



# THE ROLE OF NUCLEAR SCIENCE AND TECHNOLOGY IN ACHIEVING SUSTAINABLE AGRICULTURAL DEVELOPMENT IN DEVELOPING COUNTRIES.

International Symposium on Food Safety and Quality: Applications of Nuclear and  
Related Techniques, Vienna, Austria, 10-13 November 2014



*Tanzania Atomic Energy Commission*

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- i. Introduction,
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## 2. A. Agricultural Challenges

- a) Agricultural inputs,
- b) Water management,
- c) Soil fertility management,
- d) Pest and disease management,
- e) Under-Investment.

## 2.B. Impact on Food Safety and Quality

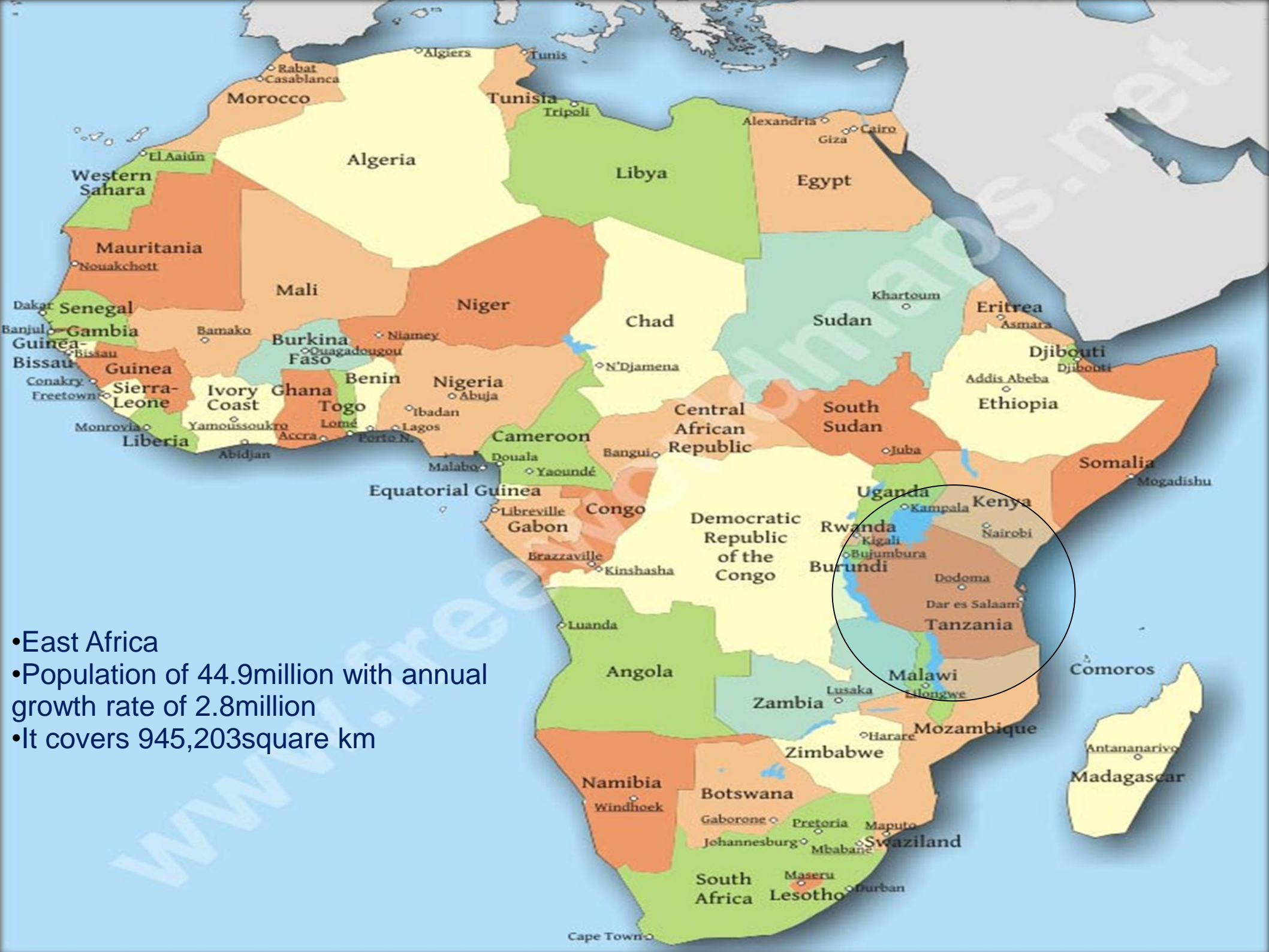
## 3. Possible Solutions

- i. Nuclear applications techniques,
  - a. Agricultural inputs,
  - b. Fertilizer and Water optimization,
  - c. Pest and diseases,
  - d. Food safety and quality,
- ii. Tanzania status.

