or National projects: - projects which drive from formal request for cooperation by individual Member State.

2. Regional projects: - project which were or are being carried out in response to the collective needs of specific countries in a continent (e.g.: Africa, Asia, and Latin America).

3. AFRA projects: - these are being carried out in the framework of the African regional cooperative agreement for research, development, and training related to nuclear science and technology.

4. ARCAL projects: - projects carried out in the framework of the regional cooperative agreement for the advancement of nuclear science and technology in Latin America and the Caribbean

5. Interregional projects INT:- these projects serve the common needs of several Member States in different geographical regions

6. Projects by field of Activity (FAC): - each project is assigned one or more field of activity codes to describe the technical fields (e.g.; nuclear medicine, radioactive waste management, hydrology, act, (Fischer, 1997).

1.3.2. IAEA as Technology Transfer Organization

A country will only benefit from a new technology if this technology matches a real need in a way that will promote national self reliance in applying technology. The primary objective of IAEAs technical cooperation programme is to assist member states in achieving self reliance in the application of nuclear technology and it promotes

technology through its Technical Cooperation Programme (TCP) providing development assistance in nemours fields. TCP consists of projects requested by the member states and covers all geographical regions and all aspect of nuclear energy and non-power applications. The assistance must meet the needs and the national priorities of developing countries. The IAEA report (1990), shows that 17 out of 32 nations operating or constructing nuclear power plants are developing countries; and most of the developing member states have gained experience in the application of isotopes and radioactive techniques in different fields. In some of these states technology mainly consists of an introduction of limited nuclear techniques and related training. A major challenge for the Agency and the member states involved in the technical cooperation programme is to maximize the impact of individual projects at a country level. The impact can be reasonably assessed only in terms of some measurable factors of achievement, for examples: a high yield of food crops, better product quality using Non Destructive Testing (NDT) techniques, better public health due to improvements and use of nuclear techniques for diagnosis and treatment. All these factors depend on the continuous use of technology or techniques by the country after the Agency inputs have been delivered. Sustainability is created at the national level through the absorptive capacity of these techniques, stable manpower situation, and continued financial support. However, the prime factor is the perception at the government level of the importance of the technology or techniques used in relation to national development goals and priorities.

Beck (1989) presented that many developing member states having been involved in technical cooperation with the Agency for several years have reached high level of sophistication in the application of nuclear techniques. Therefore, new projects for continued national development

have become more advanced and more complex, and larger in terms of both implementation and function. The Agency is seeking to ensure that its technical cooperation projects are in line with and oriented towards to the end-user, and are intended to have a significant impact on the development of the countries concerned.

Member States in IAEA include 137 countries, with 58 intergovernmental and Non Government Organizations (NGOs) world wide having formal agreements with the Agency. IAEA provides assistance to member states through its contribution to Agency's technical cooperation funds for assigned projects. It provides technical cooperation to 33 countries in Africa regionally, and 26 countries as AFRA Members. Today a total of 1409 technical cooperation projects have been or are being executed in Africa, of which 1221 are national projects and 188 project are regional projects. **Table (1)** shows the total number of projects and the distribution of the Agency's field of activity executed in Africa.

The AFRA (Africa Regional Cooperation Agreement for Research Development and Training Related to Nuclear Science and Technology) agreement provides a framework for African member states to intensify their collaboration through programmes and projects focused on the specific shared needs of its members. It is a formal intergovernmental agreement which came into force in 1990; Africa had the smallest of the programmes. Nowadays its share in the total adjusted programme has grown and time duration of programmes has been expanded. Given the increased attention and resources being devoted to the least developed member states Africa programmes are characterized by the importance given to manpower development in all fields' fellowship, Training courses and workshops. **Table (2)** shows the total number of IAEA projects by fields executed in Africa.

Table (1): IAEA Projects in Africa

Status of the projects	**No. Of project**
Total Number of Africa Projects	1589
Number of Active Projects	379
Number of Completed Projects	1109
Number of Cancelled Projects	101
Number of National Projects	1383
Number of Regional Projects	206

Source: - IAEA Technical Cooperation Department, 2004.

Table (2): Field of IAEA Projects in Africa

Major field of Activity (code)	**No. of Project**
Application of Isotopes and Radiation in Food and Agriculture [5]	464
Radiation Medicine and Health [6]	263
Isotope Hydrology and Applications of Isotopes and Radiation in Industry [8]	204
Nuclear and Radiation Safety and Nuclear Security [9]	158
Nuclear Engineering and Technology [4]	139
General Atomic Energy Development [0]	138
Nuclear and Atomic Physics [1]	77
Fuel Cycle and Waste Management [3]	59
Nuclear Chemistry and Radiochemistry [2]	52
Application of Isotopes and Radiation in Biology and Environmental Studies [7]	35
Total Number of Projects	**1589**

Source: - IAEA Technical Cooperation Department, 2004.

1.3.3. Self-reliance

Achieving self-reliance of institutions using nuclear techniques and provision of service to target beneficiaries on sustainable basis are important long-term goals of the Agency's counterparts. The institutions recognize the importance of understanding the development problems that their countries are facing and how nuclear technology can be used to solve them. The countries are learning to manage nuclear institutions according to modern and innovative management principles in order to make them more self-reliant and able to deliver their services and products to support self-reliance and sustainability of nuclear institutions. Projects under this frame-work assist the country to assess ongoing programmes in terms of relevance to national priorities, cost-effectiveness and quality of managerial practices; to design programmes which are demand-driven and can achieve socio-economic objectives; and to prepare strategic plans for nuclear institutions to gain greater self-reliance.

Self reliance is the endpoint of capacity building. Government and institutions are on their way to achieving self reliance and continue to rely on technical and financial support from IAEA to help build or improve basic nuclear infrastructure.

Sudan Atomic Energy Commission (SAEC) work to achieve self-reliance under projects in different filed e.g.; (radiotherapy, production of reagents in RIA Laboratories, NDT, and maintenance of medical and scientific instrument).

1.3.4. Strengthening Human Resources

The Technical Cooperation Report (2001) & IAEA Report (1995), indicate that a core area of the technical cooperation programme over

the years has always been human resource development, aiming at ensuring the sustained development of nuclear technology in member states. The success of technology transfer depends primarily on the absorptive capacity of the recipient country for new technology. The most significant to action which influences this capability is the availability of manpower, education, training and experience. Knowledge and skills encompass technical, managerial and policy aspects. IAEA technical assistance activities started in 1958 mainly initially in the form fellowships for training since the prime need at that time was to lay a foundation in nuclear sciences. Initially these efforts focused on long-term fellowships, and later it was decided to reduce this kind of training, as it was felt that shorter courses are better suited to strengthening human resources in developing countries. In recent years, greater attention has been given to the Agency's role in ensuring the continuity of knowledge in the nuclear field including support for shorter-term training in nuclear sciences and technology. Also the agency is supporting packages called "sandwich programmes", in which the institution involved coordinates with the Agency to ensure that training is complementary, and the trainee may receive an academic degree or certificate from a relevant institutions or university in the home country. The approach promoted over the past years is to link training to development needs defined within the projects. This has proven to be an efficient way of building institutional capacity in a selective manner and thus ensuring sustainability of agency supported activities in areas of major significance in spite of the high staff turnover being experienced in the region.

1.3.5. Socio-economics of Nuclear Energy and Application

Nuclear technology and techniques produce energy, make our food safer and more abundant, help prevent, diagnose, and cure disease, optimize sustainable water use and protect the environment. Nuclear energy effect a society's resources, institutions, public knowledge, human capital, manufactured capital and natural capital. On the national and regional levels, nuclear sciences and applications are core disciplines on the road to a technologically advanced society. All countries like advantage of nuclear application especially in health care. While utilization increases dramatically with countries social, technological, and economic development, significant socio-economic benefits can be obtained at all levels of development to realize these benefits, radiological contributions have to be properly embedded into major economic activities such as agriculture, health and energy. Accurate assessments of their costs benefits, risks are needed and continuing assessment is needed to ensure that the benefits of nuclear applications are available in these areas where it's worth utilizing the atom. Major benefits have accrued and remain available to both developed and developing countries. Investment in the requisite technical, scientific, and regulatory infrastructure can be rewarded relatively quickly, although some aspects may need many years to mature. The transfer by the Agency of human, regulatory, technical and scientific nuclear capabilities are important activities for socio-economic development, but need to be put into context in terms of "value added" or of comparative cost effectiveness with non-nuclear techniques. Assessment techniques need to be adapted to the relevant nuclear or isotopic application and studied need to be defined so that realistic boundary conditions for socio-economic impact assessments can to be meaningful. The challenges of correctly assessing the impact of nuclear sciences and applications are large, but the results could

provide clear justification to decision makers on economic and social ground for choices regarding nuclear applications, Garcia (1995).

1.3.6. Evaluation of Projects

Agency Technical Cooperation projects are approved for a two-year period (biennium) e.g.; 2004-2005, during the first year Member States prepare proposal for projects needing agency support, it may provide expert assistance in project formulation upon request. During the second year the proposals are appraised by the staff of the agency and consultations are held on the requested technical cooperation assistance. Projects approved by the board are implemented during the next two year following a clearly defined plan of work. Technical cooperation projects are in one or more of the following components; equipments and supplies, fellowship training and scientific visits, training courses and workshop, expert mission and subcontracts providing the necessary skills and equipment to establish sustainable technology in the counterpart country or region. Evaluation of projects is based on the extend to which the project has achieved or is achieving its stated objectives and is contributing to national development programmes. Jihhui (2001) explains that " Achieving good results during project lifetime is not enough, the aim is to strengthen TC by achieving sustainable impact, this includes both the sustainability of project results and the sustainability of the nuclear institution that has been supported. Dadi (1990), discussed the evaluation and the feasibility of this project 300-Mwe (the first nuclear power in China in the costal area where the plants were built) that the comparative economic analysis based on a rational comparative price system, the economic and social benefits from the development of nuclear power should be evaluated for the long-term strategy.

1.4. Objective of the Research

This study attempts to reflect the role of the nuclear techniques in the development of the developing countries. This role will be discussed through the IAEA provision of the TC projects to these countries. The discussion will deal with the impact of these projects on the socio-economic development in Sudan. ***Also it tries to show whither the national projects will be able to enhance the improvement infrastructures and technology transfer***. Another aspect is to ensure whether the capacity of institutions in Member States using nuclear technologies became more economically and financially self-reliant.

1.5. Importance of the Study

Nuclear technology has the associated benefits for economic and social development especially in developing human health, agriculture, water resources, and other fields.

The importance of this study is to reflect benefits to Sudan from the technical assistance provided by the IAEA in using nuclear technology to solve its main development problems at all levels of development (social, technological, economic development), to improve its infrastructures, achieve self-reliance, and improve to delivery of services and products. Also the study will try to identify problems facing the sustainability of these projects and help the decision makers to find solutions for such problems. This research also sheds some light on Sudan's experience in technical cooperation with IAEA, thus helping to establish data base for future studies.

1.6. Problem of the Study

Sudan became a member state of IAEA in 1958; it started receiving technical assistance in 1970 for peaceful application of nuclear technology in different development and services sectors. The assistance was mainly geared towards infrastructure development in terms of manpower, scientific and medical equipments mainly, radiotherapy and nuclear medicine.

Over the last two decades, IAEA technical assistance played a major role in addressing pressing issues such as poverty elevation, sustainable development and management of different fields related to the application of nuclear technology. The problems are the sustainability of those projects which means sustainability in socio-economic development after the completion of the period of funding. Also there are no empirical studies to explain or evaluate the statement of these assistances, and whether technical assistance is used for development purposes.

1.7. Research Hypotheses

Three main hypotheses are adopted in this research: -

First, nuclear technology affects development through its impact on socioeconomic development

Second, IAEA plays a main role in helping and promoting national projects

Third, Institutions using Nuclear Technology became economically and financially self-reliant.

1.8. Methodology: -

The methodology used aims to assess the impact of the nuclear technology in enhancing the socio-economic development in Sudan using

the TC projects approved by IAEA. The criteria used in assessing these impacts are based on the literature and data of projects selected from different fields supervised by IAEA, to review their achievements, for the period 1990 to 2004.

1.9. Data Collection and Source of Data: -

Data collection involves:-

a) Secondary data: - the study relies mainly on secondary data i.e.; reports from IAEA and project coordinator;

b) Interviews with some high ranking official.

1.10. Scope of the Work

To study and evaluate the impact of IAEA Technical Cooperation Projects in enhancing socio-economic in Sudan, for the period 1990 – 2004 (Availability of data during these period), it covers national, regional, AFRA project in different fields.

1.11. The Research Contracture

The research is made up of five chapters, which in chapter one discusses the introduction related to objectives, purpose of the study, the importance, the statement of the problem, research hypothesis, research methodology and data collection, scope of the study, and the research contracture. Chapter two is the literature review. Chapter three focuses on case studies for selected projects, and interviews. Chapter four includes the socio-economic impacts, the conclusion and recommendations in chapter five.

2. Literature Review

2.1. Introduction

This chapter is focused on reviewing the history of some non-government organizations work in Sudan and provide assistance in different fields. Also it provides some information about the Sudan TC programme.

2.2. Non-Government Organization Work in Sudan

Sudanese efforts to eliminate poverty are supported by external donors and Non-government Organization (NGOs) mainly through policy advise capital, technical cooperation programmes and projects. Tabadi (1987) observed that, quite a number of NGOs are active in Sudan; they have stressed the importance of activities involving disaster victims in development oriented activities or emergency assistance. Most of them came to Sudan during the drought period of 1983-84 that resulted in severe famine.

Relief and development aid when delivered by NGOs play an important role in economic development, religious and political life of the country. These agencies and their projects must now be carefully evaluated to see if they meet the needs of Sudan.

About 80 NGOs are providing health services in all regions of Sudan. It is felt by the Ministry of Health (MOH) that effective coordination with these agencies will further materially enhance their contribution to the national health services, and that continuous supervision will make NGOs do better. It is essential important for the government to follow up – control and evaluate these agencies. The Commission for Relief and Rehabilitation (CRR), and the Committee of Refugees (COR) director of health evaluates the activities of these NGOs work in health according to the rate of improvement of the health condition using reports submitted by NGOs on their activities every three month to RRC and (MOH).

