IMPACT OF NANOTECHNOLOGY ON WEALTH CREATION: An African Perspective

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Theme: Emerging paradigms, technologies and innovations for sustainable development: Global imperatives and African realities

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BACKGROUND

OVERVIEW OF NANOTECHNOLOGY AND WEALTH CREATION

- Possible applications of Nanotechnology
  - Treatment of tropical diseases,
  - Improvement of food availability,
  - Provision of cleaner water,
  - Easier and cheaper transportation of goods and people
  - Provision of clean and cheap energy sources.

- Overall nanotechnology has immense potentials for wealth creation

OVERVIEW OF NANOTECHNOLOGY AND WEALTH CREATION

- Indices of wealth creation
  - Money
  - Enhancement of knowledge,
  - Intellectual capital,
  - Effective exploitation of resources,
  - Preservation of the natural environment, and
  - Other factors that may contribute to raising the standard of living

OVERVIEW OF NANOTECHNOLOGY AND WEALTH CREATION

- Negative possible effects of nanotechnology on the economy also exist

- This other side to the coin calls for a balance of scale style assessment of the impact of nanotechnology

AIM OF PRESENTATION

To examine the impact of nanotechnology on Africa's wealth capacity both for the present and the future.

RISKS AND BENEFITS OF NANOTECHNOLOGY TO AFRICA

RISKS OF NANOTECHNOLOGY

- Uncertain environmental effects
  - There exists significant potential for harm on the environment
  - However, very little knowledge on possible effects of nanotechnology on the environment is available
- Health concerns
  - Differences in opinions on the potential effects of the technology,
  - Research must be sustained to gain better understanding despite differing opinions

RISKS OF NANOTECHNOLOGY (CONT)

- Impact on Africa's primary source of capital
  - Nanotechnology may lead to a decrease in the demand for the traditional raw materials
- Influence on Africa's security climate
  - Nanotechnology may lead to an arms race and subsequently proliferation of arms into Africa

BENEFITS OF NANOTECHNOLOGY

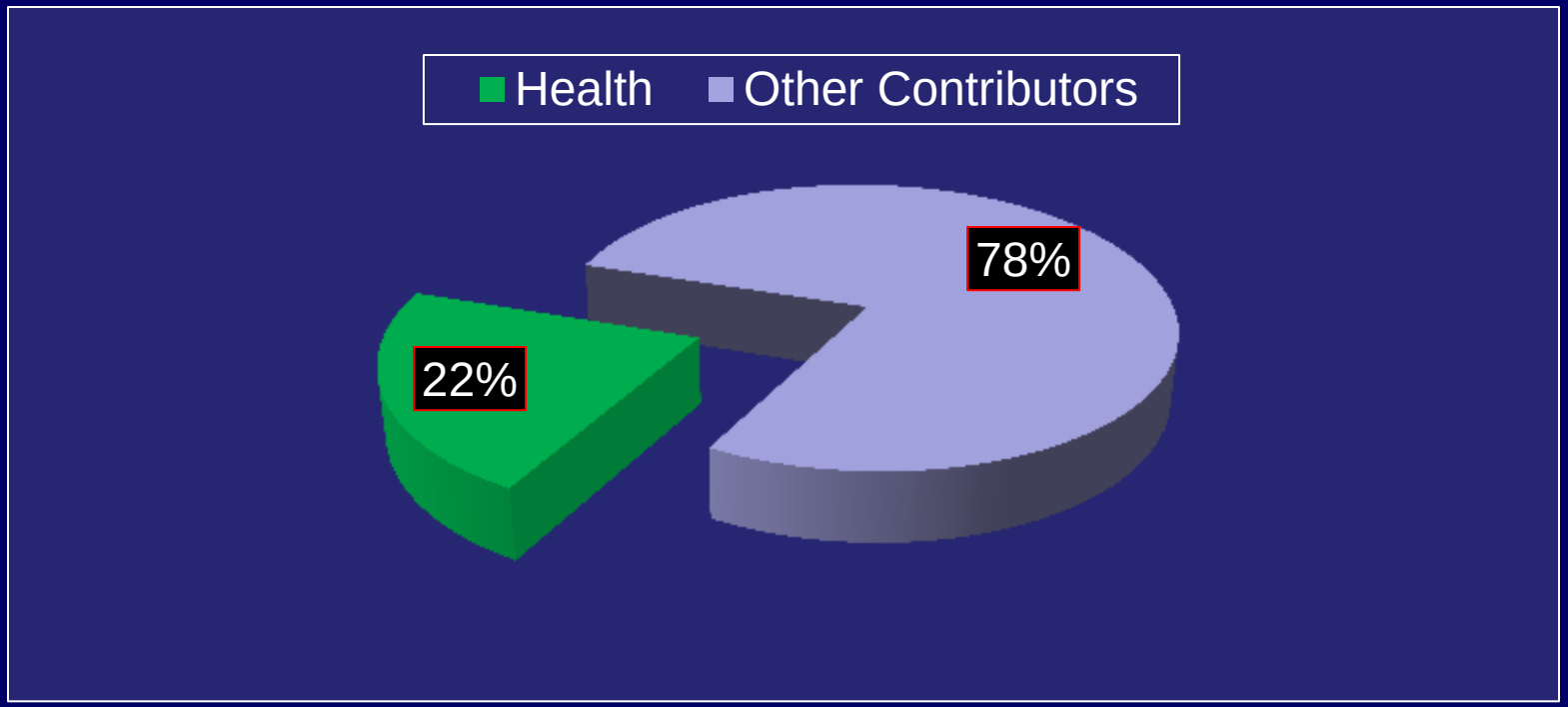
- Better healthcare delivery
- Advances in defence technologies
- Improved agricultural practices
- Environmental protection
- Advances in information technology
- Improved manufacturing processes