## 4. Recommendation & Conclusion

## DISCUSSION





- East Africa
- Population of 44.9million with annual growth rate of 2.8million
- It covers 945,203square km



UGANDA

KENYA

RWANDA

BURUNDI

Lake  
Victoria

Arusha

TANZANIA

Dodoma

Dar es Salaam

Indian  
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CONGO

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MOZAMBIQUE

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Kigoma

Mbeya



# 1.THE AGRICULTURE IN TANZANIA

## i.Introduction

- Major challenges for most of Developing Countries.
  - The climate change,
  - Trade globalization,
  - Environmental protection and poverty alleviation
- Tanzania has its development vision 2025 ( TDV2025 ),the target for sustainable agricultural development rank in the first out the nine targets.

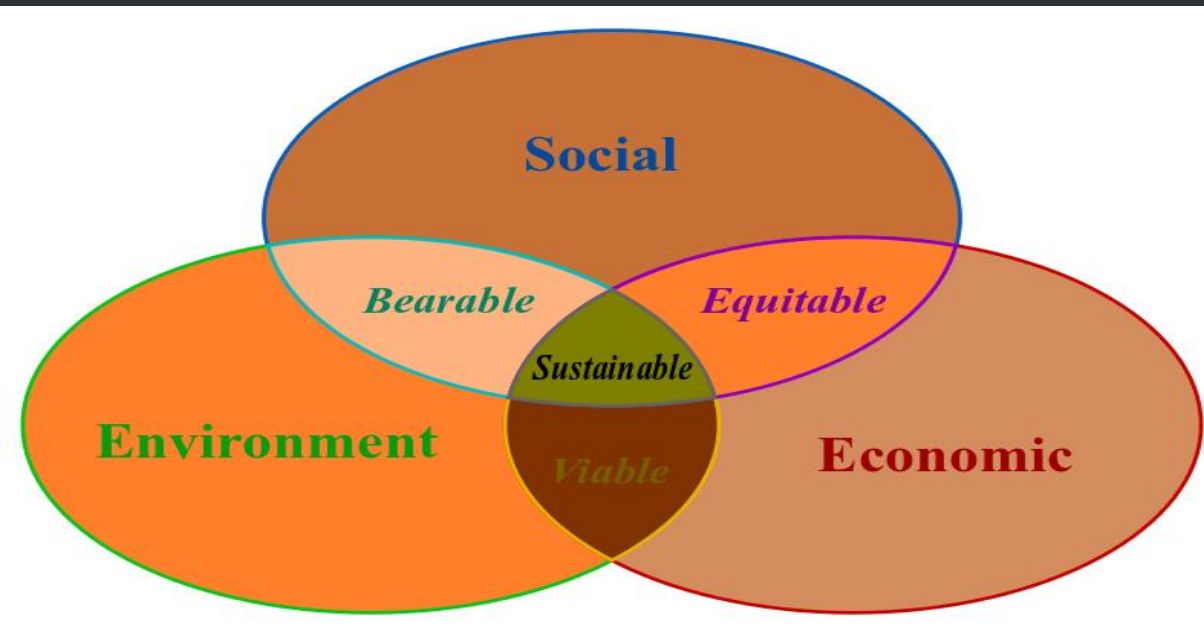


Photo by:WEF

“hunger can be overcome, and increased income reduces poverty.” Dr Jakaya Kikwete



Crops Area of Cultivation ('000' ha) Percentage (%)