Some NGOs made their own plans according to their own points of view about development, so it is difficult to evaluate their activities if we don’t

know the exact programme or plane of work. Also there was no intersectoral coordination between government ministries or departments.

A. Maged (2000) reported that the International Fund for Agricultural Development (IFAD) is an international financial institution and specialized agency of United Nations (UN). IFAD assistance is in the form of loans and grants as part of IFAD regular programme. It evaluates the effects and impact of its projects in achieving their objectives, and it focuses on providing direct funding and mobilize additional resources to finance rural development projects. It aims to assist the poorest of the world people and works for the economic and social development of the poor classes. As Sudan is one of IFADs priority countries and was among the first recipient of IFADs assistances, IFAD assisted the government of Sudan in financing six strategic food production projects in different states of the country with the total amount of US $ 65.5 million during the period 1979-1986. She discussed the weakness of the local government in its attempt to delegate more autonomy to states, provincial and district governments, which was less than successful. Also the tight budgetary situation makes it extremely difficult for the government to meet its local funding obligations towards externally financed projects. Fdul Elmoula (1995) reported that many projects were provided by IFAD in the agriculture development sector which have created strong base for sustainable rural development in different regions of the country, aimed to realize the vast food production potential and to improve the standard of living. He suggested that the economic issue is a sensitive matter and it is difficult to determine precisely the level of income based on interviews among the participants in the project.

Kheir (2001), stated that UNDP under this frame-work had supported several projects that addressed the poverty problems for the third and fourth programmes for the Sudan. It is aimed to increase the income

levels and improving the living standards of half million people of the poorest and most environmentally fragile area of Sudan; it supported aids projects working directory with rural communities in 2000 villages.

Fadull (1999) found out the relationship between energy price and economic growth, energy consumption and Growth Domestic Production (GDP). He observed that the shocks in energy supply can severely limit the growth of the product and capacity of the economy. The impact of inadequate and unreliable energy supply on the performance of the national economy and the welfare of the society is significant. The shortage of energy supply hinders the growth in different services sectors. It could be stated very clearly that energy has strong links with economic growth and development; for instance most of all oil producing countries have very high growth rates, and this could be attributed to the availability of energy sources. Adequate and reliable supply of energy supports sustainable economic growth and improves quality of life.

The factors or reasons of sustainability or suspension of the projects provided by donors is discussed by Dadi (1990), in China some projects were suspended for years, due to the decision makers underestimation of the energy demand and the importance of improving the energy structure. There was no adequate long-term planning for nuclear power development and the fund allocations among relevant ministries was not coordinated for nuclear power development and the financial channels for investments in nuclear power plant and in nuclear equipments manufacturing industry were not defined in the national economy planning.

2.3. Sudan TC Programme

Since Sudan became one of IAEA member state in 1958 it has evolved to place itself at the forefront of 31 African member states. The agency's technical assistance is to help implement end-user oriented project integrating isotopes techniques on their on-going national development programmes.

In the past the Sudan TC projects didn't aim at achieving sustainable development or linked to the country's development planning, and hence they didn't establish sustainable services after they exhaust their approved funds. But today the TC projects are associated to the country's development programmes framework (CPF) and support socio-economic activities. The basic aspects to be considered during the appraisal of a project approval are as follows: -

- Orientation towards the end user.
- Responding to a major need of the country.
- Strong Government commitment (sustainability)
- Projecting the role of nuclear technology.
- It must have a social or economic impact.

The TC projects requested by Government to the Agency shall be detailed in close coordination between the Agency and National liaison officer.

The evaluation of TC project by IAEA is based entirely on which project has spent fully funds allocated to it by the IAEA in the form of equipments, training, and expert missions. Sudan TC Programme had achieved a financial implementation rate of 80%-98% for the period 1998-2003. **Table (3)** shows the implementation rate of some TC projects from the current year financial status presented by IAEA.

This way of evaluation by the IAEA is not sufficient to give an indication of projects sustainability in development, nor does it give information on the continuity and services rendered by the project. For

example: some projects received fully funds allocated to them, and their implementation rate was 100%; yet they were not able to achieve their objectives and equipments were not fully utilized.

Table (3): The Implementation Rate of Some Sudan Projects

Project No.	Field	Project status Act/comp	Implementation rate% by the IAEA	Implementation rate% by the PC*	Total Budget US $
SUD/6/020	Human Health	Completed	160 %	100%	1,045,215
SUD/6/023	Human Health	Active	34.4 %	80%	88,080
RAF/5/046	Animal Resources	Active	-5.0%	40%	1,184,617
RAF/8/036	Water Resources Management	Active	42.1%	70%	852,210
SUD/8/006	NDT	Completed	100%	100%	242,230
SUD/8/008	NDT	Active	98%	100%	828,79
SUD/6/024	Human Health	Active	33%	80%	30,955.16
SUD4/006	Maintenance & Repair	Active	40%	50%	67,813.73
RAF/8/033	Environmental Application	Active	80%	40%	712,150
RAF/9/029	Radiation Protection	Active	75%	-	2,335,262
SUD/5/027	Animal Resources	Active	80%	90%	-
RAF/0/016	Energy	Active	100%	100%	1,007,900
RAF/4/017	Maintenance & Repair	Active	85%	80%	1,596,750
RAF/5/050	Agriculture	Active	80%	60%	921,350
RAF/8/028	Water Resources Management	Active	90%	90%	521,611
RAF/6/018	Human Health	Completed	95%	100%	1,122,319

Source: - Interviews with PCs, and reports by IAEA, 2004

* **PC:** - Coordinator Project

2.3.1. Sudan Atomic Energy Commission (SAEC)

Sudan Atomic Energy Commission (SAEC) under the supervision of the Ministry of Science and Technology is the national authority for the coordination as well as liaison with the Agency. SAEC (2004) reported that since Sudan started receiving technical assistance from IAEA in 1968 the total support provided by the Agency up to 1998 amounts to about US **$ 883.64,** and it amounted to about US $ 4.626,935 million by 2004. During the period 1984-1994 the three largest areas of technical assistance in terms of disbursement have been nuclear medicine (23%), general atomic energy development (21%), and agriculture (19%). Particularly in the past fifteen years substantial efforts have been made by national counterparts to enlarge and diversify the application of nuclear techniques in sectors of social and economic importance mainly in agriculture, human health and general application instruments. **Table (4) show** Sudan technical cooperation projects by fields during 1990-2004.

The technical cooperation (TC) provided by the Agency depends on the local component of the country; also it depends on Sudan payments of it is annual share to the IAEA technical cooperation budget consisting of US $ 7000 million (or 1.4% of the Agency's budget). **Table (5)** gives the details of the total amount of technical cooperation provided by the Agency for the period 1990 -2004 through the national projects. Sudan participates in AFRA as well as in other regional activities. **Appendixes 1, 2, 3, and 4** give the total number of all projects (national, regional & AFRA) provided by the Agency for 1990-2004.

Table (4): Total Amount of Technical Cooperation (National Projects) by Fields, 1990 -2004

Field	No. of Projects	IAEA Input $
Agriculture	5	482,672
Animal Resources	**6**	271,088
Medicine & health	10	1,493,506
Industry	1	1,127,009
Water& Hydrology	6	162,132
Maintenance of Scientific & Medicine Equipments	2	89,866
Energy	1	67,870
Human Resource & Development	1	88,169
Safety& Nuclear Security, Waste Management	3	363,369
Biology & Environmental	1	150,200

☒ **Source:** *SAEC TC Annual Reports 2001, by TC Director*

Table (5): The Total Amount of Fund Provided by IAEA (National Projects) 1990- 2004

Year	IAEA Cost Share US $	Gov. cost share US $
1990	487000	4500
1991	568100	4900
1992	47400	5250
1993	516400	5550
1994	356300	5850
1995	532600	6200
1996	374600	6500
1997	339900	6800
1998	566900	7150
1999	637700	6570
2000	200035	5110
2001	340750	5000
2002	277640	4611
2003	545200	5000
2004	306840	4485
Total	**6097365**	**83476**

Source: - TC Annual Reports 2004, by TC Director SAEC

2.3.2. Sudan Country Programme Framework (CPF)

The use of Country Programme Framework (CPF) as a planning tool improves the project selection by placing it in the context of national priorities. CPF helps national authorities to identify the problems to be addressed with nuclear technologies, to outline the result expected in a given timeframe and to take ownership of the programme. Also it must show the key areas where the application can play significant role in reaching national development objectives and where the Agency should concentrate its technical cooperation efforts and resources. The CPF covers a period of 4-6 years. A key to the success of CPF is for government to take ownership of the process, working with Member State to design and implement projects in fields where their significant impact is likely to assist in raising awareness of the value of the nuclear technologies involved, fostering new partnership and identifying additional funding sources for these projects.

CPF will not only facilitate a development oriented national TC Programme but will also provide an opportunity to initiate a regional Programme where district benefits can be derived through cooperation activities.

2.4. The Role of Nuclear Techniques in Sudan Development through the TC Programme

2.4.1. Human health

Considering the relevance of nuclear techniques in the diagnosis and treatment of the diseases prevalent in the country, it showing a significant impact on the progress of nuclear medicine/radiotherapy in Radiation and Isotope Centre, Khartoum (RICK), Institute of Nuclear Medicine and Molecular Biology (INMO), and their contribution to the

overall improvement of health care in the country. The projects implemented under this field achieve significant impacts in term of: -

1. - Transforming the facility at RICK into national/region referral center
2. Supporting human resource development by local training of medical doctors and physicists.
3. RICK is now able to introduce management of gynecological cancer, interstitial and intra-luminal barchytherapy procedures for management of cancer of the esophagus, rectum and bladder.
4. The establishment of nuclear-based diagnostic capabilities for chlorquine-resistant malaria and tuberculosis, which lowered the capital cost by improving methods for monitoring drug resistance in malaria and tuberculosis.
5. Installment and use of important equipment (Single-Photon Emission Computed Tomography SPECT gamma camera & Low Dose Rate LDR machine, Linear accelerator); and the use of these modern nuclear medicine practices will cut short the expenses of management abroad by 20%. **Tables (6) & (7) show the** patients studies and the income generated by using Gamma Camera in two institutions. **Table (8)** shows cancer patients treated in (RICK) during the past 6 years as out patients at (INMO). The number is annually increasing, and by 2004 it reached 492 patients.
6. Sudan is one of the few less developed countries LDCs that have successfully produced Radioimmunoassay (RIA) kits. The country aims at satisfying all its needs and export surplus to its neighbors. Construction of RIA labs in the regions (Dongola, Nyala, Waw, Port Sudan, Elfashir, and Kosti), improves medical services to the locals. Monthly income generated from these activities is estimated to be SD 1,850550.

7. Introduction of Tumor marker techniques to all medical fields

Table (6): Patient's Studies and Income Generation Using Gamma Camera During 2002

Institute	Total No. of studied	Incomes generated $
RICK	2824	40882
INMO	1202	18,351

Source: - Annual Report 2002, by project coordinator, RICK

Table (7): Patient's Studies and Income Generation Using RIA Techniques During 2002

Institute	Total No. of studied	Incomes generated/ $
RICK	27014	81054
INMO	12308	73,848

Source: - Annual Report 2002, by project coordinator, RICK

Table (8): Patients Treated During 1999-2004 at RICK

Years	**Sex**		**Total**
	Male	**Female**	
1999	57	84	141
2000	103	159	262
2001	162	199	361
2002	161	241	402
2003	198	253	451
2004	209	283	492
Total	890	1219	2109

Source: - RICK, project coordinator, Annual Report 2004.

2.4.2. Non destructive testing NDT

Over the last two years, there has been a rapid expansion in NDT applications in Sudan, arising from development in the petroleum industry. The refineries, sugar factories, railways, and thermal electricity power stations all need to use NDT. The progresses in this respect include the following: -

1. A complete unit of NDT to cover the requirements of all NDT in Sudan was established, so as to save hard currency being paid abroad, and to extend its work on commercial basis to make profit.
2. A training and certification center was also established; thus the national NDT capability was less costly and was to tune the work need, and this programme is also oriented to income generating activities. The training activities under the umbrella of the training center graduated more than 183 participants with an income generation of SD 215 million during 2004/2005. Furthermore, it was able to offer NDT services using national man-power, and almost succeeded in completely replacing foreign labour.
3. A radiotracer and sealed source techniques were applied to meet the needs of the petroleum and mineral industries for better of management of natural resources and industrial growth. Also NDT provides an indispensable quality control (QC) service to various sectors.

2.4.3. Maintenance and Repair of Equipments

The electronic workshop of SAEC is providing services of repair and maintenance to a number of institutes in the country. The activity within this field covers RICK and INMO, the two centers housing appreciable number of radiotherapy and nuclear medicine equipments installed at different times within the last fifteen years, and belonging to different manufacturers. The two centers also employ a number of service engineers with different qualifications and experiences, their achievement as following: -

1. Establishment of Central Electronic Workshop and the instrumentation Center of SAEC to run its activities in training, research, and maintenance. The center is allowed to generate income from training personnel and repairing instruments, where total revenue amounts to SD 16. 7 million in 2004. Establishment of a Tele-center with equipped Information Communication Techniques ICT-Laboratory at SAEC, to provide training facilities and to enhance awareness among the end-users to the usefulness of ICT-facilities. The cost-effectiveness of the ICT-training and learning is further improved by the capability of group training and distance learning.
2. The Department of repair and maintenance of Nuclear Medical Instrumentation at RICK, is of direct benefit to the end-users (all Radiotherapy equipments in use all over the country), and nuclear medical equipment reached maximum capacity of 90% with a minimum service cost.
3. Availability and provision of national training courses and equipped maintenance and repair groups

2.4.4. Life-stock Production& Disease Eradication

The use of nuclear techniques in animal nutrition and in controlling animal's diseases by tackling the highly prioritized problems of some tropical diseases include eradicating the Rinderpest virus, trypanosomiasis (tsetse), Theileriosis, and other animal diseases. These help in increasing animal productivity, animal resources, export of animal products, and improving food security. Five main activities were carried out in this respect: -

1. The central Veterinary Research Laboratories (CVRL) was enabled to produce a vaccine to the satisfaction of the end-users (the farmers) and the sustainability of vaccine production. CVRL in collaboration with universities participates in different MSc. and PhD. student exchange programmes.
2. Establishment of Artificial Insemination (AI).
3. Benefits from Preparing different nutritive formulae of supplemented molasses in urea blocks and cheaper protein supplement.
4. Substantial increase in the productivity of meat and milk, thereby increasing farm profitability, improving the socio-economic status of farmers.
5. Reduced imports of animal by-products and export fatting animal will conserve foreign currency and contribute to national and regional food security.