BETTER HEALTHCARE DELIVERY

- Improvements in the drug delivery system
- Development of replacement body organs and fluids,
- Development of molecular machines comparable to the natural machinery inside living cells,
- Nano-sensors to monitor human health
- Development of materials to be used for regeneration of bones
- Improved water purification methods

BETTER HEALTHCARE DELIVERY

- Better health delivery entails improved wealth creation capacity



Contributing Factors to Transition Growth Rate of Per Capita Income in Sub-Saharan African Countries [Ref 7]

NANOTECHNOLOGY AND POWER GENERATION

- Traditional means of power generation are likely to be dissuaded in future
- Nanotechnology provides a means to secure the future energy creation capacity of the continent

NANOTECHNOLOGY AND SECURITY

- Nanotechnology has the potential to improve security in Africa through applications such as miniaturised surveillance systems

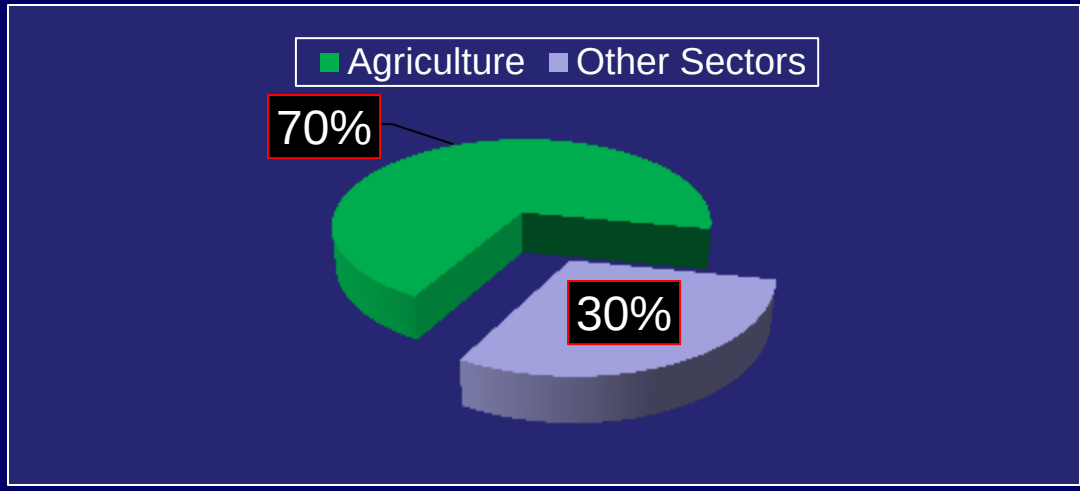
NANOTECHNOLOGY AND AGRICULTURE

- Potential improvements in agriculture due to nanotechnology may be similar to those of the Green Revolution