Cereals 5,830.972 67

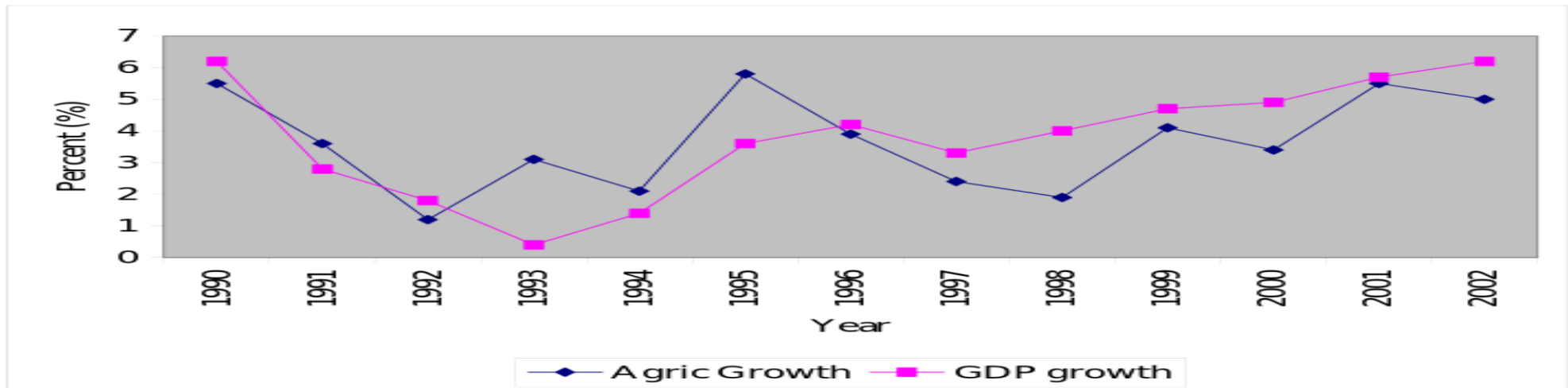
Pulses 1,002.819 11.5

Oil seeds/nuts 966.583 11.1

## ii. Economic contribution

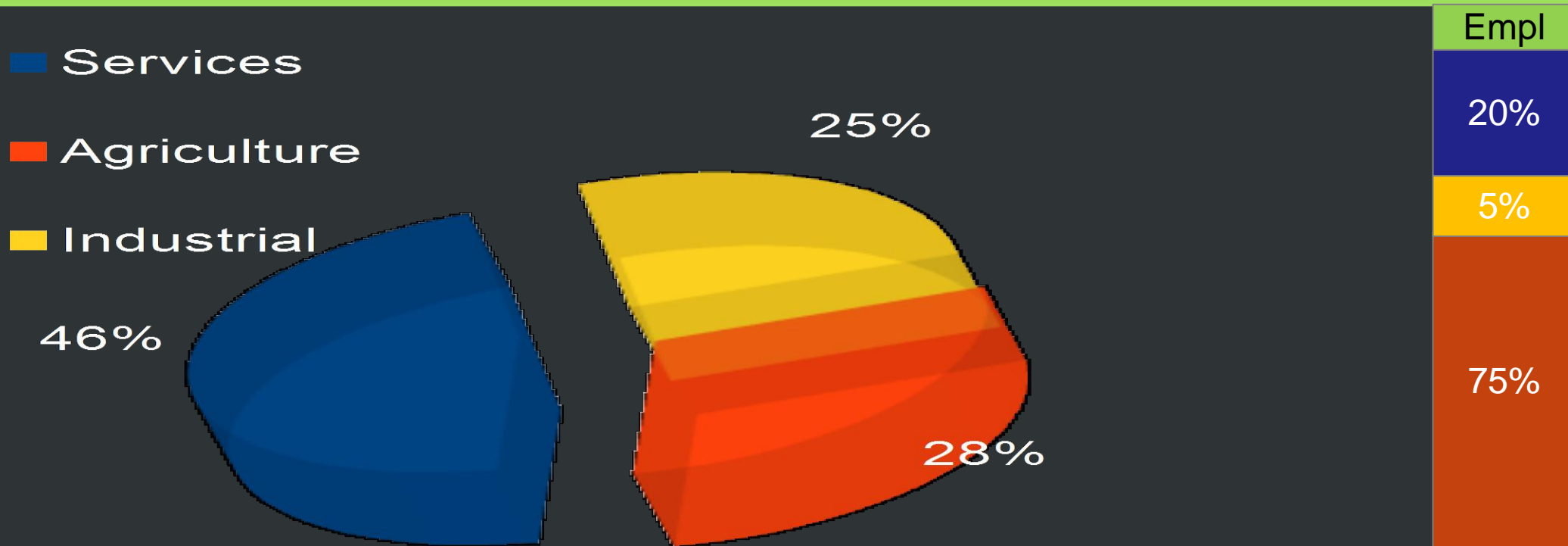
- Employs more than 75% of total population.
- Contributes about 28% of the GDP.
- Have high Multiplier effect.
- Feed more than 95% of the population.
- Rank as first in factors contributing to Inflation.
- Exports 30% and >65% -as input for local industries.

**Figure 1: Trends in Annual Growth of Agriculture and Real GDP**



Source: Economic Surveys (Various Years)

## ii. Economic contribution cont..



Agflation is a compound word of agriculture and inflation. This means once prices of agricultural products increase, price of other products also increase



## 2. AGRICULTURAL CHALLENGES.

- Tanzania total Land 94.5m h
- Suitable for agriculture 44m h
- Only 10.1m h is used ( 23% )



- The Agricultural inputs
- The water management
- The soil management
- The pest and disease
- Under-Investment

- Infrastructure
- Science and technology
- Regulatory control
- Local industries

**Agricultural challenges**



**Impact on food safety and quality**



**1. Production,**



**2. Transportation and storage**



**3. Process and distribution**



**4. Regulatory infrastructure**



## a.Agricultural input challenges

- **High demand low supply:**

Agricultural Year	Demand-seeds	Supply -seeds	Demand-Fertilizer	Supply-Fertilizer
2011/2012	60,000	28,000	452,202	240,350
2013/2014	60,000	32,000	-	-

imported. The rest are from previous production season,

- **The high cost:** Imported seeds are expensive for small scale farmers to afford,
- **Low quality seeds:** locally produced from previous production are of low quality,





- **Fake seeds in the supply chain:** The challenge for fake seed as a result of agents who are not honest.

#### ▶ DECEPTION

Dishonest extension officers collude with agents to supply 'fake' seeds to farmers

## Arumeru farmers up in arms over 'fake' seeds from agents

Farmers are suspicious whether the improved seeds they have been hearing about from experts through various media, were the ones being distributed to them by agents

By The Citizen Reporter

**Arumeru.** Farmers in Kikati Ward, Arumeru District, Arusha Region, are up in arms over alleged sale of fake seeds by some unscrupulous agricultural inputs agents in their area.