2.4.5. Improving Crop Production

The production of food and fiber will continue to be the locomotive of the domestic economy and primary source of foreign exchanges for the foreseeable future. Of immediate concern is the high opportunity cost of producing large quantities of sorghum in the capital intensive farming systems, to the detriment of export crops such as sesame and cotton. Use of micro-propagation techniques is needed both as an aid to plant

breeding and for rapidly multiplying desirable genotypes. The use of nuclear methods could contribute towards the improvement of fertility of soil in various regions of Sudan.

Almost 35% of total technical cooperation programme for Africa is spent on food and Agriculture assistance (IAEA report, 1999). Nuclear techniques are used with conventional methods to increase agriculture output and production.

The projects aim also at improving crops genetically to solve problems of declining productivity, through establishing laboratories for insect pesticide, soil fertility, mutation breeding and tissue culture.

2.4.6. Water Resource and Management

To develop and establish infrastructure in Sudan through application of isotope techniques in hydrology, it has been identified that, it will have to concentrate on the study of Northern State Adjacent Nile aquifers. Activities carried out in Sudan in water management beyond this object are many tolds : -

1. Potential application and contribution of isotope techniques in water resources assessment and management in Sudan can be grouped into; ground water, wadi aquifer system, and dam's safety. All these contributed to the improvement of the daily life of about 2-5 million people who were resettled along the Nile due to the recurrent of drought.
2. Establishment of isotopes hydrology laboratory.
3. The use of isotopes techniques can help to determine groundwater resources and identify any sources of contamination.
4. Develop the isotopes hydrology expertise for water resources management and establish a regional capability to provide training on isotopes hydrology techniques in related fields.

5. Finding a means to avoid water level drop and salinity increase in regions where water resources are extensively used in expanding agriculture.

2.4.7. Strengthening Waste Management Infrastructure

Use of radioisotopes in Sudan started 45 years ago. The medical field was the main users, and recently industry (especially oil) because the main user in the country. The industrial sources now amount to about 80% of all sources in the country including medic (SAEC report, 2005). Currently, management of spent/disused sources from industrial application gained great importance to the radioactive waste management programme of the country. The programme was established, and 25 sources were collected and safely stored in the waste management facility at Soba (Southern Khartoum), and the total number of sources registered amounted to 570. The radiation waste management registry software is being now used for the registration of radioactive waste. A total of 18 neutron sources were collected from Hydrology Department, RICK hospital, Research Corporation and Khartoum University. These sources are stored in the facility waiting for further treatment or return to supplier. 12 sources were backed and shipped to South Africa for return to the manufacturer. More efforts are needed in the registration and follow-up of sources being used in the industrial applications.

2.4.8. Radiation Safety

The existence of an adequate radiation safety infrastructure is an essential pre-requisite for the promotion and development of the peaceful application of nuclear technology in the country. The Radiation Protection Technical Committee is the Regulatory Authority, responsible

for licensing, and inspection of radiation facilities. Every institution is under surveillance including both facility and workers**.** Programmes of nuclear techniques for undergraduate and post graduate university students were established to strengthen the base progress in science and technology. Also established are codes/ or safety guides on remaining aspects of nuclear applications, diagnostic and therapeutic radiology.

2.4.9. Human Resource Development

The SAEC through the TC Projects has implemented national and regional training courses in different fields to sustain the implementation of the IAEA project and for staff training in nuclear sciences and technology. **Table(9) shows** the total numbers of trained personnel under the TC project (regional training courses) in different fields for the years 2000-2005, and **Table (10) shows** the total number of trained personnel and workshops through national training courses in different fields during 1995-2000.

The expert missions and scientific visits are approved by IAEA to follow-up the projects, to exchange expertise, and idea to find suitable solution for the problems facing the same institutions in the developed countries. **Table (11) gives** the total number of the expert missions implemented as 47, while most of scientific visits were carried out by IAEA, compared with only 14 by Arab Atomic Energy Agency (AAEA) for the same period 1995-2000 (SAEC report, 2005).

Support was extended for post graduate teaching programmes in medical physics (M.Sc). and Nuclear Sciences (Diploma). Many projects in supported the human resources development aimed to develop self-reliance of institutes applying nuclear sciences, strengthening managerial capability in nuclear techniques using Information Communication

Techniques (ICT), and supporting further contacts between the Less Development Countries (LDCs) in nuclear energy application.

Table (9): Number of Regional Trained Personnel, 2000- 2005

Field	Number of participants
Medicine	54
Agriculture & Animal Production	15
NDT	11
Maintenance and Repair	27
Protection	2
Waste Management	9
Water Resources Management	18
Environment	9
Nuclear Safety	20
Energy	11
Human Resources Development	67
Total	**243**

Source: -Reported by Technical Cooperation Directorate, SAEC 2004

Table (10): The Total Number of National Training Courses and the Workshops, 1995-2000

Year	Total number of personnel	Workshop
1995	16	1
1996	28	2
1997	38	2
1998	55	5
1999	145	6
2000	64	5
Total	**346**	**21**

Source: - Reported by Technical Cooperation Directorate, SAEC 2004

Table (11): The expert missions and scientific visits, 1995-2000

Activities	Total No.
Expert Missions	47
Fellowship and Scientific Visits	31
Training Courses by IAEA	54
Training Courses by AAEA	14

Source: Reported by Technical Cooperation Directorate, SAEC 2004

* AAEA: Arab Atomic Energy Agency

2.4.10. Sustainable Energy Development

Energy is an essential condition to ensure macro-economic growth and stability in the context of sustainable development. Sudan adoption of the project "Sustainable Energy Development" has achieved good results in developing the energy supply that include: -

1. Forecasting Energy and Electricity demands for Sudan up to year 2025
2. Develop the indigenous energy resources and sustain energy supply so that the economy will reach its targeted goals and manpower to gain experience to develop further future energy plans.
3. Improved the national and regional capacities for long-term strategic planning of the energy system.

Chapter Three

3. Use of Nuclear Technology in Development Efforts in Sudan

3.1. Introduction

This chapter presents case studies that had been carried out. It is an analytical study and targets the role of the IAEA Technical Cooperation in development. The study concentrates on four project samples in three fields to reflect the role of IAEA in development and the contribution of these projects which were implemented under SAEC. The fields are: -

1. ***Human Health:*** - two project;
    1) Development of National Radiotherapy Network SUD/6/020
    2) Improving Local Radio immunodiagnostics Capabilities SUD/6/023
2. ***Water Resources Management***: one project;
    1) Sustainable Development of Nubian Aquifer RAF/8/036
3. ***Animal Health:*** **-** one project;
    1) Increasing and Improving Milk and Meat Production "RAF/5/046

Moreover, the study aims at elaboration the objective of each project , the fund allocated from IAEA, local components, and project achievements will be assessed, i.e. how much the country benefits from the implemented project in the form of infrastructure, human resource development, economic improvement. The analysis is based on data and literature available for the selected four projects.

3.2. Radiotherapy and Nuclear Medicine in Sudan

Good health is an essential prerequest for sustainable human development. IAEA is building capabilities of developing member states

to address these important health problems using nuclear techniques. In many instances, these techniques offer unique and cost effective means to prevent, diagnose, and treat a wide variety of disease conditions that affect health. IAEA applies nuclear and isotopic techniques and introduces more new radionuclide investigations and therapeutic procedures for thyrotoxicosis, cancer thyroid and metastasis bone diseases.

By the year 2000, over 3.9 million people died from cancer in less developed countries, some 400,000 in Africa alone. Cancer can be cured in approximately 45 per cent of patients with access to the best current treatment. Radiation therapy, one of the earliest medical applications of radiation remains a major part of cancer treatment used to compliment surgery and chemotherapy. Effective use of radiation therapy requires trained specialists, equipment and infrastructure, so that radiation can be used safely.

Cancer over the period 1990-2000 was rated as the third killer disease in the Sudan (4.7%0 of all deaths). The expected cancer incidence increased by 18% over the last five years if we take the period from 1998 till the end of Nov. 2003, while the actual number of cases detected increased by 50% and the number of new cancer cases treated by radiotherapy increased by 83% **as shown in table (12).** This reflects awareness and advances in health care, the availability of new diagnostic procedure, and large coverage and improved efficiency of diagnostic techniques. SAEC and Ministry of Health are collaborating with IAEA to provide technical assistances for national and regional projects in medicine in order to improve cancer health care by extending basic radiotherapy services to end-user and making it available nationwide in a vast country. **Appendix 5 shows** the number of projects in Radiotherapy and Nuclear Medicine and their total budget provided by IAEA. These projects had been

implemented by two institutions to provide radiotherapy services for 40% of the total population. The first radiotherapy and Isotope Centre for nuclear medicine was established in 1965 at Khartoum (RICK), and the second one is the Institute of Nuclear Medicine and Molecular Biology (INMO) established at Wad Medani in 1998.

Table (12): Cancer Status in Sudan, 1998-2003

Year	Expected	Detected	Treated
1998	28,000	5,000	2,100
2003	33,000	7,500	3,850
Increase %	18	50	83

Source: - Project Progress Report, by project coordination, 2002.

3.2.1.. Development of National Radiotherapy Network SUD/6/020

This project was approved in 1997 and was completed in 2001 with a total budget amounting to US $1,045,215 provided by IAEA. Its main objectives are to improve health care for cancer patients and make it available nationwide, specifically to bring Brach therapy into routine use at the Radiation and Isotope Centre in Khartoum, and to introduce Teletherapy and sate therapy at a satellite centre in Gezira. The recipient institutes are Ministry of Health, RICK and INMO (University of Gezira, Faculty of Medicine). The government provided the project with 4,000,000 SD (as local Component) to construct a three-story building for

the Radiotherapy Department to accommodate out-patients, clinics lab, Physics lab, offices, lecture room, simulator, treatment planning system, Co 60 machine, chemotherapy day work, pharmacy, clinical lab, statistics Department, in addition to construct an extension block to accommodate Nuclear Medicine Dept, linear accelerator and other machines rooms. The number of staff under this project is assumed to be 29 personnel.

Under this project 12 persons were trained and 3 experts' missions have been excused during 1999-2000. The most important equipment provided by the project, and highly use are: Modiso Camera, Gamma Counter, and Gas Cooled Reactors (CGR), and a Cobalt Machine.

During the work of the project cancer patients were treated and the basic infrastructure covered the installation of CO 60 Machine, established all contraction units including building, furniture, electrical & water supply equipments, which are provided by the government of Sudan. In addition 10 personnel were locally trained in repair and maintenance of medical equipment. This enabled the two concerned institutes to generate reasonable incomes that made the authority to secure a continuous supply of radiation materials and necessary reagents through out the year and kept maintenance cost minimum, while some spare parts were made available using locally generated funding.

During the project work there were still some problems limiting the operation of this project such as lack of spare parts due to changes in the product version, the shortage of Quality Control (QC) kits & IAEA (equipments) to complete the work, need for Technical staff, and the rising need for addition local finance.

One of the most important benefits generated from operating this project is the facts that introducing nuclear medicine equipments increased efficiency to more than 90%, reducing the cost of treatment to low minimum, increased revenue generated in each centre on a regular bases,

treating thousands of patients who benefited from the nuclear medicine services, and training of several services engineers on an ongoing job training at RICK. The project scored an implementation rate estimated by IAEA as 160%, and it is rated as a model project.

Although the duration of the project, Development of National Radiotherapy Network SUD/6/020 was completed, but nuclear medicine Development at RICK and INMO need to be upgraded and expanded to meet the rising demand for patients treatment. A new national project ***Development and Upgrading of Nuclear Medicine Practices "SUD/6/024"*** has been approved for a two-year period, 2002-2004. The project is an extension to the projects in radiotherapy and nuclear medicine which aims at upgrading the nuclear medicine development by SPECT Gamma Camera to perform Cardiac studies for ischemic heart disease, brain perfusion studies, thyroid disorder, and to participate and improve medicine research and personnel training for graduate and post graduate studies.

The budget allocated to this project amounts to ***US $ 605,896,*** and the local component provided by the government amounts to the equivalent of ***US $ 120,000*** as extra budget with IAEA for the procurement of 2 SPECT Gamma Cameras. The socials and economic impact of this project is that the availability of nuclear medicine techniques mainly in the cardiac of Central Nervous System (C.N.S) will reduce the expenses of management abroad by an estimated 80% of modern nuclear medicine practices uses SPECT Cameras and generated income in two centers as presented in **tables (6) & (7)**.

3.3. Radioimmunoassay (RIA)

The Agency's regional activities towards promoting Radioimmunoassay RIA in human health were initiated in 1986, and to day cover all regions. The Agency TC Programme has included a large number of RIA related projects in the human health sector in many of it's developing member state. Evaluation had been conducted by IAEA to assess the impact of these activities on human health through recipient member state, also the continued relevance of the technology being transferred.

RIA as effective tool for measurement of hormones, and it is essential for both clinical diagnostic profile, and research. RIA substance depends on the use of selected specific antibodies as reagents. Despite the advancements, RIA technology in developing countries is still lagging behind, hindered by economic and administrative factors. However, considerable efforts are continuously being made by IAEA to overcome obstacles and fill in this gap.