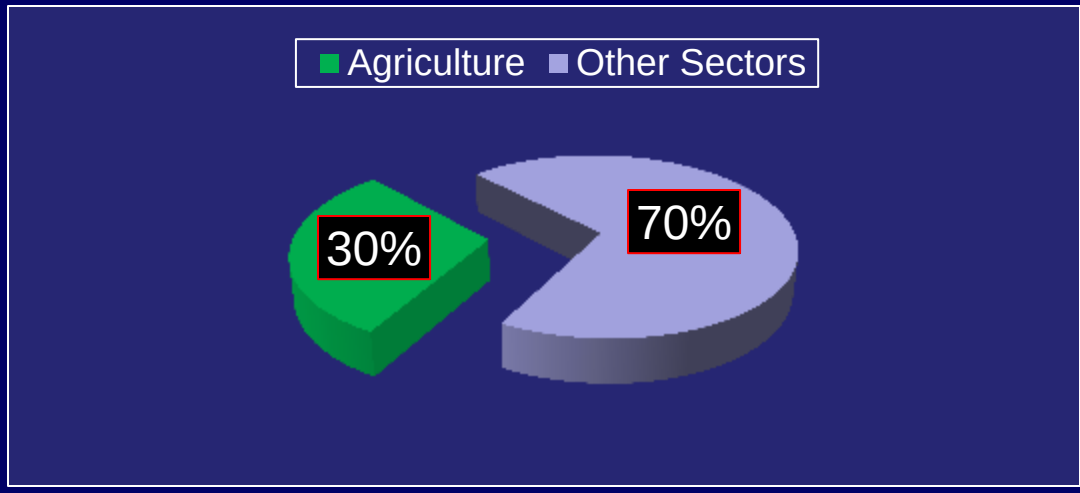
- Expected breakthroughs include:
  - Crop DNA decoding
  - Nano-sensors for crop health monitoring
  - Extension of food shelf life using nano-materials

NANOTECHNOLOGY AND AGRICULTURE

Contribution to employment in Sub-Saharan African Countries by sector [Ref 11]

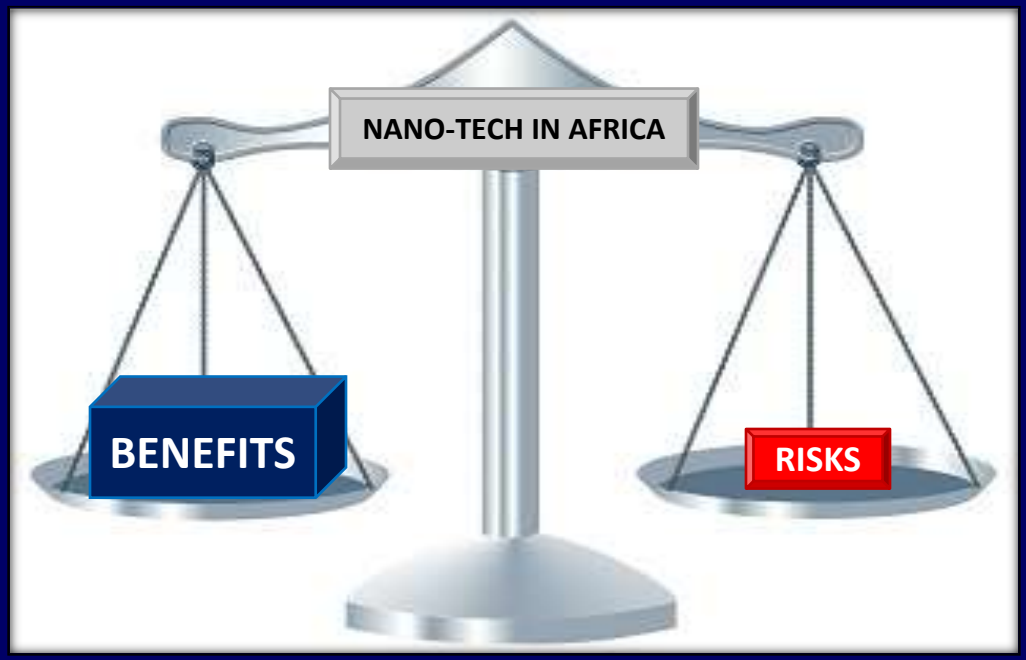


Contribution to GDP in Sub-Saharan African Countries by sector [Ref 11]



- Advances in nanotechnology would increase the export capacity and food security of the continent.

NANOTECHNOLOGY ON THE BALANCE OF SCALE



- Nanotechnology provides a wide range of solutions to the developmental needs of the global community including Africa
- On the balance of scale, the continent stands to benefit hugely from this emerging technology

CURRENT EFFORTS TOWARD NANOTECHNOLOGY DEVELOPMENT

FACTORS INFLUENCING NANOTECHNOLOGY DEVELOPMENT

- Quality of funding
- Educational investment
- Guiding policies
- Partnership between the public and private sectors
- Commercialization of technology

Africa is currently lagging far behind in the nano-race

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT

USA

- Year 2000 - Created the National Nanotechnology Initiative (NNI) to bring together experts to advance nanotechnology in the country
- Today – World leader in nanotechnology development

Globally

- Year 2001 - At least 30 countries had begun development of nanotechnology
- Year 2007 – About $13.8 billion was already being spent worldwide annually on nanotechnology