They have called on the government to increase the supply of subsidised seeds and make sure they are distributed to growers before the beginning of the rainy season which is only a few weeks away.

One of them, Ms Veronica Alex, said the improved seeds they have been hearing about

from experts through various media, were not the ones often being distributed to them.

She claimed there was collusion between some agents and government extension staff to supply them with seeds which are below quality instead of those recommended by experts.

Her remarks were echoed by other farmers, Mr Frank Moses and Mr Juma Athumani during an event in which a new entrant in the seed business, Zambia Seed Company, visited the farmers in order to sensitise them on the use of improved seeds.

They claimed that despite favourable rains in recent years, their farm yields have been low because of the poor quality seeds that are sold or supplied to them by some agents. But an agricultural

#### MORE: ON SEEDS

A seed is an embryonic plant enclosed in a protective outer covering called the seed coat, usually with some stored food. It is a characteristic of spermatophytes (gymnosperm and angiosperm plants) and the product of the ripened ovule which occurs after fertilization and some growth within the mother plant.

officer with Zambia Seed, Mr Oscar Mushi, pleaded with the farmers that getting supplied with the quality seeds was not a solution to the crisis and that, instead, they have to adhere to the required agricultural production techniques. "We have distributed

enough seeds to many farmers in Kikati area, but we have to conduct sensitisation seminars on how to plant them and raise maize production according to what the experts want," he explained.

A ward executive officer for Kikati, Mr Ndweirwa Mbisa said although the government was keen to supply farmers with improved seeds for higher productivity, this year it has reduced subsidy to only 50 farmers from between 200 and 300.

Kikati Ward, midway between Arusha City and the Kilimanjaro International Airport (Kia) junction along the highway to Moshi is one of the key maize growing zones in Arusha Region.

Of late, farmers have been growing maize alongside pigeon peas, a new cash crop for smallholders.

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## Hospital short of blood

By Zephania Ubwani  
The Citizen Reporter

mothers and children.  
The facility also receives

▶ EDUCATION: Everybody is getting set as crucial O-Level



## **b. Water management challenges**

Optimum water and nutrients are required for healthy and quality agricultural products.

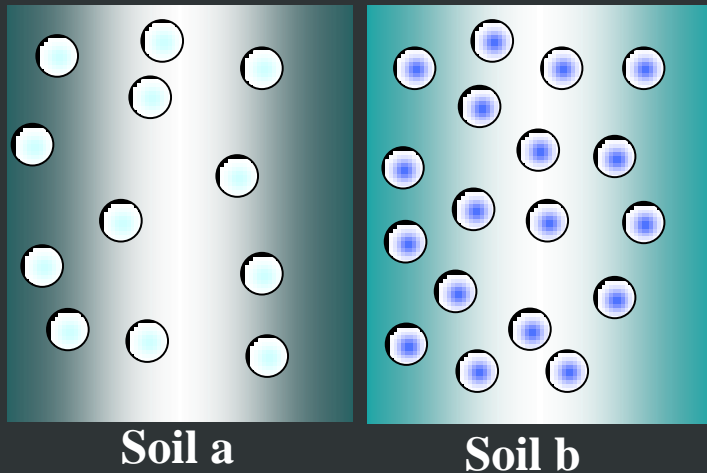
- Over dependence on rain fed agricultural system
- The agricultural runoff due to climate change which contaminate drinking water and sometimes destruct water ways.
- The Industrial sector in Tanzania is growing, poor regulatory control contaminate water and agriculture products.
- The infrastructure for sewage system are old, causing floods in major city like Dar Es Salaam



## c. Soil management challenges

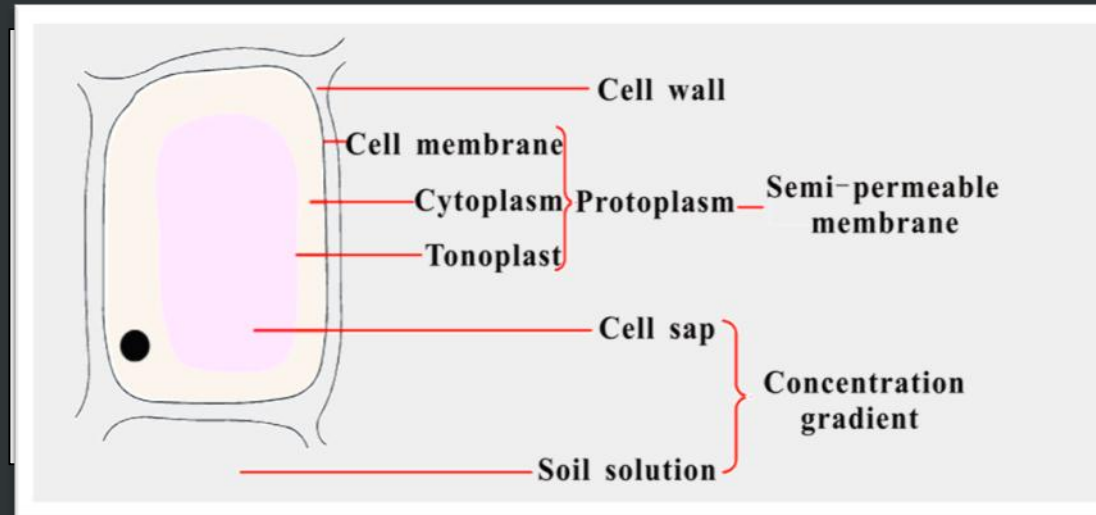
- Among the key obstacles limiting food output in Tanzania is decline of soil fertility and poor soils management.
- The infertile soil in some part of rural areas is one of the factor for wide spread of malnutrition and environmental degradation.
- The salinity and water logging problems.