SAEC, RICK, and INMO launched in collaboration with IAEA, the establishment of laboratories in measurement of thyroid hormones stimulation (TSH), triodothyronine (T3), tetraiodothyronine (T4), in addition their routine work in assessing plasma level of reproductive hormones such as leuthinizing.

Sudan is a large country with poor means of transportation. Most of the inhabitants work in poorly-paid jobs. The local production and distribution of reagents to the satellite labs within the country, saving people from the hardship of traveling towards the centre in Khartoum. Assays will be designed to suit the insufficiency of the electrical power supply in that area. Then a person who pays about 85 US $ for a T3, T4, and TSH investigation might pay a figure around US $10.

The first project supported by IAEA to offer RIA services and establish laboratory of thyroid hormones at SAEC and Wad Medani (INMO) Faculty of Medicine, Gezira University in 1992, which offered RIA services to patients of the central state. The laboratories were well equipped and RIA of thyroid and productive hormones are routinely conducted in a bid to expand its range of activities. Subsequently under a new TC project SUD/6/019, the IAEA had upgraded the nuclear medicine setup at the INMO by providing a new Gamma Camera system.

The implementation of SUD/6/014 results in a good impact on the improvement of the healthy service to (Central State) and lowers the cost of investigation by reducing the expenses of travel by patients to Khartoum or abroad. In addition to that, the project strengthened the research capabilities of the institute (INMO) and provided training site for the medical students and postgraduates.

The problems facing project SUD/6/014 were the continuous supply of reagents which affected the continuity of service and the availability of hard currency to import reagents. This problem has been solved by the new regional project RAF/6/018 "Consolidated RIA Capability for Tumour Markers" 1997-2003 and the active national project SUD/6/023 "Improving Local Radio Immunodiagnostics Capabilities".

3.3.1. Improving Local Radio immunodiagnostics Capabilities SUD/6/023

The overall objectives of this project are to produce Radioimmunoassay (RIA)/ Immunoradiometricassay (IRMA) and related reagents for investigation of thyroid-related diseases, and to develop radioimmunodignostic reagents for estimation of serum T3, T4, TSH with

the aim to distribute reagents locally within the country to regional laboratories, and transfer the technology associated with RIA technique through training activities.

The duration of this project is from 2003 to 2005 (active project), with a total budget of about US $ 88,080; and the local government input in the form of laboratories and animal house built for this purpose are located in Soba, south east of Khartoum. The building is ready to accommodate the cell culture and production facilities. The recipient institution is the SAEC Ministry of Science and Technology. The numbers of staff working in the project include 4 researchers, 3 research assistances, and 2 technologists.

The major activities implemented under this project are, designing of facilities and planning, setting up a quality management system, training of RIA staff on Good Laboratory Practice (GLP) and the requirements of the international standard ISO 9001-2000, writing Standard Operating Programme SOP, and creating quality system. The main patches of equipments received by the project include Biohazard safety Cabinet class II, Autoclave, and Co2 incubator.

Within the project 2 trained personnel attempted for long term courses (2-3 menthes), and 2 expert missions were excused in 2003**.** Problems concerning to slow implementation rate of the programme as planned were attributed to lack of governmental fund and the poor response from the technical officer of the project at IAEA. **Table (13) shows** available fund spent on human resources, procurement, and the implementation rate of the project for the year 2004.

Table (13): Human Resource Funds and implementation for 2004

	Budget	Current Year Implementation	Funds Available	Implementation Rate
Human Resources	12,418.95	9,904.85	2,514.10	79.8%
Procurement	15,751.01	0.00	15,751.01	0.0%
Total	28,169.96	9,904.85	18,265.11	35.2%

Source: - Report by TC pride, IAEA, 2005

3.4. Isotope Techniques for Water Resources Development and Management

Isotope hydrology techniques are increasingly recognized as indispensable tools for water resources assessment and development when adequately utilized with other hydrological methods in an integrated manner. More than 80% of the total 65 Agency TC projects in isotope hydrology and management operated during 1997-1998 cycle involving 46 member states and a total budgetary allocation of US $ 2.7 million were related to field projects in water resources development and management. Out of these projects 24 were completed and a total of 28 new national projects and 6 regional project were included in the 1999-2000 cycle with total budgetary allocation of US $ 6.7 million (IAEA report,2001).

In Sudan, over the last two decades IAEA has supported TC activities to address water assessment and management issues in Nubian Aquifer, ground water, lockage, Nile valley, and Dam safety, both at the national and regional levels. IAEA national counterparts have used the isotope techniques to address problems of ground water management in parts of the Nubian Aquifer System. A number of TC projects in water resources management in Sudan were initiated between 1990-2004, which highlight the importance of these activities in enhancing the country's development.(appendix 6)

As a result of the Agency's assistance in this area several field studies were completed or initiated in the following areas: (1) El Gezira area (2) aquifers along the Nile Valley (Northern Sudan, Wadi Mugadam and north Kordufan). These studies helped to delineate the extent of recent changes and to identify areas where only pale-water is present. The information being produced is highly important for the settlement development programme along the river Nile which is being pursued by the Government of Sudan.

Based on the experience acquired and the established infrastructure in Sudan, it has been identified that, for the medium term, the application of isotope techniques in hydrology will have to concentrate on the study of Northern State Adjacent Nile aquifers. The Nubian Aquifer System is one of the largest aquifers in the world, covering approximately two million squares Km of Northeast Africa in Libya, Chad, Sudan and Egypt. The Nubian Aquifer is of significant importance for the countries that share its valuable natural resources as a source of drinking water, water for irrigation, etc. Destruction of ecosystem is leading to increased desertification and loss of habitat. Too little water for too many people is an open cause of potential conflict. Thus the uncoordinated use of the NAS could lead to significant transboundry conflict. One challenge in developing an adequate management strategy is the continued lack of sufficient knowledge about aquifer needed to develop a rational use of the aquifer resources that can benefit the four countries in the frame of developing a sufficient management framework. In general there is a lack of a proper database system and capacity to synthesize available information as a base for determining and undertaking future investigations and developing strategies.

The national project Assessment of the Nubian Sandstone Aquifer System (NSAS) in Northern Sudan "SUD/8/007" was approved in 2001-

2002 TC programme; so any remaining activity in this project could be accommodated within the framework of the new regional project RAF/6/036. The area of study of the project SUD/8/007 concentrated on Northern Sudan, the project aimed at investigating the influence of the river Nile system and big seasonal Wadis on the adjacent parts of the (NSAS), investigate the connection between the water-bearing zones within the (NSAS), and to propose a sustainable development plan for them. The expected output of this project was; to assist in the evaluation of the potentials of the (NSAS) through estimate of recharge and water dynamic. The implementation rate of this project till June 2003 is estimated by IAEA as 82.6%. The analysis of samples from project SUD/8/007 could be used in studying the project (NSAS) (RAF/8/036). Thus a better estimate of Aquifer budget, importance and improvement of knowledge on the hydrology are expected. The continuation of these projects aims at solving some problems including the safeguarding of the traffic routes to Libya and Egypt, develop irrigation schemes, develop and upgrade mining activities, improve fodder production and pasture land development, resolve tribal frictions which are caused by conflict over the insufficient resources or services. A number of IAEA assisted TC projects were executed to covered different parts of the country, and valuable results were obtained.

3.4.1. Sustainable Development of Nubian Aquifer

RAF/8/036

The project was approved for 2003-2005 with total budget of US$852,210. Its main objectives are; to promote and support the development of a framework for the sustainable management and use of the Nubian Aquifer System shared by Chad, Libya, Egypt, and Sudan, to

use isotope techniques to expand and consolidate the technical, scientific knowledge, data base regarding the Aquifer System, to develop groundwater management plan, to develop and strengthening of transboundry management framework, in order to define the groundwater dynamic and response to climate and human impact.

The Study area covers Northern State and Northern Darfour State. In the period 1984-1990, the Germans Technishe University of Braunschweig (TUB) launched a special research project on arid zone, covering hydrological, hydrochemical and isotopic investigations, and these activities were of regional nature. Nevertheless, valuable data and information were compiled. During 1998-2002 a programme for the development of regional strategy for the utilization of the Nubian Sandstone aquifer system was executed. The programme concentrated on capacity building in the co-basin countries

The recipient counterpart or institute is the Ministry of Water and Irrigation, Directorate of Groundwater and Wadies. The institutions involvement with the project are; local offices in the project area, state government (northern state), and council for Environmental National Water Cooperation.

The local government contributed to establish the main infrastructures of the projects in the form of laboratories, technical staff, transportation, and funds to facilitate the work. The number of staff employed in this project are 12 persons.

During the operation of this project no expert mission was carried out, while only one expert mission executed under the project SUD/8/007. A number of equipments and materials were received by the project including items for laboratories, data collections, and analysis, and some of them have not been used due to the harsh nature of the area of study.

The achievement obtained so far including advice and data provision to decision makers of the Northern State Government, advice to farmers on ground water situation in the oases and near Nile area, and participation in desert road, oases development and nomads settlement in Wadi Hawar and Wadi Muggadam. In addition to some activities including chemical analysis of water sample, field campaign for water sampling for isotopes analysis, and clearance of equipment and materials.

The main constraints facing the project during its work conclude severe shortage of financial supports from government and stakeholders to repair the Gamma Counter at a high cost, delay in equipment procurement, shipment and delivery, the harsh areas and tough roads, some part of project area is not accessible and reliable vehicle for field work not available.

Table (14) shows the fund spent on human resources and procurement and the implementation rate for 2004 of the project.

Table (14): Financial Resources and Implementation Rate for 2004

	Budget	Current Year Implementation	Funds Available	Implementation Rate
Human Resources	70,849.19	3,597.71	67,251.48	5.1%
Procurement	98,768.48	67,864.57	30,903.91	68.7%
Total	169,617.67	71,462.28	98,155.39	42.1%

Source: - IAEA, 2005.

3.5. Animals Resources Development

Sudan possesses an immense and diversified wealth of animal resource, ranging from domesticated species to the wide an aquatic life which contributes significantly to the food security as well as the economy of the country. Indeed livestock accounts for some 20-22 % of the country's gross domestic production GDP and its population are estimated in 2000 to be 116 million. Although Sudan has the largest animal population in Africa yet production level epical milk production remained to be very low. Many attempts were made to improve the production level but the success rate is also low due to many factors, and more than 80% of animals are owned by nomadic people (IAEA report, 2001).

With regard to livestock sub-sector, considerable support has been provided by the Agency in the field of animal production and health over a number of years. So far, some results have been achieved by using radio-immunoassay techniques for the diagnosis and epidemiological surveillance of livestock diseases and in using this method to monitor control and eradication programmes.

The joint FAO/IAEA Programme has supported animal production research in Sudan for many years through country technical cooperation projects, National and regional projects (AFRA). These activities have helped to build up the infrastructure needed in the countries concerned to conduct much of the research in animal reproduction and nutrition.

3.5.1. The Artificial Insemination Centre

Artificial Insemination (AI) center was established in 1976 with substantial aid of the Overseas Development Association ODA which played an important role in supporting the centre with equipments, chemicals, frozen semen, and experts. Measuring differences between indigenous and the first generation of the cross-bred cows, many farmers were convinced on the AI activities. By the end of 1980 FAO had supported AI and continued supporting it until 1991, the AI lab was well equipped, a Liquid Nitrogen (LN_2) plants was imported, semen was continuously supplied, and a number of local sub-centers were established to produce of semen was started since 1992.

Artificial Insemination made great impact on dairy production; it played a vital role on increasing milk production in Sudan. Before the establishment of AI it was difficult to keep dairy cows in Khartoum, where cattle owners came around Khartoum during the rainy season, and then move away during dry season following natural grazing. Using semen from the best Friesian bulls for upgrading the indigenous breeds made it possible to keep dairy cows. Many modern farms were established in Khartoum and other cities.

3.5.2. Increasing and Improving Milk and Meat Production RAF/5/046

The regional project Increasing and Improving Milk and Meat Production "RAF/5/046 – AFRA III_2" as one of AFRA projects “being carried out in the framework of the African Regional cooperative

agreement”; the African countries counterparts of this project are operative in 18 countries, include Sudan. The objectives of the project are to increase productivity and profitability in milk and meat production, to assess and improve the performance of artificial insemination (AI) programmes for small-scale dairy farmers in AFRA members States, to establish sustainable routine non-pregnancy diagnosis and related services, and to harmonize managerial and field practices and share expertise within the region. At the national level it aims at attaining self sufficiency in milk production and export milk to the neighboring countries.

The project was approved in 1999 for duration of 5 years, with total budget of US $1,184,617, a local component of 1290,000.0 SD in kind to be provided by the government to finance such activities as repairing, spare parts, laboratories, equipments and maintenance, transport, training, and running cost. The expected out-put is to increase milk productivity from 1800 kg lactation to 2500 kg, and to increase the productive efficiency. The expected result to farmers, due to the addition of 700 kg of milk/lactation, is to raise the family income, and improve the living standards of the community. The recipient institutes and counterparts are the Ministry of Science and Technology, and Faculty of Veterinary Science of the University of Khartoum. Other organization were involved in this project such as the Arab Authority for Agricultural Investment Development "AAAID", with the objective of seeking the provision of funds and to facilitate processing and marketing milk and milk by-products, Gezira State and Khartoum State to monitor bodies in collaboration with AFRA.

Two areas of the study were selected for the project as farms: Soba and Kuku area north of Khartoum. Soba farm has been chosen because of the

availability of laboratory, equipments and materials such as semen which has been imported, and trained inseminators.

Assistance has been received in-kind from IAEA in the form of executing one expert mission and training of 2 personnel. The equipments received consist of about 15 patches as lab materials (reagents). The local government also assist in improving the veterinary services providing mobile clinics composed of about 70 cars well equipped to provide direct services to the farmers and improvement of dairy cattle in Gezira state and south Khartoum.

During the project implementation some obstacles were encountered at the local and regional levels such as lack of LN_2, imported of frozen semen, and reagents which resulted in the collapse of IA field services, and complete closure of some sub-center, delay in receiving equipments, some of which had been sent by IAEA, lack of transportation of live animals and animal products to the major markets, lack of financial, shortage of qualified inseminators.