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT

Japan

- Has made major advances in nano-devices and nano-instrumentation

S Korea

- Allocates $10 million per annum for the development of nano-electronic memory chips

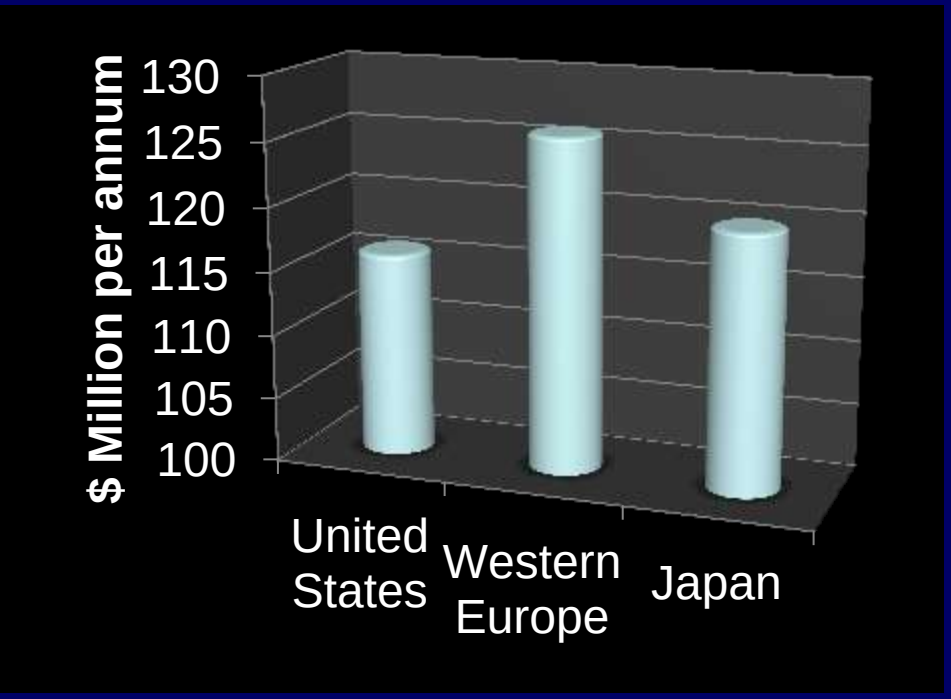
EU

- Invests heavily in areas such as nano-biotechnology

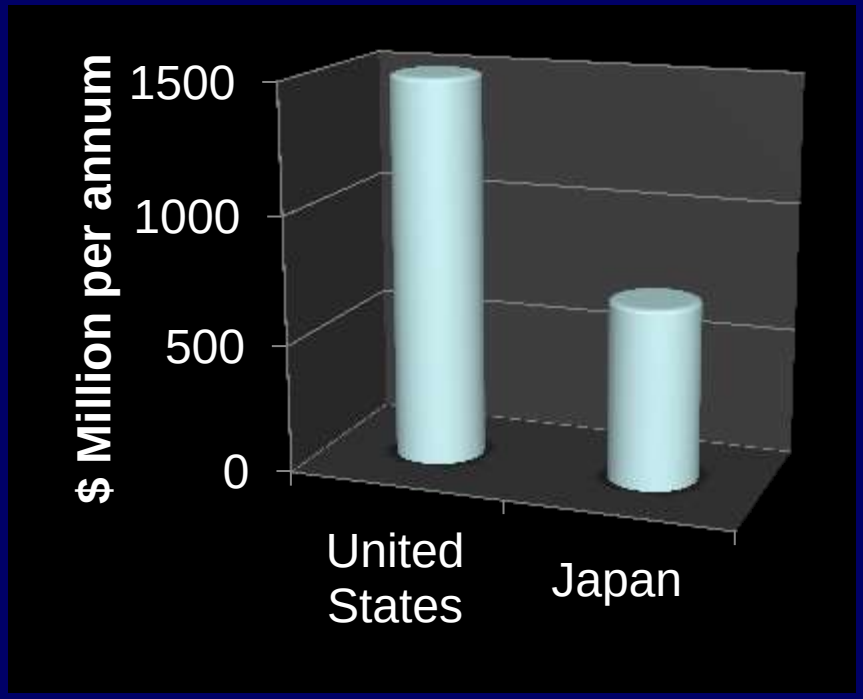
Globally

- Investments in nanotechnology have continued to increase over the past 2 decades

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- *The American Experience*



As at 1997 [Ref 13]



As at 2008 [Ref 15]

Estimated Government Expenditure on Nanotechnology for some top spenders

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The American Experience

- US level of nanotechnology investment
  - *Currently the world's biggest spender*
- Driver for immense investment
  - *National Nanotechnology Initiative*
- Results of US investment in nanotechnology
  - *Highest number of nanotechnology publications, patents, companies and overall capability globally*