Salinity



$(a \rightarrow b) < (b \rightarrow a)$

- Water molecule
- Salt molecules





## d. Pest and disease challenges

- Pest and diseases attack
  - Crops, livestock as well as human being,
- Up to 40% of all food produced in Tanzania is lost to insects, bacteria and moulds
- Diseases like malnutrition, food poison, malaria, AIDS, typhoid, which are common in developing countries directly affect agricultural production
- In 1991 10 cases for contaminated food (daturastramonium )
- Every year in major cities like Dar Es Salaam, Mwanza and Arusha Cholera outbreak are reported.



## d.Pest and disease challenges cont...

- Rinderpest was one of the biggest problem for livestock in Tanzania back 1990's.
- Tsetse fly attack animal and human beings, hence reducing production as well as food safety and quality.
- Conventional and non-conventional methods of food and crop preservations are applied in more than 75% of Tanzanian.



## g.Under-Investment challenges

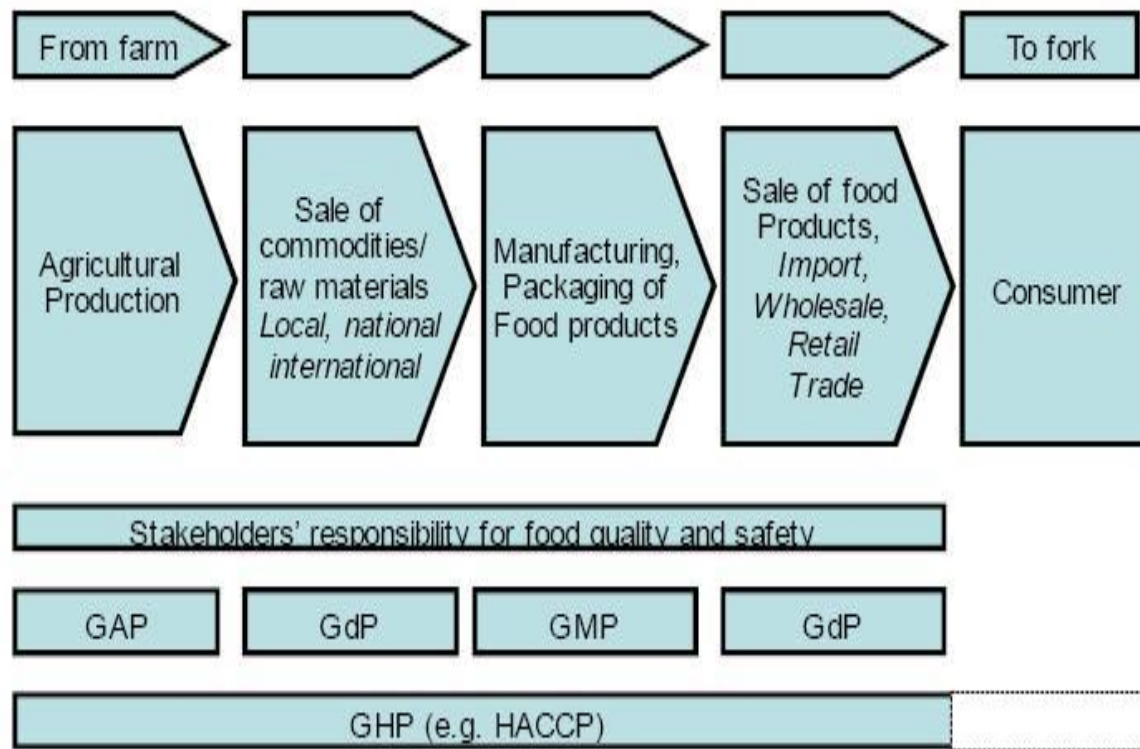
- Irrigation, transportation, electricity, ICT, water and sanitation
  - The electricity reliability in Tanzania is very low,
  - The road in rural areas are seasonally accessible
  - The rain fed agriculture with poor irrigation infrastructure
- Limited access to financing for uptake of medium and large scale farming with modern technologies.