Interviews

In addition to the what has been revealed from available literature and information gathered by the author, an interview was conducted covering 21 respondents of officials considered to be stockholders including coordinators of the projects in different institutes using nuclear techniques, Director General & Director of TC at SAEC). Interview (1) was conducted with coordinators of the projects, and interview (2) was conducted with the Director of TC and Director General at SAEC. The details of these interviews are attached in appendix 8, 9 and the list of the persons interviewed is attached in appendix 10.

The main objective of the interview was to fill-in missed information or to clarify issues which were not stated in documents. Such issues include general information about IAEA/TC projects, TC in SAEC, sources of funds, evaluation of projects, the objectives of the projects, the role of nuclear techniques used in solving specific problems, and their contribution used to the economic development of the country, elaborate the projects status, and suggested solutions for the main problems.

The outcome of the interview is as follows: -

1) Projects chosen by IAEA must be geared to the achievement of sustainability; stop brain drain, and clarify national commitment to the project implementation.
2) Sudan technical cooperation is highly appreciated and, thought to have achieved a financial implementation rate of 90% - 98% during 1998-2003 and of 80%-34% during 2004-2005.
3) The total number of national & regional projects increased rapidly from 16 projects in 1995 to 55 projects in 2004

4) The projects input were received through the IAEA /TC programme in kind (expert missions, long and short term training, and provision of equipment).
5) The number of expert mission executed are between 3 to 6 missions for each project.
6) 70% of projects achieved good results and fulfilled their objectives; on the other hand 30% of the projects have not achieved their objectives and need to be extended.
7) IAEA evaluates the projects as a financial implementation rate (fund spent in the form of equipments, expert mission, training courses) and this rate ranged between 100% to 33%.
8) Projects proposed to be approved by IAEA must be within the Country's Programme Framework (CPF) which is used to help the national authorities to identify the problems considered to be of national priorities. The project subject to approval must use nuclear techniques, be oriented towards end-users, and to be one of the country's development priorities.
9) The local components in the form of infrastructures, staff, and other facilities in 90% of the projects were very weak.
10) The main problems facing 80% of the projects consist of: -
    1. Lack or shortage of local funds.
    2. Inability of the institute to contact other institutes or end users to get the maximum benefit.
    3. Insufficient equipment in some projects.
    4. Slow response from the former Technical Officer of the country; in addition to that he was replaced by another officer.

The Socio-economic Impacts

This section aims at providing highlights on major socio-economic impacts resulting from the operation of different nuclear schemes in different fields of activities.

Agriculture: - Almost 35% of the total technical cooperation programme for Africa is spent on food and Agriculture assistance. The use of genetic crop diversity and micro propagation techniques to improve verities of crops, germless of various cereals, technique to deal with drought-tolerance crops, will generate higher income to farmers in stress-prone production areas of cereal, legume cultivation, and provide a balanced diet to reduce micronutrient malnutrition in the region. These techniques are needed both as an aid to plant breeding, for rapidly multiplying desirable genotypes (the high opportunity cost of producing large quantities of sorghum in the capital intensive farming systems, to the detriment of export crops such as sesame and cotton), and to increase agriculture output.

Life-stocks: - The use of nuclear techniques in animal nutrition and in controlling animal diseases is to select improved breeding stock, sustainable services for diagnosis of non-pregnancy and fertility, and strategies for supplementary feeding to promote higher live-stock productivity. Ultimately, this will result in substantial increases in the productivity for milk and meat, thereby increasing farm profitability, improving farmers socio-economic status, reducing importation of animal by-products and thus saving hard currency, and contributing to national and regional food security, export of animal product, and export fatting animal.

Locally produced vaccine to the satisfaction of the end-users (farmers) will be at a lower cost, reducing the price for vaccination based on a cost-recovery basis, and it will ensure sustainability of vaccine production.

Nuclear safety and Waste Management: Strengthening waste management will enhance the status of radiological safety through the resolution of many problems, thereby safeguarding the population and environment from radiological hazards associated with radioactive waste and, hence it will conserve the environmental conditions for a healthy life.

Isotopes Hydrology and Water Management: - Establishment of infrastructure in Sudan through application of isotope techniques in hydrology for the aquifer and provision of potable water for domestic and agricultural use will be a very important contribution to the development of the area. It will eventually lead to a sustainable production of drinking water, improve agricultural production, resulting in an improvement of the daily life of about 2-5 million people who were resettled along the Nile due to the recurrent of drought, to reduce the population pressure and decrease migration from rural to urban areas. In addition to that it will be beneficial in terms of control of desertification, upgrade health and economic conditions of local communities (IAEA report, 1999).

Nuclear Medicine and Human Health: - Introduction of new and important nuclear medicine techniques through purchasing the relevant equipment by IAEA, will reduce the expenses of management abroad by an estimated 80% of the total cost. This is clearly reflected in the growth of the number of patients treated in 2004 by about 25% compared to 2003; in addition, to reduction in the cost of treatment (TC report,2005).

The equipments are operating properly, providing accurate and meaningful data to healthcare teams, this will lead to a reduction in the number of down time for equipment, improved healthcare services, and patients will be assured of high-quality services. All this has resulted in an increase in income.

Sudan is one of the few less developing countries that have successfully produced radioimmunoassay (RIA) kits. The country aims to satisfy all its needs from these kits and export surplus to its neighbors. Construction of RIA labs in the states (Dongola, Nyala, Wow, Port Sudan, Elfashir, Kosti), the local production and distribution of reagents to the satellites labs will protect people from suffering and traveling towards the center (Khartoum), and will save a considerable amount of money, time, and energy.

The establishment of nuclear-based diagnostic capabilities for chlorquine-resistant malaria and tuberculosis, lowered the capital cost by improving methods for monitoring drug resistance in malaria and tuberculosis and would have a great improvement on morbidity and mortality attributed to the two diseases. This will improve the quality of life of the large proportion of people at risk and subsequently increase productivity.

Industry: - in the field of industry there is a need to establish national capabilities in quality management and control to raise competitiveness and productivity of industrial enterprises in nuclear and related technologies. This enables the country to improve credibility and strengthen the reliability of those enterprises to clients.

Several specific market opportunities for radiation processing will be developed and commercially established in the African countries with a potential market for radiation-processed products. This will enhance inter-country trading and remove trade barriers.

Non Destructive Testing (NDT) – Over the last few years, there has been a rapid expansion in Non Destructive Testing application in Sudan, where most of NDT work is carried out by foreign companies at a very high cost. The country needs sustained national schemes for the qualification and certification of NDT personnel which will be in compliance ISO rules. Good NDT practices will be routinely performed at the industrial level, and the country will be self-reliant by saving hard currency being paid against these activities. To extend their work on commercial bases to make profit, such schemes will be able to offer NDT services using national man-power, almost completely replacing foreign labour.

Maintenance of Equipment: - The center electronic workshop at SAEC, and RICK for maintenance and repair of the nuclear medical equipment reached maximum capacity of more than 90% with minimum service cost, and it provides spare part for equipments to save hard currency. In addition the establishment of the Tele- center with equipped Information Communication Techniques ICT-Laboratory at SAEC, to provide training facilities and to enhance awareness among the end-users of the usefulness of ICT-facilities, will make it cost-effective through group training and distant learning.

Human Resource Development: - Availability of skilled manpower in the fields specified in the project, national, reliable qualification and Certification body is highly needed to serve qualified and expertise personnel. The Technical Cooperation Projects have implemented national and regional training courses in different fields in nuclear science and technology to sustain the implementation of the IAEA projects when

they have exhausting their funds. Such courses include postgraduate studies in nuclear science, radiation protection, and medical physics.

A total of 243 personnel were trained under the TC project (regional training courses), and a total of 347 personnel were trained under national training courses in different fields during 1995-2000. The fees paid by the post graduate students and the income generated from the national training courses are normally used to maintain equipments and other related activities.

Some projects were oriented as income generating in the form establishing centers for national training such as: -

1) Central Electronic Workshop of SAEC & RICK to run its activities in training, research, and maintenance. The center at SAEC is to generate income from training personnel and repairing instruments and its total revenue amounted to SD 16, 7 million in 2004.
2) Functioning Training and Certification Center; working as part of Non Destructive Testing Programme is also oriented to socio-economic welfare by generating income and providing qualified personnel (60-80 NDT personnel will be trained annually).

The above mentioned section indicate the important role of the TC projects and their impact in the socio-economic development, which present the significant contribution of the nuclear medicine human health, transfer the services to regions, and institution involved provide good welfare and became more self-reliant . It also reveals the major role played by the IAEA in establishing infrastructures through installation of provisional equipments, qualify manpower, and transfer the nuclear techniques.

Conclusions

The study is an attempts to explain the impact of the IAEA technical Cooperation Programme in enhancing socio-economic development in Sudan. Through reviewing the achievement of the TC projects, supported by interviews with stakeholders (coordinators of the projects, Director General & Director of TC at SAEC) certain conclusions were drawn: -

1. The important role played by Sudan Atomic Energy Commission (SAEC) in its capacity as the national coordinating body with respect to Technical Cooperation (TC) is highly appreciated. This is the main reason why there was a relatively high implementation rate of 90% - 98% during 1998-2003 and of 80% in 2004.
2. The performance indicates that the management of TC projects activated at the national level were successful and have significant impact, particularly in human health, waste management, instrumentation, and agriculture.
3. It is very clear from the study that if these projects were to succeed in getting the maximum benefit from the IAEA TC the following conditions must be satisfied:
    1) Achievement of sustainability;
    2) Stop brain drain,
    3) Clarify national commitment to the project implementation.
4. The main objectives of the TC projects implemented in Sudan are to achieve self-reliance in the application of nuclear techniques; contribute directly to the goal of the institutes and development strategy in Sudan; and promote technology which is compatible with the national priorities of the country. The latter objective entails:

1) The continued uses of technology or techniques by the country after the Agency inputs have been delivered.
2) Continuous participation in the project by end-users.

5. The total number of national & regional projects increased rapidly from 16 projects in 1995 to 55 projects in 2004.
6. All projects received their assistance only from IAEA. The IAEA through the TC programme provides its support in kind (expert missions, long and short term training, and provision of equipment).
7. Most of the equipments received are normally functioning. However, some of them were not in use due to same constraints in the provision of local components.
8. The numbers of expert missions executed are between 3 to 6 missions for each project.
9. Most of the projects achieved their objectives and showed good results.
10. The project SUD/6/020 "Development of National Radiotherapy Network" scores an implementation rate of 160% as estimated by IAEA, and it is rated as a model project. This project is regarded as the first provider for nuclear radiotherapy in Africa, and its duration has been extended for further periods and new projects were added.
11. Some projects were not highly successful in achieving their objectives as planned, with low implementation rates ranging between 0% and 33 %, that due to lack of local components and other constraints.
12. Government participation and commitment is very weak; the Government is not fully committed to the project finance.

13. Most of the projects implemented are concentrated in Khartoum State. It is considered to be the largest user of radiation application and other facilities.

14. 60% of the projects are continuous and sustainable. Although 30% of them have been completed they continues to provide services to the end user.

15. The interviews with the stakeholders have revealed the most important problems, facing all projects at the national level which include: -

    1) Lack or shortage of local funds which led to poor equipped labs, lack of transportation, poorly trained personnel and meager facilities.
    2) Insufficient of equipment in some projects, the fund allocated for equipment in national projects is not sufficient and in regional projects the whole funds go to manpower (training personnel).
    3) Lack of communication means in some institutes.

The Recommendation

Based on the findings and analysis reviewed in the previous sections, the following recommendations are suggested: -

1. There is a high need to convince decision makers and end-users with the importance of the new radiation techniques (food irradiation), and its contribution to national development, as a new alternative sources of energy for peaceful purposes.
2. To find means and ways to enlarge the TC projects within the country program framework.
3. Device policies aimed at increasing local government inputs (local component) whereby the government updates the construction and complements of the laboratory facilities.
4. Collaboration between project coordinators in different fields is essential, and they have to communicate with institutes outside of Khartoum, to spread the services of project, and transfer nuclear techniques to regions.
5. More efforts are needed to get sufficient financial support to the project, this should be done in collaboration with other organizations.
6. Should be good connection with the counterparts of the projects, TC at SAEC, and technical officer at IAEA
7. More effort should be directed towards expanding national training courses than the regional courses.
8. Addition effort to evaluate the project implementation by SAEC through :
    1) Establishing a committee to follow up the projects.

2) Continuous follow up and visits the institute where the projects are being implemented, and submitting the project report on time.
3) Maintaining close contact between the coordinator and TC staff.

More investigation is needed on such topics, such as the way of IAEA in funding and evaluating the projects, availability of government grantee to increase the local fund, and provide addition funds from other organizations.