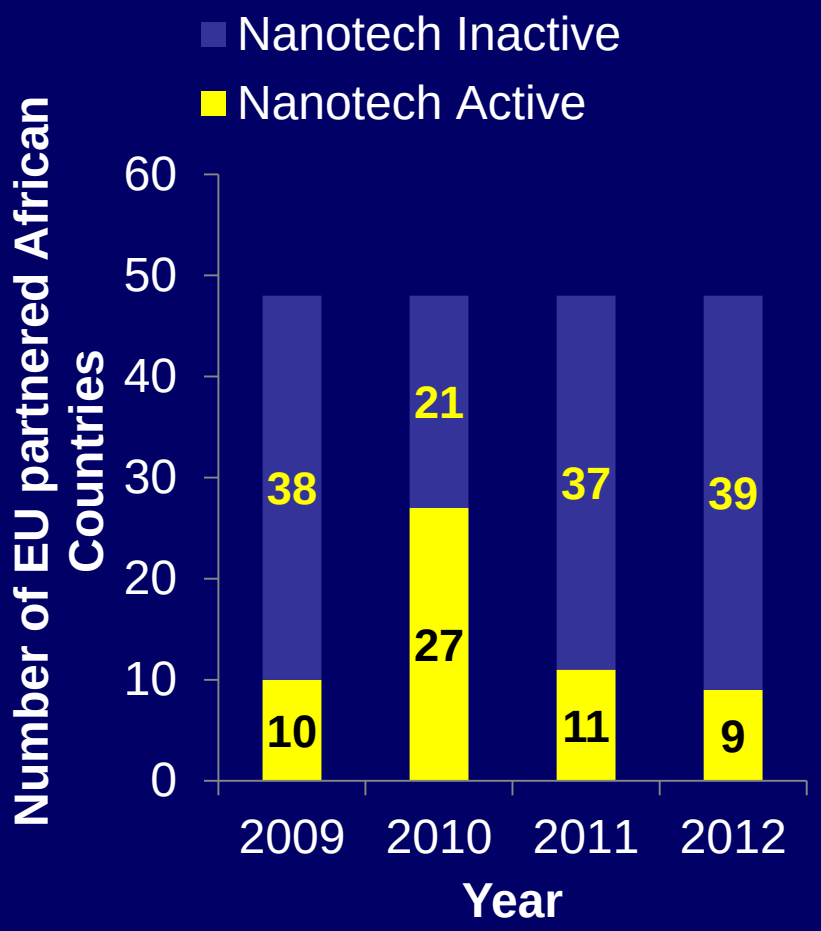
EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- Learning from the American Experience

- Similar nanotechnology initiatives and policies have been adopted by many countries

- Focuses areas of adopted nanotechnology development policies include:
  - Research innovation
  - Human resource development
  - Consideration of societal concerns
  - Industrial innovation

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario

Map showing Sub-Saharan Africa
(containing most of the 48 EU-partnered African countries)

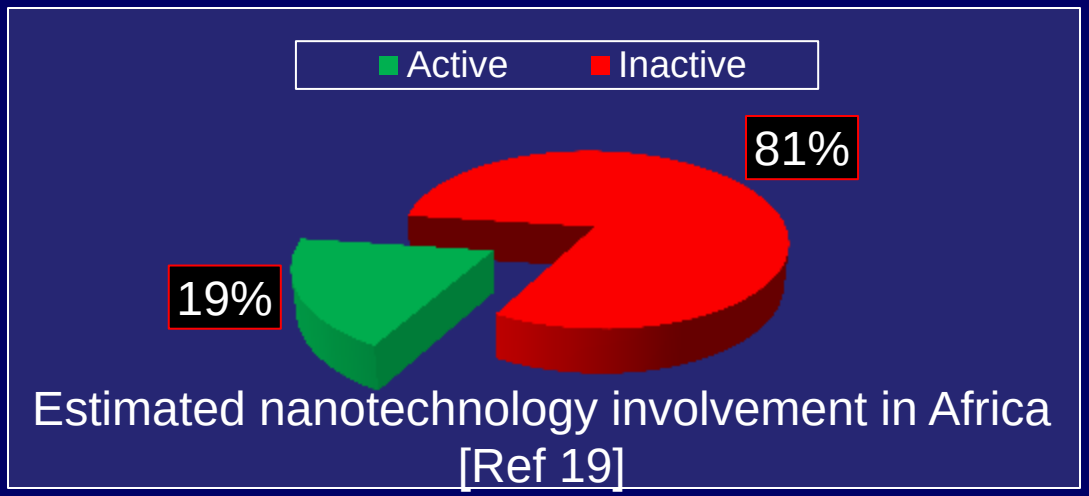


Representation of African Activity in Nanotechnology [Ref 16,17,18,19]