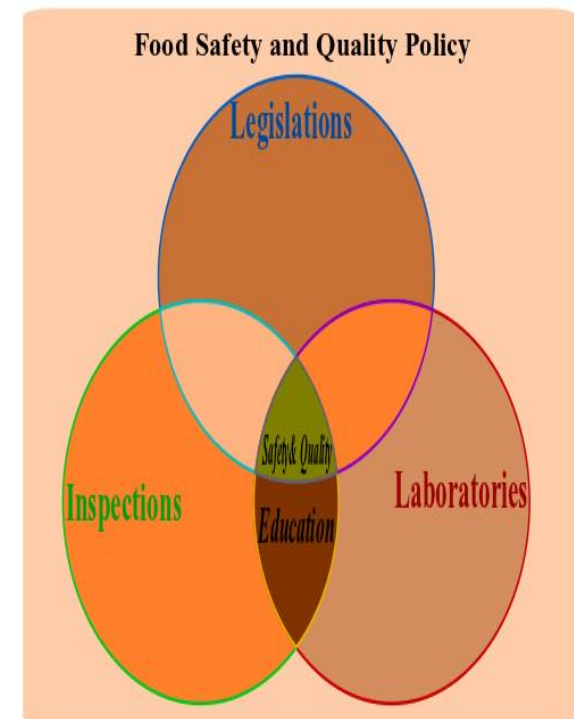


## 2.B.IMPACT ON FOOD SAFETY AND QUALITY

- The food safety and quality is the totality of characteristics of food products that bear on their ability to satisfy all legal, customer and consumer requirements.(Assurance of not causing harm when consumed)



Food Supply Chain from farm to fork. Adapted from Will and Guenther [1] With some modifications by A.Kileo



**Competent regulatory authority, accredited laboratories, Inspections and continual educations for all stakeholders in food chain will assure the food safety and quality.**

## Low quality seeds.

- Low quality seeds contributes to low production and quality.
- The seeds cannot resist to harsh conditions like drought, pest and diseases.
- They increases production cost, and degrade the land, replanting, no uniformity of the agricultural output.
- Low quality seeds determine how low is nutritional values can be obtained in agricultural output.



# Contaminated water

- Bacteria, molds and heavy metals are found in soil and water, therefore contaminated water contaminate the crops.
- Rapid increase in population 2.8million per year pose high risk for urban and some rural population.Dar Es Salaam FBDs Outbreaks every year.



Photo by:Gsengo



# Contaminated soil

- Heavy metals are found in soil and water, therefore contaminated soil contaminate the crops.
- Growth of small scale industries, and mining activities in rural area with low technology.
- The salt water from Indian ocean contaminate the soil along the costal regions.



Photo by Kizito,M

Salt water intrusion in Rufiji 2012.

## Pesticides and fungicides

The pesticide residue, microbial and mycotoxin, that remain in the crops and animal feed reduce the safety and quality of food.

The traditional food preservation have significant effect on the nutrients and food safety.



Photo by Mwananchi



# Unde-Investment

✓ Few skilled people, old technology and infrastructures, few R&D projects, and the poor regulatory control stimulates poor agricultural practice, low hygiene practice, poor manufacturing practice, and hence low food safety and quality.

Low returns



@ emanuel feruzi



GAP

High returns



Quality food products

GMP





# The regulatory control for food safety and quality

The food safety and quality control system in Tanzania.

- **Quality seeds regulation** : Tanzania Official Seed Certifying Institute (TOSCI) regulates seeds quality,
- **Quality fertilizer**: Tanzania Atomic Energy Commission control the **radioactivity safety**, Tanzania Fertilizer Regulatory Authority, **fertilizer demand distribution and utilization**
- **Pesticides quality**: Ministry of Agriculture control
- **Finished food products**: Tanzania Bureau of Standard, **food quality**, Tanzania Food and Drug Authority **safety composition**, Tanzania Atomic Energy Commission **radioactivity safety**, Local Government Authorities **hygiene of food and their environments**, (**License of food restaurants** )

# The regulatory control for food safety and quality challenges

Inadequate with limited resources - fund, skills, equipments, and infrastructure

URT shares common borders with 8 countries together with soft borders which are difficult to control for imported goods.

Multiple stakeholders are involved in the control process which make it difficult to ensure the safety and quality integrity along the food chain.

Inadequate public education on food safety and quality in the region.

*Guidelines for Importation and Exportation of food, Revision 3, November, 2011*

## **Schedule VIII**

List of approved ports of entry

(Made under Regulation 6)

1. Bagamoyo Sea Port
2. Bukoba Lake Port
3. Dar-es-salaam International Airport,
4. Dar es salaam Sea Port
5. Holili
6. Horohoro
7. Isaka Dry Port
8. Itungi Lake Port
9. Kabanga
10. Kassesya Lake Port
11. Kasumulu
12. Kemondo Bay Port
13. Kigoma Air Port
14. Kigoma Lake Port,
15. Kilimanjaro International Airport,
16. Kipili Lake Port
17. Lindi Sea Port
18. Mabamba
19. Mafia
20. Manyovu
21. Mbamba Bay Lake Port
22. Mtwara Sea Port
23. Musoma Lake Port
24. Mutukula/ Kyaka
25. Mwanza Air Port
26. Mwanza Lake Port,
27. Namanga,
28. Rusumo Falls Port
29. Sirari,
30. Tanga Sea Port
31. Tarakea
32. Tunduma