Appendix 1

The total Active National Projects (13), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	1st Year of Approval	Total Budget
SUD0009	Supporting Postgraduate Teaching Programmes	0I	2005	96,740
SUD0010	Human Resource Development and Nuclear Technology Support	0A	2005	98,580
SUD4006	Upgrading Capabilities for Maintenance and Repair of Scientific and Medical Instruments	4G	2003	112,700
SUD5026	Improvement of the Productivity and Sustainability of Industrial Crops	5C	2001	258,010
SUD5029	Characterization and Quality-assured Production of an Attenuated Theileria Annulata Vaccine	5F	2005	159,380
SUD6022	Establishment of a High-Dose Brachytherapy Unit at Gezira, Wad Medani, Sudan	6C	2001	99,049
SUD6023	Improving Local Radioimmunodiagnostics Capabilities	6A	2003	88,080
SUD6024	Development and Upgrading of Nuclear Medicine Practices	6B	2003	605,896
SUD6025	Validation of the Use of Isotope-based Molecular Techniques in Malaria Control	6B	2005	234,170
SUD6026	Evaluating the Nutritional Status and the Body Composition of Vulnerable Groups	6J	2005	139,760
SUD8006	Quality Control in the Industrial and Infrastructural Sectors	8C	2001	242,230
SUD8008	Development of National Capabilities for Training and Certification for Non-destructive Testing Personnel	8P	2005	163,110
SUD9007	Strengthening Food and Environmental Monitoring	9K	2005	51,020

Appendix 2

The total active Regional/Interregional Projects (42), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	1st Year of Approval	Total Budget
INT0060	Technical Co-operation Between Developing Countries	0A	1995	961,250
INT0074	Pre-Project Assistance (Africa and East Asia and the Pacific)	0A	2001	541,706
RAF0011	Human Resource Development and Nuclear Technology Support	0A	1995	9,498,840
RAF0012	Institutional Support to Least-Developed Countries	0A	1995	1,917,878
RAF0013	ICT-Based Training to Strengthen LDC Capacity	0I	2000	600,270
RAF0014	Promoting National and Regional Self-reliance in Nuclear Science and Technology (AFRA V-2)	0A	2001	941,990
RAF0015	Legislative Assistance for the Safe and Peaceful Uses of Nuclear Energy	0D	2001	987,160
RAF0016	Sustainable Energy Development in Sub-Saharan Africa	0E	2001	1,007,900
RAF0017	Strengthening the Managerial Capability of AFRA Member States (AFRA V-1)	0G	2001	642,383
RAF0018	Human Resource Development and Nuclear Technology Support	0A	2003	2,385,928
RAF0019	Country Programme Review	0A	2003	306,400
RAF0020	ICT-based Training/Learning to Strengthen Training Capacity (AFRA V-3)	0I	2003	1,350,250
RAF0021	Nuclear Security Implementation Support (AFRA I-3)	9U	2003	488,136
RAF3005	Sustaining the Waste Management Infrastructure (AFRA I-4)	3H	2005	2,153,890
RAF4015	Strengthening Waste Management Infrastructure (AFRA I-1)	4O	1997	3,110,148
RAF4017	Sustaining Regional Capability in Maintenance and Repair (AFRA IV-4)	4K	2001	1,596,750
RAF4018	Quality Management and Control Using Nuclear and Related Technologies (AFRA IV-9)	4M	2003	1,086,100
RAF5040	SIT for Tsetse and Trypanosomiasis Management in Africa	5D	1997	2,307,848
RAF5046	Increasing and Improving Milk and Meat Production (AFRA III-2)	5E	1999	1,184,617
RAF5050	Increasing Production of Nutritious Food Through Mutation Breeding and Biotechnology (AFRA III-3)	5C	2001	921,350
RAF5051	Sterile Insect Technique for Area-wide Tsetse and Trypanosomosis Management	5D	2001	4,604,242
RAF5052	Sterile Insect Technique for Control of Anopheles Mosquito	5D	2001	745,656
RAF5053	Assistance to OAU/IBAR PACE Programme for the Control and Eradication of Major Diseases Affecting	5F	2001	1,785,058

	Livestock			
RAF6014	Improvement of Clinical Radiotherapy (AFRA II-1)	6C	1995	2,881,299
RAF6024	Management of the Most Common Cancers in Africa (AFRA II-4)	6C	2001	1,670,050
RAF6025	Detection of Drug-Resistant Malaria and Tuberculosis	6B	2001	1,795,750
RAF6026	Application of Nuclear Medicine Techniques	6B	2001	1,344,300
RAF6027	Strengthening Regional Capability in Medical Physics (AFRA II-5)	6F	2001	1,372,470
RAF6032	Promoting Regional and National Quality Assurance Programmes for Medical Physics in Nuclear Medicine (AFRA II-7)	6B	2005	932,300
RAF8028	Investigating Dam and Reservoir Leakages and Safety (AFRA IV-5)	8N	1999	521,611
RAF8032	Strengthening Regional Training Capability in Non-Destructive Testing (AFRA IV-6)	8P	2001	1,131,450
RAF8033	Radiation Processing for Materials and Environmental Applications (AFRA IV-8)	8H	2001	712,150
RAF8034	Isotope Hydrology Integration in the Water Sector	8M	2001	818,397
RAF8036	Sustainable Development of the Nubian Aquifer	8M	2003	852,210
RAF8037	Sustainable Development and Equitable Utilization of the Common Nile Basin Water Resources	8M	2003	749,170
RAF8039	Towards a Sustainable Development of the Nubian Aquifer	8M	2003	22,673
RAF9028	Post-Graduate Training in Radiation and Waste Safety	9C	2001	1,698,065
RAF9029	Development of Technical Capabilities for Sustainable Radiation and Waste Safety	9C	2001	2,335,262
RAF9031	Strengthening National Regulatory Infrastructure for the Control of Radiation Sources	9H	2005	811,300
RAF9033	Strengthening Radiological Protection of Patients and Medical Exposure Control	9J	2005	445,800
RAF9034	Establishment of National Capabilities for Response to a Radiological and Nuclear Emergency	9L	2005	390,150
RAF9035	Education and Training in Support of Radiation Protection Infrastructure	9C	2005	952,000

Appendix 3

The total Completed National Projects (30), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	Completed on	Total Budget
SUD0006	Nuclear Science Laboratory	0H	1993-06-25	1,129,235
SUD0007	Manpower Development for Nuclear Energy Applications	0A 0B 0I	1997-01-31	85,210
SUD0008	Energy Economics and Power Planning	0E	2002-08-02	94,774
SUD1005	Secondary Standards Dosimetry Laboratory	1K	1994-09-30	155,072
SUD2003	Radiometric Investigation of the Red Sea	2C 7F	2003-12-17	186,217
SUD4003	Nuclear Instrumentation	4B	1991-01-08	89,866
SUD4004	Nuclear Instrumentation (Phase II)	4G	1994-08-23	113,699
SUD4005	Production of Bulk Reagents for Immunoassays (Phase II)	4G	1997-10-31	118,672
SUD5012	Pesticide Residues	5G	1990-09-12	118,229
SUD5016	Animal Science	5E	1991-10-24	88,706
SUD5018	Mutation Breeding	5C	1993-11-16	142,312
SUD5019	Pesticide Residues in Cotton Seeds	5G	1995-04-04	65,083
SUD5020	Immunoassay Techniques for Animal Diseases Diagnosis	5F	1995-06-30	50,396
SUD5021	Management of Nutrients, Water and Organic Matter	5B	1998-11-27	238,917
SUD5022	Increasing Productivity of Smallholder Dairy Cattle	5F	1999-08-30	120,812
SUD5023	Improving Cotton and Sugar Cane Crops (Phase II)	5C	2000-11-29	134,529
SUD5025	Improving Productivity of Goats	5E	2003-12-17	189,146
SUD6009	Nuclear Medicine	6B	1990-09-10	92,550
SUD6012	Use of Gamma Camera	6B	1994-05-27	288,823
SUD6014	Nuclear Medicine (Gezira University)	6B	1994-05-30	47,367
SUD6017	Nuclear Medicine (Phase II)	6B	1994-10-28	85,026

SUD6018	Production of Bulk Reagents for Immunoassays	6B 2F	1996-02-29	61,488
SUD6019	Upgrading Nuclear Medicine Facility with Gamma Camera	6B	1998-04-20	352,800
SUD6020	Development of a National Radiotherapy Network	6C	2001-08-31	1,045,215
SUD6021	Isotopes and Molecular Techniques in Malaria Control	6B	2004-12-22	190,216
SUD8004	Isotopes in Hydrology	8M	1991-01-08	162,132
SUD8005	Use of Isotopes in Groundwater Assessment	8M	1995-06-30	73,304
SUD8007	Assessment of the Nubian Sandstone Aquifer System in Northern Sudan	8M	2004-12-22	142,797
SUD9005	Radiation Protection (Phase II)	9C	1996-09-25	149,418
SUD9006	Upgrading Radiation Protection Services	9C	1997-01-31	99,095

Appendix 4

The total Completed Regional/Interregional Projects (24), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	Completed on	Total Budget
INT9143	Upgrading Radiation Protection Infrastructure	9C	2000-12-08	5,306,472
RAF0010	Project Formulation Meetings (AFRA XIII)	0B	2003-07-29	513,266
RAF4009	Nuclear Instrumentation (AFRA Iv)	4G	1999-07-30	694,004
RAF4014	Maintenance of Medical and Scientific Instruments (AFRA IV-3)	4G	2003-11-28	1,443,240
RAF5027	Radioisotopes in Animal Reproduction & Nutrition (AFRA Viii)	5E	1997-10-31	956,685
RAF5029	Nucl. Techniques in Plant Breeding & Biotechnology (AFRA X)	5C	1999-12-21	201,542
RAF5034	Diagnosis and Control of Livestock Diseases	5F	1997-12-11	439,706
RAF5041	Animal Feed Supplementation Packages (AFRA II-17)	5E	2003-07-29	694,870
RAF5042	Development of Improved Crop Varieties (AFRA III-1)	5C	2003-06-25	1,049,196
RAF5043	Assistance to Complete Eradication of Rinderpest from Africa	5F	2002-09-11	851,766
RAF5045	Biofertilizers for Increasing Crop Production and Soil Fertility by Smallholders	5B	2003-03-28	769,021
RAF6007	Local Preparation of Radioimmunoassay Reagents (AFRA V)	6B	1999-12-21	898,086
RAF6017	Isotopes for Control of Human Communicable Diseases	6B	2002-08-12	956,162
RAF6018	Consolidated RIA Capability for Tumour Markers (AFRA II-2)	6B	2003-12-31	1,122,319
RAF8010	Water Resources in the Nile Valley	8M	1992-09-15	175,830
RAF8016	Irradiation Processing (AFRA III)	8H	1996-06-28	118,898
RAF8017	Non-Destructive Testing Techniques (AFRA Vi)	8C	2003-07-29	390,793
RAF8022	Isotopes in Groundwater Resources Development	8M	2001-09-13	1,580,610
RAF8024	Radiation Processing Food and Industrial Products (AFRA IV-1)	8H 5H	2003-07-29	724,511
RAF8025	Non-Destructive Testing in Industry (AFRA IV-2)	8C	2003-05-30	1,016,088
RAF8026	Investigation of Leakage in Dams & Reservoirs (AFRA Iv-22)	8F	1999-07-30	92,071
RAF9007	Waste Management (AFRA I)	9E 4O	1997-10-31	353,229
RAF9016	Upgrading Radiation Protection Infrastructure in Africa	9C	1997-12-23	496,317
RAF9024	Upgrading Radiation Protection Infrastructure	9C	2004-10-29	2,947,059

Appendix 5

The number of Projects in Radiotherapy and Nuclear Medicine in Sudan and the Total Budget Provided by IAEA

Title of project	**Code No.**	**Recipient institute**	**First year approval**	**Total of budget US $**	**Complete/ active**
Upgrading Nuclear Medicine Facility with Gamma Camera	SUD/6/019	-- Ministry of Health - INMO	1995	313.050	Comp.1998
Nuclear Medicine	SUD/6/014	-- Ministry of Health - INMO		47,367	Comp. 1994
Improving of Clinical Radiotherapy	RAF/6/014	RICK	1995		
Developing of National Radiotherapy Network	SUD/6/020	-- Ministry of Health - INMO -RICK	1997	1,045,215 US $	2001
Development & Upgrading of Nuclear Medicine	SUD/6/024	-- Ministry of Health - INMO -RICK	2003	605,896	Active
Local Production of Bulk Immunoassay Reagents	SUD/6/018	- SAEC	1993	61,488	Comp. 1996
consolidated RIA capability for Tumor Markers	RAF/6/018	SAEC	1997	1,122,319	Comp. 2003
Improving Local Radio immunodiagnostics Capabilities	SUD/6/023	SAEC	2003	88,080	Active

Source: *- TC Directorate Report, 2005, SAEC*

Appendix 6

The total number. of project (National & Regional) provided by IAEA served water resources.

Title of project	**Code No.**	**Recipient institute**	**First year approval**	**Total of budget US $**	**Complete/ active**
Investigation Dam and Reservoir Leakages and safety	RAF/8/028	-- Ministry of water and irrigation, Dams Administration	1999	521,611	Active
Isotope hydrology Integration in the water sector	RAF/8/034	Ministry of water and irrigation, Groundwater and Wadis	2001	818,397	Active
Sustainable development of the Nubian aquifer	RAF/8/036	Ministry of water and irrigation, Groundwater and Wadis	2003	852,210	Active
Sustainable development & Equitable Utilization of the common Nile Basin water resources	RAF/8/037	Ministry of water and irrigation, Dams Administration	2003	749,170	Active
Towards a Sustainable development of the Nubian aquifer	RAF/8/039	Ministry of water and irrigation, Groundwater and Wadis	2003	22,673	Active
Isotopes in Hydrology	SUD/8/004	Ministry of water and irrigation	1982	162,132	Comp. 1991
use isotopes in groundwater assessment	SUD/8/005	Ministry of water and irrigation	1991	73,304	Comp. 1995
Assessment of the Nubian Sustainable development aquifer system	SUD/8/007	Ministry of water and irrigation	2001	142,797	Comp. 2004
Water resources in the Nile valley	RAF/8/010	Ministry of water and irrigation	1983	175,830	Comp. 1992
Isotope in groundwater resource development	RAF/8/022	Ministry of water and irrigation	1995	1,580,610	Comp. 2001
Investigation of Leakages in Dam and Reservoir	RAF/8/026	Ministry of water and irrigation	1997	92,071	Comp. 1999

Source: *- Report by TC Directorate, 2005, SAEC*

Appendix 7

The total number of project (National & Regional) provided by IAEA served Animal Production and Health:-

Title of project	Code No.	Recipient institute	First year approval	Total of budget US $	Complete/ active
SIT for Tsetse and Trypanosomiasis Management in Africa	RAF/5/040	Ministry of Animal Resources	1997	2,307,848	Active
Increasing Improving Milk & Meat Production	RAF/5/046	Ministry of Animal Resources & Ministry of Sciences & Technology	1999	1,184,617	Active
Sterile Insect Technique for Area-Wide Tsetse and Trypanosomiasis Management	RAF/5/51	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	4,604,242	Active
Sterile Insect Technique for control of Anopheles Mosquito	RAF/5/052	Ministry of Health, National Center for Research, Tropical Medicine Research Institute	2001	745,656	Active
Assesstance to OAU/IBAR PACE Programme for the control and Eradication of Major Diseases Affecting Livestock	RAF/5/053	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	1,785,058	Active
Radioisotopes in Animal Reproduction & Nutrition	RAF/5/027	Ministry of Sciences & Technology, Central Veterinary Research Lab	1993	956,685	Copm. 1997
Diagnosis and Control of Livestock Diseases	RAF/5/034	Ministry of Sciences & Technology, Central Veterinary Research Lab	1995	439,706	Comp. 1998
Animal Feed Supplementation Packages	RAF/5/041	Ministry of Sciences & Technology, Central Veterinary Research Lab nimal Resources	1997	694,870	Copm.
Assistance to Complete Eradication of Rinderpest from Africa	RAF/5/043	Ministry of Animal Resources	1997	851,766	Comp. 9.2002
Animal Science	SUD/5016	Ministry of Animal Resources	1984		COPM. 1992
Immunoassy Trechniques for Animal	SUD/5/20	Ministry of Sciences & Technology,	1993	50,396	COMP. 06.1995

Diseases Dignosis		Central Veterinary Research Lab			
Increasing Productivity of Smallholder Dairy Cattle	SUD/5/022	Ministry of Sciences & Technology, Central Veterinary Research Lab	1995	120,812	Comp. 08.1999
Improving Productivity of Goats	SUD/5/025	University of Khartoum, Faculty of Veterinary	1999	189,146	Copm. 12.2003
Control of Ticks and Tick-Borne Diseases using ELISA	SUD/5/027	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	244,417	Comp. 2005

Source: *- Report by TC Directorate, 2005, SAEC*

Appendix 8

Interview (1) Conducted With the Director General of SAEC and the Director of the Technical Cooperation at SAEC.