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Nanotechnology Active Countries

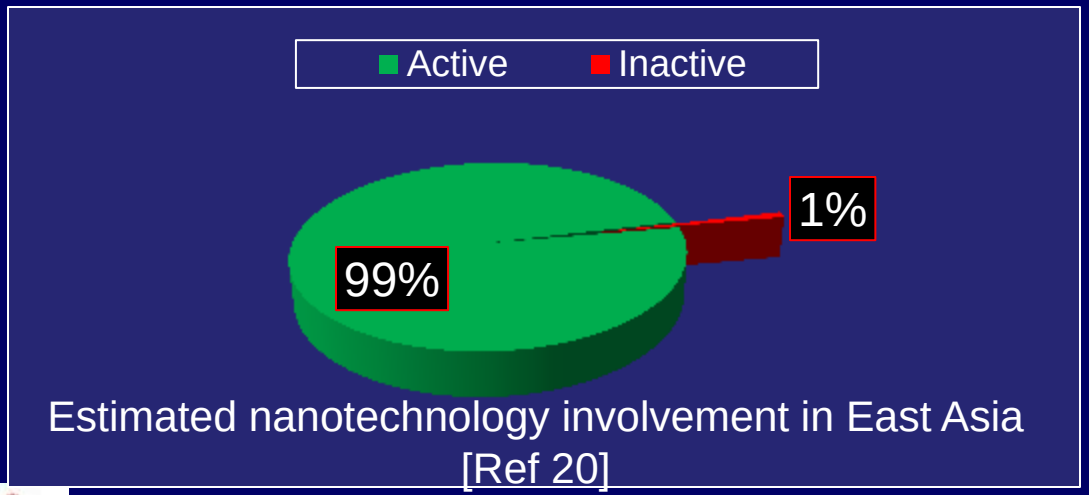
- Cameroon
- Ethiopia
- Kenya
- Namibia
- Nigeria
- Republic of South Africa
- Senegal
- Sudan
- Tanzania

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Comparison with World Best Practices



Estimated nanotechnology involvement in Africa [Ref 19]

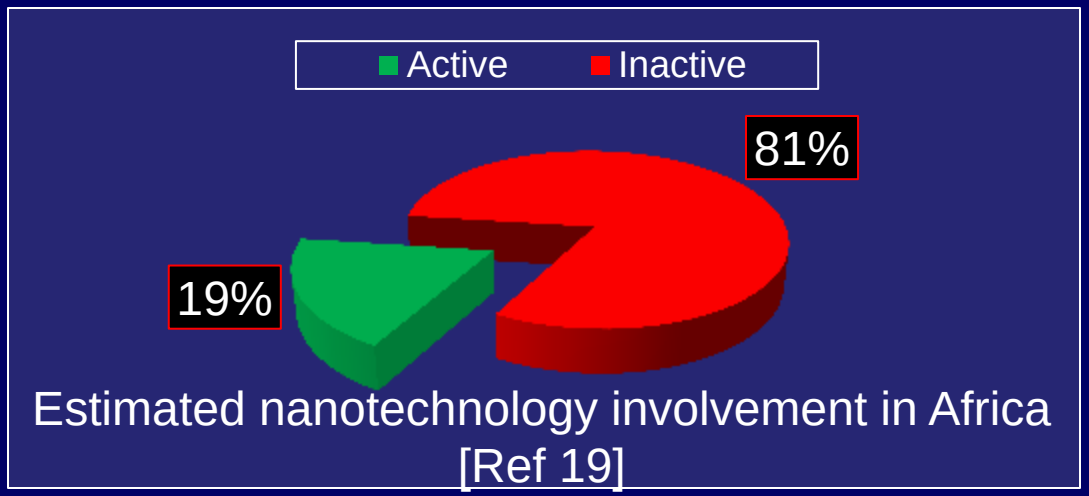
- *Less than a quarter of sub-Saharan African countries are active in nanotechnology*



Estimated nanotechnology involvement in East Asia [Ref 20]

- *Almost the entire East Asia is active in nanotechnology development*

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Comparison with World Best Practices



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Africa is currently lagging far behind in the nano-race

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Continent's Nanotechnology Leaders

- Republic of South Africa (RSA)
  - Year 2003 : Published a 10-year nanotechnology action plan
  - Today : By a large margin, the leading nanotechnology country in Africa
  - Today : RSA is yet to be recognized as a major nanotechnology player at the world stage

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Assessing its Nanotechnology Leaders

- Nigeria
  - Year 2006 : Launch of its own nanotechnology initiative
  - Today : Second most prolific African country in terms of nanotechnology development
  - Today : Road map of the country's Nanotechnology and Advanced Material Programme is only now being drawn

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Assessing its Nanotechnology Leaders

- Verdict - Despite the existence of nanotechnology programs in Africa, current impetus is insufficient to position Africa as a major player on the world stage.