# The regulatory control for food safety and quality challenges



**FBDs outbreak 2009 Reported-Tanzania Today**



**Imported Fish 2013 Reported-Mwananchi**

**“7 died and 33 hospitalized”**

<http://www.freemedia.co.tz/daima/kipindupindu-chaua-saba-33-walazwa/>



**Availability of expired products 2014-TBC**



# Public education on food safety and quality

- The stakeholders involved in food supply chain has little or not aware about food safety and quality due to limited resources available or lack of priority for stakeholders education,
- There is no consumer organization specific for food safety and quality to exert pressure over producers and other stakeholders involved,
- Public trust on regulatory authorities is declining because of lack of skilled personels,laboratories and better public communications,



# Public education on food safety and quality



WWW.GLOBALPUBLISHERSTZ.COM



WWW.GLOBALPUBLISHERSINFO



Photo by Kent Bradford



# 4.POSSIBLE SOLUTIONS

## i.Nuclear ApplicationsTechniques



Source IAEA



## a.Speed breeding of improved crops


### New species:

- ✓ Increased crop yields (reduced fertilizer use)
- ✓ Better disease, pest, & draught resistance (less pesticides& water)
- ✓ Enhanced maturing times (allows crop rotation)
- ✓ Improved nutritional value
- ✓ Improved quality
- ✓ Improved processing quality
- ✓ Enhanced customer acceptance

> 30 nations have developed ~ 2250 new crop varieties  
(radiation used in 89% of these!)

## ....Animal Production & Health

### Technical basis

- RIA is used to measure the presence of the reproductive hormone **progesterone** through immunological definition
  - Isotope **I-<sup>125</sup>** is used as a label to enable the immunological reaction to be assayed
  - Disease diagnosis using molecular tools (PCR-ELISA)
  - DNA assisted selection for productivity and disease resistance
  - Production of safe standard reagents by irradiation
  - Evaluation of locally available feeds to overcome nutritional deficiencies
- 

## **b.Optimization of water and fertilizer use**

Water and fertile soil are the two basic elements for plant growth,

Optimization of fertilizer:

- Label ( tracer property ) to determine optimal effectiveness
- Minimize fertilizer needed
- Quantify biological Nitrogen fixation

Optimization of water

- Neutron moisture gauges to determine proton content (moisture)
- Mutation (crop resistant to drought)
- Minimize soil erosion and degradation





## c. Insect and pest control

### • Sterile Insect Technique (STI)

- Produce or capture large numbers of male insects and sterilize them
- Release them into their native environment
- No offspring!

### • Tsetse fly eradicated in parts of Africa (allowing human settlement)

### • Other examples: Mediterranean fruit fly, Mexican fruit fly, Boll Weevil



## b. Food safety and quality

### Magnitude of Problem

Infestation & spoilage prevents ~ 50% of food grown in many parts of the world to be wasted

Spoilage of sea food sometimes as high as 90%

In the United States *every year* Over 76,000,000 cases of food poisoning  
Over 325,000 hospitalizations  
Over 5,000 deaths

In the United Republic of Tanzania;-There is no database for risk assessment of food born diseases.

Most common Food Preservation Techniques in Tanzania are;

✦ Sun drying      Salting      Smoking      Canning  
✦ Heating      Freezing      Chemical treatments (e.g. methyl bromide)

# Irradiation and quality control



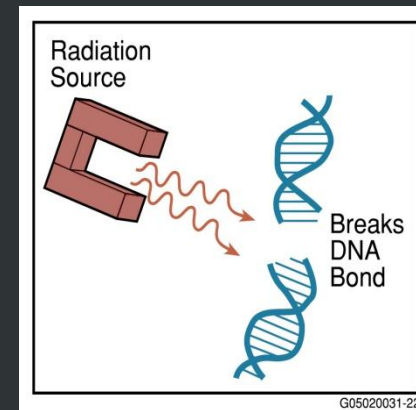
- Hygienic production and safe distribution
- Stable supply of agricultural commodities
- Efficient and scientific quarantine measures