1. Name:----------
2. Address:----------
3. Project title:----------
4. Recipient Institute: ----------

Questions: -

1. General information about the IAEA Technical Cooperation include: -

- Kind of TC
- To whom concern

2. How to be one of IAEA Member State?

3. The contributed of Sudan

4. Kind of projects: - National, Regional, AFRA, the different in their objectives, and amount of fund to each kind of project

5. How to request for new project? (information about CPF)

6. How IAEA interested to chose the project?

7. General information about Technical Cooperation in SAEC

8. How TC deal with the Projects coordination?

9. How IAEA evaluate the projects?

10. Your opinion in evaluation the TC project in Sudan, include the

11. Your opinion in evaluation some projects and their implementation rates : -

- RAF/5/046 "Improving and Increase Productivity of Meat and Milk"
- SUD/6/020"Development of National Radiotherapy Network"
- SUD/6/032 'Improving Radio immunodiagnostics capabilities"
- RAF/8/036 "Sustainable Development of the Nubian Aquifer"

12. The main constraints facing TC at SAEC?

13. Suggest solutions

14. Do you think the use of Nuclear Techniques, (TC) in Sudan contribute in enhancing socioeconomic? If yes, the future

15. Any addition information

Thank you for taking the time to reply in this interview

Appendix 9

Interview (2) Conducted With the Projects Coordinators

5. Name:----------
6. Address:----------
7. Project title:----------
8. Recipient Institute: ----------

Questions: -

1. What are the main problems that face the ….. (Sectors)./ project priority?

2. What are the objectives of the project and it's established to solve specific problems in the …. (Sectors)?

3. How can use of nuclear techniques contribute in solving the specific problems?

4. Area of the project, Reason for choosing this area

5. Assistance provided by IAEA: -

i) Equipments; received –delay – being regularly used– function well- repaired/ maintenance - other problems

ii) Training: - number of staff has been trained – are they no longer with the project?

ii) Expert mission: - number of expert mission executed

6. Collaboration with other organizations/ Are there other international and/or bilateral programmes supporting this project

7. Kind of their assistances.

8. Kind of Government assistances or inputs

9. The most effective assistance received is from;

i) IAEA ii) other organizations iii) or government (explain/ compare)

10.The main constraints: -

i) At the national level ii) IAEA level

10. Suggest solutions: -

11. After the execution of the project, did you fulfill the objectives of the project and what is the implementation rate (percentage)?

12. Do you think that the project has a good impact/ contribution in development or in enhancing Scio-economic in Sudan?

13. Do you feel that this project needs to be extended, or not? If yes why?

- ***Thank you for taking the time to reply in this interview***

Appendix 10

List of the person who conducted in the interview 1, 2 and their address.

1. Prof. Mohamen A. H. Eltayeb - Director General of SAEC
2. Dr. Ibrahim A. Shaddad, TC Director at SAEC

A. Water Resources Sector: -

1. Dr. El magzoob Ahmed Taha, Ministry of Irrigation & Water Resources – Dams Administration
2. Dr. Eldoory, Ministry of Irrigation & Water Resources
3. Abd Alla Mohamed Khir, Ministry of Irrigation & Water Resources – Ground Water and Wadis

B. Human Health: -

1. Dr. Hussien M. Ahmed, Radiation and Isotope Centre, Khartoum (RICK)
2. Dr. Kamal Hamad, Radiation and Isotope Centre, Khartoum (RICK)
3. Dr. A. Elmajed Elrofaai, Radiation and Isotope Centre, Khartoum (RICK
4. Dr. Awad Drag, Institute of Nuclear Medicine and Molecular Biology (INMO)

C. Maintenance & Repair: -

1. Mr. Elmalih Ali Elbashir, The National Ribat University
2. Mr. Yousif Awad Elamain, SAEC

D. Radioimmunoassay (RIA): -

1. Mr. Abd Elmoniem M. Elhassan, SAEC
2. Mr. Omer M. Abdalla, SAEC

F. Animal Resources: -

1. Dr. Abubaker Adam, Central Veterinary Research Laboratories
2. Mr. Yousif Elmansory, Central Veterinary Research Laboratories
3. Dr. A. Elrahim M. Hussien, Central Veterinary Research Laboratories

H. NDT: -

1. Dr. Rifaat Kabashi Hassona, SAEC

2. Mr. Sayed Kabashi Megany, SAEC

G. Radiation Protection & Waste Management: -

1. Dr. A. Elrahim Shaddad, SAEC
2. Mr. Mumdouh Ysin, SAEC
3. Mr. Eltayeb Haj Musa, SAEC

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Appendix 1

The total Active National Projects (13), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	1st Year of Approval	Total Budget
SUD0009	Supporting Postgraduate Teaching Programmes	0I	2005	96,740
SUD0010	Human Resource Development and Nuclear Technology Support	0A	2005	98,580
SUD4006	Upgrading Capabilities for Maintenance and Repair of Scientific and Medical Instruments	4G	2003	112,700
SUD5026	Improvement of the Productivity and Sustainability of Industrial Crops	5C	2001	258,010
SUD5029	Characterization and Quality-assured Production of an Attenuated Theileria Annulata Vaccine	5F	2005	159,380
SUD6022	Establishment of a High-Dose Brachytherapy Unit at Gezira, Wad Medani, Sudan	6C	2001	99,049
SUD6023	Improving Local Radioimmunodiagnostics Capabilities	6A	2003	88,080
SUD6024	Development and Upgrading of Nuclear Medicine Practices	6B	2003	605,896
SUD6025	Validation of the Use of Isotope-based Molecular Techniques in Malaria Control	6B	2005	234,170
SUD6026	Evaluating the Nutritional Status and the Body Composition of Vulnerable Groups	6J	2005	139,760
SUD8006	Quality Control in the Industrial and Infrastructural Sectors	8C	2001	242,230
SUD8008	Development of National Capabilities for Training and	8P	2005	163,110

	Certification for Non-destructive Testing Personnel			
SUD9007	Strengthening Food and Environmental Monitoring	9K	2005	51,020

Appendix 2

The total active Regional/Interregional Projects (42), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	1st Year of Approval	Total Budget
INT0060	Technical Co-operation Between Developing Countries	0A	1995	961,250
INT0074	Pre-Project Assistance (Africa and East Asia and the Pacific)	0A	2001	541,706
RAF0011	Human Resource Development and Nuclear Technology Support	0A	1995	9,498,840
RAF0012	Institutional Support to Least-Developed Countries	0A	1995	1,917,878
RAF0013	ICT-Based Training to Strengthen LDC Capacity	0I	2000	600,270
RAF0014	Promoting National and Regional Self-reliance in Nuclear Science and Technology (AFRA V-2)	0A	2001	941,990
RAF0015	Legislative Assistance for the Safe and Peaceful Uses of Nuclear Energy	0D	2001	987,160
RAF0016	Sustainable Energy Development in Sub-Saharan Africa	0E	2001	1,007,900
RAF0017	Strengthening the Managerial Capability of AFRA Member States (AFRA V-1)	0G	2001	642,383
RAF0018	Human Resource Development and Nuclear Technology Support	0A	2003	2,385,928
RAF0019	Country Programme Review	0A	2003	306,400
RAF0020	ICT-based Training/Learning to Strengthen Training Capacity (AFRA V-3)	0I	2003	1,350,250
RAF0021	Nuclear Security Implementation Support (AFRA I-3)	9U	2003	488,136
RAF3005	Sustaining the Waste Management Infrastructure (AFRA I-4)	3H	2005	2,153,890
RAF4015	Strengthening Waste Management Infrastructure (AFRA I-1)	4O	1997	3,110,148
RAF4017	Sustaining Regional Capability in Maintenance and Repair (AFRA IV-4)	4K	2001	1,596,750
RAF4018	Quality Management and Control Using Nuclear and Related Technologies (AFRA IV-9)	4M	2003	1,086,100
RAF5040	SIT for Tsetse and Trypanosomiasis Management in Africa	5D	1997	2,307,848
RAF5046	Increasing and Improving Milk and Meat Production (AFRA III-2)	5E	1999	1,184,617
RAF5050	Increasing Production of Nutritious Food Through Mutation Breeding and Biotechnology (AFRA III-3)	5C	2001	921,350
RAF5051	Sterile Insect Technique for Area-wide Tsetse and Trypanosomosis Management	5D	2001	4,604,242
RAF5052	Sterile Insect Technique for Control of Anopheles Mosquito	5D	2001	745,656
RAF5053	Assistance to OAU/IBAR PACE Programme for the Control and Eradication of Major Diseases Affecting	5F	2001	1,785,058

	Livestock			
RAF6014	Improvement of Clinical Radiotherapy (AFRA II-1)	6C	1995	2,881,299
RAF6024	Management of the Most Common Cancers in Africa (AFRA II-4)	6C	2001	1,670,050
RAF6025	Detection of Drug-Resistant Malaria and Tuberculosis	6B	2001	1,795,750
RAF6026	Application of Nuclear Medicine Techniques	6B	2001	1,344,300
RAF6027	Strengthening Regional Capability in Medical Physics (AFRA II-5)	6F	2001	1,372,470
RAF6032	Promoting Regional and National Quality Assurance Programmes for Medical Physics in Nuclear Medicine (AFRA II-7)	6B	2005	932,300
RAF8028	Investigating Dam and Reservoir Leakages and Safety (AFRA IV-5)	8N	1999	521,611
RAF8032	Strengthening Regional Training Capability in Non-Destructive Testing (AFRA IV-6)	8P	2001	1,131,450
RAF8033	Radiation Processing for Materials and Environmental Applications (AFRA IV-8)	8H	2001	712,150
RAF8034	Isotope Hydrology Integration in the Water Sector	8M	2001	818,397
RAF8036	Sustainable Development of the Nubian Aquifer	8M	2003	852,210
RAF8037	Sustainable Development and Equitable Utilization of the Common Nile Basin Water Resources	8M	2003	749,170
RAF8039	Towards a Sustainable Development of the Nubian Aquifer	8M	2003	22,673
RAF9028	Post-Graduate Training in Radiation and Waste Safety	9C	2001	1,698,065
RAF9029	Development of Technical Capabilities for Sustainable Radiation and Waste Safety	9C	2001	2,335,262
RAF9031	Strengthening National Regulatory Infrastructure for the Control of Radiation Sources	9H	2005	811,300
RAF9033	Strengthening Radiological Protection of Patients and Medical Exposure Control	9J	2005	445,800
RAF9034	Establishment of National Capabilities for Response to a Radiological and Nuclear Emergency	9L	2005	390,150
RAF9035	Education and Training in Support of Radiation Protection Infrastructure	9C	2005	952,000

Appendix 3

The total Completed National Projects (30), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	Completed on	Total Budget
SUD0006	Nuclear Science Laboratory	0H	1993-06-25	1,129,235
SUD0007	Manpower Development for Nuclear Energy Applications	0A 0B 0I	1997-01-31	85,210
SUD0008	Energy Economics and Power Planning	0E	2002-08-02	94,774
SUD1005	Secondary Standards Dosimetry Laboratory	1K	1994-09-30	155,072
SUD2003	Radiometric Investigation of the Red Sea	2C 7F	2003-12-17	186,217
SUD4003	Nuclear Instrumentation	4B	1991-01-08	89,866
SUD4004	Nuclear Instrumentation (Phase II)	4G	1994-08-23	113,699
SUD4005	Production of Bulk Reagents for Immunoassays (Phase II)	4G	1997-10-31	118,672
SUD5012	Pesticide Residues	5G	1990-09-12	118,229
SUD5016	Animal Science	5E	1991-10-24	88,706
SUD5018	Mutation Breeding	5C	1993-11-16	142,312
SUD5019	Pesticide Residues in Cotton Seeds	5G	1995-04-04	65,083
SUD5020	Immunoassay Techniques for Animal Diseases Diagnosis	5F	1995-06-30	50,396
SUD5021	Management of Nutrients, Water and Organic Matter	5B	1998-11-27	238,917
SUD5022	Increasing Productivity of Smallholder Dairy Cattle	5F	1999-08-30	120,812
SUD5023	Improving Cotton and Sugar Cane Crops (Phase II)	5C	2000-11-29	134,529
SUD5025	Improving Productivity of Goats	5E	2003-12-17	189,146
SUD6009	Nuclear Medicine	6B	1990-09-10	92,550
SUD6012	Use of Gamma Camera	6B	1994-05-27	288,823
SUD6014	Nuclear Medicine (Gezira University)	6B	1994-05-30	47,367
SUD6017	Nuclear Medicine (Phase II)	6B	1994-10-28	85,026