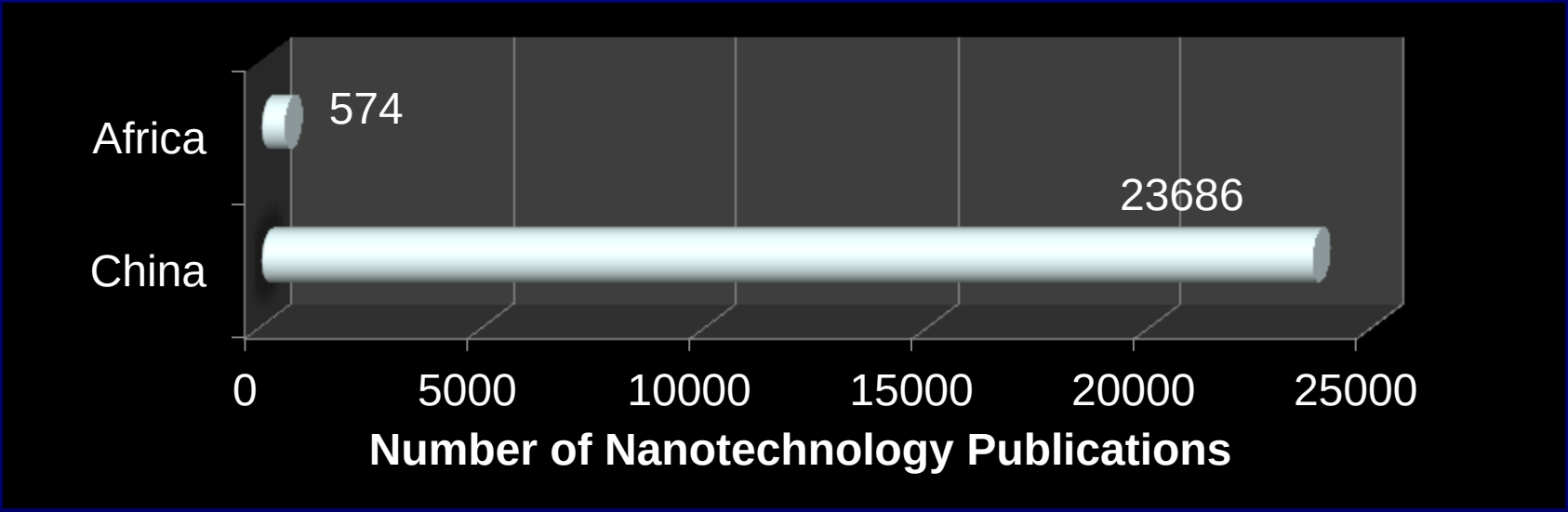
EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Academic Research and Education

- Important due to the research based development trajectory of nanotechnology
- The global requirement for nanotechnology trained people by 2015 would be about 2.2million
- Resulting skill-biased technological change would lead to significant rise in unemployment levels if Africa does not keep up to speed with nanotechnology developments.

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Academic Research and Education

- Publications are one of the most effective methods of assessing the quality of innovation, research and education
- US is the dominant force in nanotechnology academic activities
- China is the next most productive country in terms of nanotechnology academic outputs
- What is Africa's position in this field?

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT-
The African Scenario : Academic Research and Education



Representation of Nanotechnology Academic Activity in Africa and China [Ref 19,20]

Africa is currently lagging far behind in the nano-race

EFFORTS TOWARDS NANOTECHNOLOGY DEVELOPMENT- The African Scenario : Commercialization of Nanotechnology

- As at 2008

- Globally, there were about 1600 nanotechnology companies

- In Africa, no country was among the first 25 countries with the highest number of nanotechnology companies

- Africa is already being short-changed in terms of contribution of nanotechnology to current GDP

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION TO THE NANOTECHNOLOGY WEALTH IMPACT ANALYSIS

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION

- Generally
  - Economic Output = f(Capital, Labour)
- Currently, many forms of productions functions are in existence
- One of the most commonly used functions is the Cobb Douglas Production Function