## c.Irradiation

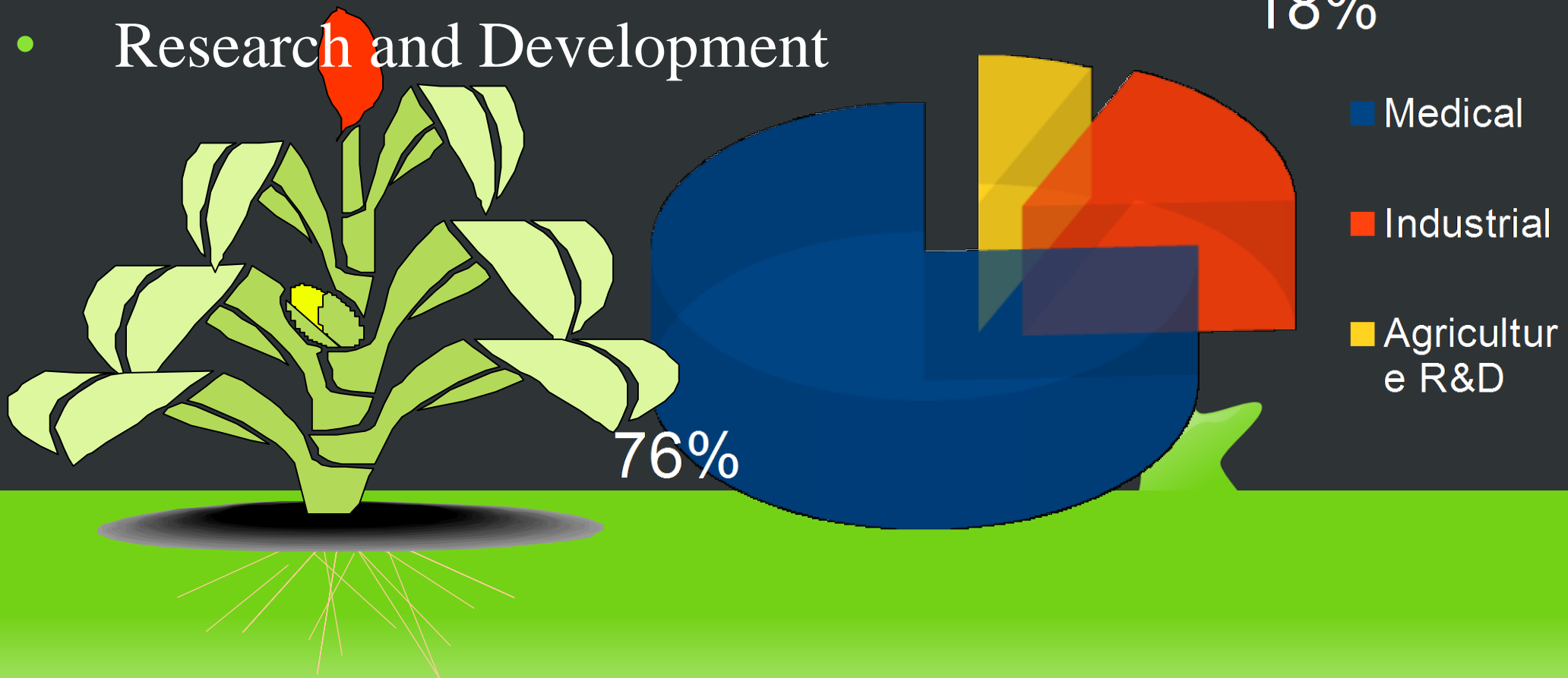
- Beta particles or gamma rays will kill bacteria & pathogens by breaking DNA bonds
  - (particularly effective during reproductive cycle)
- Specific pathogens targeted include:
  - Salmonella
  - E-coli (0157:H7)
  - Listeria monocytogenes
- NOTE: Goal is not to totally eliminate contamination
  - Some pathogens necessary in body to stimulate immune system
  - ~5 orders of magnitude reduction generally sufficient



## ii. Tanzania status

Joint Division support Tanzania.

- Capacity building
- Equipment and Tools
- Research and Development



# i.Quality Seeds

SUPA BC-mutant varieties 2011.

- Benefits to farmers:
  - proving high yield,
  - Resistant to salinity
  - taste good and pleasant aroma

MWANGAZA

- Resistant to Rice Yellow Mottle Virus (RYMV)





# i. Water management

Neutron probes techniques.

- Benefits to farmers:
- Measure water in non destructive way,
- Optimization of available water.

Project underway:-

Isotope hydrology techniques.

sprinklers, mini-sprayers and drippers



# i. Pest and disease management

Tsetse fly:

- In 1996 Zanzibar was declared Tsetse fly free

Rinderpest:

- biggest problem for livestock
- Eradicated in 2007.

Mutant varieties

- Resistance to disease and pest.



## 4.Recomendation & Conclusion

- Capacity development:-Policy makers, National Reseachers,Regulators,Instructors,Industries and Farmers.
- Political will, and state allocation of resources in agricultural development, especially in science and technology applications.
  - Improve laboratories
  - Improve infrastructures
  - Improve regulatory controls
- Local and international co-operation between the research institutions and the training institutions,regulators,policy markers and farmers for fully utilization of international and local institutions with science and technology (nuclear application technologies) in agriculture.
- Encourage financial sectors to support agriculture, to increase production through financing new technologies and **local industries.**



## Conclusion

The food security, safety and quality challenge are the global problems that need global solutions. The nuclear applications techniques is one of the solution among other solutions that can have significant impact in food security, food safety and quality, specifically in developing countries like Tanzania which depend on agriculture for its development.



# THANK YOU FOR YOUR ATTENTION