SUD6018	Production of Bulk Reagents for Immunoassays	6B 2F	1996-02-29	61,488
SUD6019	Upgrading Nuclear Medicine Facility with Gamma Camera	6B	1998-04-20	352,800
SUD6020	Development of a National Radiotherapy Network	6C	2001-08-31	1,045,215
SUD6021	Isotopes and Molecular Techniques in Malaria Control	6B	2004-12-22	190,216
SUD8004	Isotopes in Hydrology	8M	1991-01-08	162,132
SUD8005	Use of Isotopes in Groundwater Assessment	8M	1995-06-30	73,304
SUD8007	Assessment of the Nubian Sandstone Aquifer System in Northern Sudan	8M	2004-12-22	142,797
SUD9005	Radiation Protection (Phase II)	9C	1996-09-25	149,418
SUD9006	Upgrading Radiation Protection Services	9C	1997-01-31	99,095

Appendix 4

The total Completed Regional/Interregional Projects (24), the total budget, and field of activity in Sudan provided by IAEA from 1990-2004

Project Number	Title	Field	Completed on	Total Budget
INT9143	Upgrading Radiation Protection Infrastructure	9C	2000-12-08	5,306,472
RAF0010	Project Formulation Meetings (AFRA XIII)	0B	2003-07-29	513,266
RAF4009	Nuclear Instrumentation (AFRA Iv)	4G	1999-07-30	694,004
RAF4014	Maintenance of Medical and Scientific Instruments (AFRA IV-3)	4G	2003-11-28	1,443,240
RAF5027	Radioisotopes in Animal Reproduction & Nutrition (AFRA Viii)	5E	1997-10-31	956,685
RAF5029	Nucl. Techniques in Plant Breeding & Biotechnology (AFRA X)	5C	1999-12-21	201,542
RAF5034	Diagnosis and Control of Livestock Diseases	5F	1997-12-11	439,706
RAF5041	Animal Feed Supplementation Packages (AFRA II-17)	5E	2003-07-29	694,870
RAF5042	Development of Improved Crop Varieties (AFRA III-1)	5C	2003-06-25	1,049,196
RAF5043	Assistance to Complete Eradication of Rinderpest from Africa	5F	2002-09-11	851,766
RAF5045	Biofertilizers for Increasing Crop Production and Soil Fertility by Smallholders	5B	2003-03-28	769,021
RAF6007	Local Preparation of Radioimmunoassay Reagents (AFRA V)	6B	1999-12-21	898,086
RAF6017	Isotopes for Control of Human Communicable Diseases	6B	2002-08-12	956,162
RAF6018	Consolidated RIA Capability for Tumour Markers (AFRA II-2)	6B	2003-12-31	1,122,319
RAF8010	Water Resources in the Nile Valley	8M	1992-09-15	175,830
RAF8016	Irradiation Processing (AFRA III)	8H	1996-06-28	118,898
RAF8017	Non-Destructive Testing Techniques (AFRA Vi)	8C	2003-07-29	390,793
RAF8022	Isotopes in Groundwater Resources Development	8M	2001-09-13	1,580,610
RAF8024	Radiation Processing Food and Industrial Products (AFRA IV-1)	8H 5H	2003-07-29	724,511
RAF8025	Non-Destructive Testing in Industry (AFRA IV-2)	8C	2003-05-30	1,016,088
RAF8026	Investigation of Leakage in Dams & Reservoirs (AFRA Iv-22)	8F	1999-07-30	92,071
RAF9007	Waste Management (AFRA I)	9E 4O	1997-10-31	353,229
RAF9016	Upgrading Radiation Protection Infrastructure in Africa	9C	1997-12-23	496,317
RAF9024	Upgrading Radiation Protection Infrastructure	9C	2004-10-29	2,947,059

Appendix 5

The number of Projects in Radiotherapy and Nuclear Medicine in Sudan and the Total Budget Provided by IAEA

Title of project	**Code No.**	**Recipient institute**	**First year approval**	**Total of budget US $**	**Complete/ active**
Upgrading Nuclear Medicine Facility with Gamma Camera	SUD/6/019	-- Ministry of Health - INMO	1995	313.050	Comp.1998
Nuclear Medicine	SUD/6/014	-- Ministry of Health - INMO		47,367	Comp. 1994
Improving of Clinical Radiotherapy	RAF/6/014	RICK	1995		
Developing of National Radiotherapy Network	SUD/6/020	-- Ministry of Health - INMO -RICK	1997	1,045,215 US $	2001
Development & Upgrading of Nuclear Medicine	SUD/6/024	-- Ministry of Health - INMO -RICK	2003	605,896	Active
Local Production of Bulk Immunoassay Reagents	SUD/6/018	- SAEC	1993	61,488	Comp. 1996
consolidated RIA capability for Tumor Markers	RAF/6/018	SAEC	1997	1,122,319	Comp. 2003
Improving Local Radio immunodiagnostics Capabilities	SUD/6/023	SAEC	2003	88,080	Active

Source: *- TC Directorate Report, 2005, SAEC*

Appendix 6

The total number. of project (National & Regional) provided by IAEA served water resources.

Title of project	**Code No.**	**Recipient institute**	**First year approval**	**Total of budget US $**	**Complete/ active**
Investigation Dam and Reservoir Leakages and safety	RAF/8/028	-- Ministry of water and irrigation, Dams Administration	1999	521,611	Active
Isotope hydrology Integration in the water sector	RAF/8/034	Ministry of water and irrigation, Groundwater and Wadis	2001	818,397	Active
Sustainable development of the Nubian aquifer	RAF/8/036	Ministry of water and irrigation, Groundwater and Wadis	2003	852,210	Active
Sustainable development & Equitable Utilization of the common Nile Basin water resources	RAF/8/037	Ministry of water and irrigation, Dams Administration	2003	749,170	Active
Towards a Sustainable development of the Nubian aquifer	RAF/8/039	Ministry of water and irrigation, Groundwater and Wadis	2003	22,673	Active
Isotopes in Hydrology	SUD/8/004	Ministry of water and irrigation	1982	162,132	Comp. 1991
use isotopes in groundwater assessment	SUD/8/005	Ministry of water and irrigation	1991	73,304	Comp. 1995
Assessment of the Nubian Sustainable development aquifer system	SUD/8/007	Ministry of water and irrigation	2001	142,797	Comp. 2004
Water resources in the Nile valley	RAF/8/010	Ministry of water and irrigation	1983	175,830	Comp. 1992
Isotope in groundwater resource development	RAF/8/022	Ministry of water and irrigation	1995	1,580,610	Comp. 2001
Investigation of Leakages in Dam and Reservoir	RAF/8/026	Ministry of water and irrigation	1997	92,071	Comp. 1999

Source: *- Report by TC Directorate, 2005, SAEC*

Appendix 7

The total number of project (National & Regional) provided by IAEA served Animal Production and Health:-

Title of project	Code No.	Recipient institute	First year approval	Total of budget US $	Complete/ active
SIT for Tsetse and Trypanosomiasis Management in Africa	RAF/5/040	Ministry of Animal Resources	1997	2,307,848	Active
Increasing Improving Milk & Meat Production	RAF/5/046	Ministry of Animal Resources & Ministry of Sciences & Technology	1999	1,184,617	Active
Sterile Insect Technique for Area-Wide Tsetse and Trypanosomiasis Management	RAF/5/51	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	4,604,242	Active
Sterile Insect Technique for control of Anopheles Mosquito	RAF/5/052	Ministry of Health, National Center for Research, Tropical Medicine Research Institute	2001	745,656	Active
Assesstance to OAU/IBAR PACE Programme for the control and Eradication of Major Diseases Affecting Livestock	RAF/5/053	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	1,785,058	Active
Radioisotopes in Animal Reproduction & Nutrition	RAF/5/027	Ministry of Sciences & Technology, Central Veterinary Research Lab	1993	956,685	Copm. 1997
Diagnosis and Control of Livestock Diseases	RAF/5/034	Ministry of Sciences & Technology, Central Veterinary Research Lab	1995	439,706	Comp. 1998
Animal Feed Supplementation Packages	RAF/5/041	Ministry of Sciences & Technology, Central Veterinary Research Lab nimal Resources	1997	694,870	Copm.
Assistance to Complete Eradication of Rinderpest from Africa	RAF/5/043	Ministry of Animal Resources	1997	851,766	Comp. 9.2002
Animal Science	SUD/5016	Ministry of Animal Resources	1984		COPM. 1992
Immunoassy Trechniques for Animal	SUD/5/20	Ministry of Sciences & Technology,	1993	50,396	COMP. 06.1995

Diseases Dignosis		Central Veterinary Research Lab			
Increasing Productivity of Smallholder Dairy Cattle	SUD/5/022	Ministry of Sciences & Technology, Central Veterinary Research Lab	1995	120,812	Comp. 08.1999
Improving Productivity of Goats	SUD/5/025	University of Khartoum, Faculty of Veterinary	1999	189,146	Copm. 12.2003
Control of Ticks and Tick-Borne Diseases using ELISA	SUD/5/027	Ministry of Sciences & Technology, Central Veterinary Research Lab	2001	244,417	Comp. 2005

Source: *- Report by TC Directorate, 2005, SAEC*

Appendix 8

Interview (1) Conducted With the Director General of SAEC and the Director of the Technical Cooperation at SAEC.

9. Name:----------
10. Address:----------
11. Project title:----------
12. Recipient Institute: ----------

Questions: -

16. General information about the IAEA Technical Cooperation include: -

- Kind of TC
- To whom concern

17. How to be one of IAEA Member State?

18. The contributed of Sudan

19. Kind of projects: - National, Regional, AFRA, the different in their objectives, and amount of fund to each kind of project

20. How to request for new project? (information about CPF)

21. How IAEA interested to chose the project?

22. General information about Technical Cooperation in SAEC

23. How TC deal with the Projects coordination?

24. How IAEA evaluate the projects?

25. Your opinion in evaluation the TC project in Sudan, include the

26. Your opinion in evaluation some projects and their implementation rates : -

- RAF/5/046 "Improving and Increase Productivity of Meat and Milk"
- SUD/6/020"Development of National Radiotherapy Network"
- SUD/6/032 'Improving Radio immunodiagnostics capabilities"
- RAF/8/036 "Sustainable Development of the Nubian Aquifer"

27. The main constraints facing TC at SAEC?

28. Suggest solutions

29. Do you think the use of Nuclear Techniques, (TC) in Sudan contribute in enhancing socioeconomic? If yes, the future

30. Any addition information

Thank you for taking the time to reply in this interview

Appendix 9

Interview (2) Conducted With the Projects Coordinators

13. Name:----------

14. Address:----------

15. Project title:----------

16. Recipient Institute: ----------

Questions: -

11. What are the main problems that face the ….. (Sectors)./ project priority?

12. What are the objectives of the project and it's established to solve specific problems in the …. (Sectors)?

13. How can use of nuclear techniques contribute in solving the specific problems?

14. Area of the project, Reason for choosing this area

15. Assistance provided by IAEA: -

i) Equipments; received –delay – being regularly used– function well- repaired/ maintenance - other problems

ii) Training: - number of staff has been trained – are they no longer with the project?

ii) Expert mission: - number of expert mission executed

16. Collaboration with other organizations/ Are there other international and/or bilateral programmes supporting this project

17. Kind of their assistances.

18. Kind of Government assistances or inputs

19. The most effective assistance received is from;

i) IAEA ii) other organizations iii) or government (explain/ compare)

20. The main constraints: -

i) At the national level ii) IAEA level

10. Suggest solutions: -

11. After the execution of the project, did you fulfill the objectives of the project and what is the implementation rate (percentage)?

12. Do you think that the project has a good impact/ contribution in development or in enhancing Scio-economic in Sudan?

14. Do you feel that this project needs to be extended, or not? If yes why?

- ***Thank you for taking the time to reply in this interview***

Appendix 10

List of the person who conducted in the interview 1, 2 and their address.

3. Prof. Mohamen A. H. Eltayeb - Director General of SAEC
4. Dr. Ibrahim A. Shaddad, TC Director at SAEC

A. Water Resources Sector: -

4. Dr. El magzoob Ahmed Taha, Ministry of Irrigation & Water Resources – Dams Administration
5. Dr. Eldoory, Ministry of Irrigation & Water Resources
6. Abd Alla Mohamed Khir, Ministry of Irrigation & Water Resources – Ground Water and Wadis

B. Human Health: -

5. Dr. Hussien M. Ahmed, Radiation and Isotope Centre, Khartoum (RICK)
6. Dr. Kamal Hamad, Radiation and Isotope Centre, Khartoum (RICK)
7. Dr. A. Elmajed Elrofaai, Radiation and Isotope Centre, Khartoum (RICK
8. Dr. Awad Drag, Institute of Nuclear Medicine and Molecular Biology (INMO)

C. Maintenance & Repair: -

3. Mr. Elmalih Ali Elbashir, The National Ribat University
4. Mr. Yousif Awad Elamain, SAEC

D. Radioimmunoassay (RIA): -

3. Mr. Abd Elmoniem M. Elhassan, SAEC
4. Mr. Omer M. Abdalla, SAEC

F. Animal Resources: -

4. Dr. Abubaker Adam, Central Veterinary Research Laboratories
5. Mr. Yousif Elmansory, Central Veterinary Research Laboratories
6. Dr. A. Elrahim M. Hussien, Central Veterinary Research Laboratories

H. NDT: -

3. Dr. Rifaat Kabashi Hassona, SAEC

4. Mr. Sayed Kabashi Megany, SAEC

G. Radiation Protection & Waste Management: -

4. Dr. A. Elrahim Shaddad, SAEC
5. Mr. Mumdouh Ysin, SAEC
6. Mr. Eltayeb Haj Musa, SAEC

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