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION

- The Cobb Douglas Production Function is expressed as
  - $Q = AK^aL^b$

Q = Level of Output

A= Total Factor Productivity

K= Level of Capital

L= Level of Labour

a= Output Elasticity for Capital

b= Output Elasticity for Labour

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Capital Level

$$Q = AK^{a}L^{b}$$

- *Availability of Resources: A major contributing factor to level of capital*
- *Abundance of natural resources provides a ready source of capital for African countries*
- *However advances in nanotechnology may lead to decrease in demand for Africa's natural resources*

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Capital Level

Crude Oil

Fuel Cell

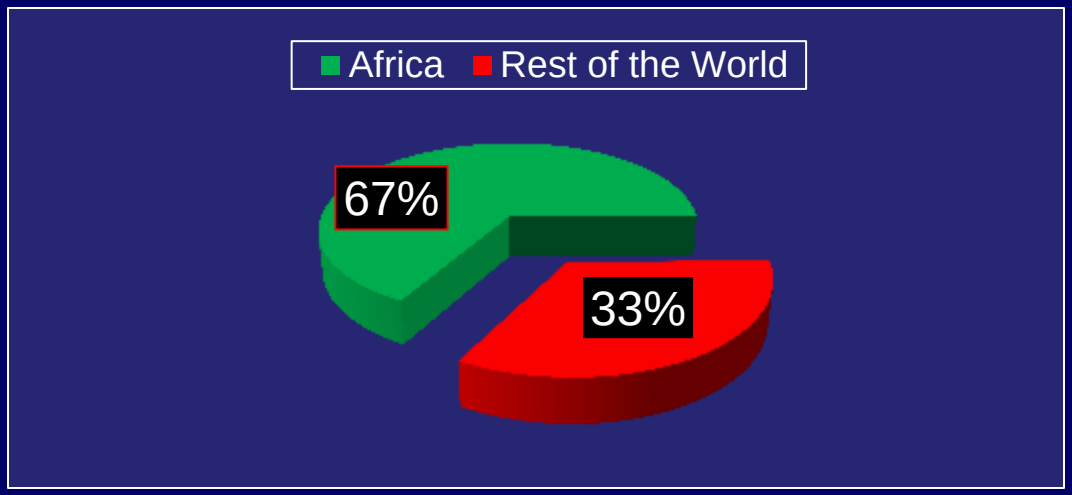
- If traditional base materials are replaced…….
- Africa stands the risk of losing a significant part of her source of capital and by extension.....

$$Q = AK^{a}L^{b}$$

..... her wealth creation capacity

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Capital Level

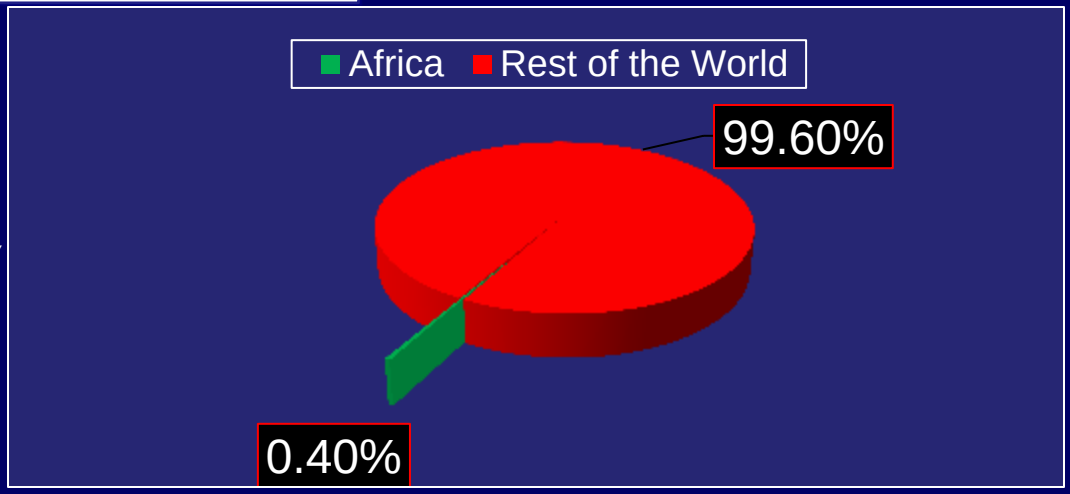
*Percentage of global natural resources located in Africa [*Adeyinka, F. (2007)*]*



- *Africa likely to remain the world's primary source of base materials*
- *However, due to intellectual property rights on nanotechnology, Africa may be sidelined in the usage of newly discovered base materials*

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Capital Level

*Percentage of global nanotechnology intellectual property rights owned by Africa [*Adeyinka, F. (2007)*]*



- *Worrisome considering the huge importance of rights in determining potential benefactors of emerging technologies*
- *More worrisome is the gradual patenting of Africa's natural resources through research in areas such as nanotechnology*

APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Capital Level

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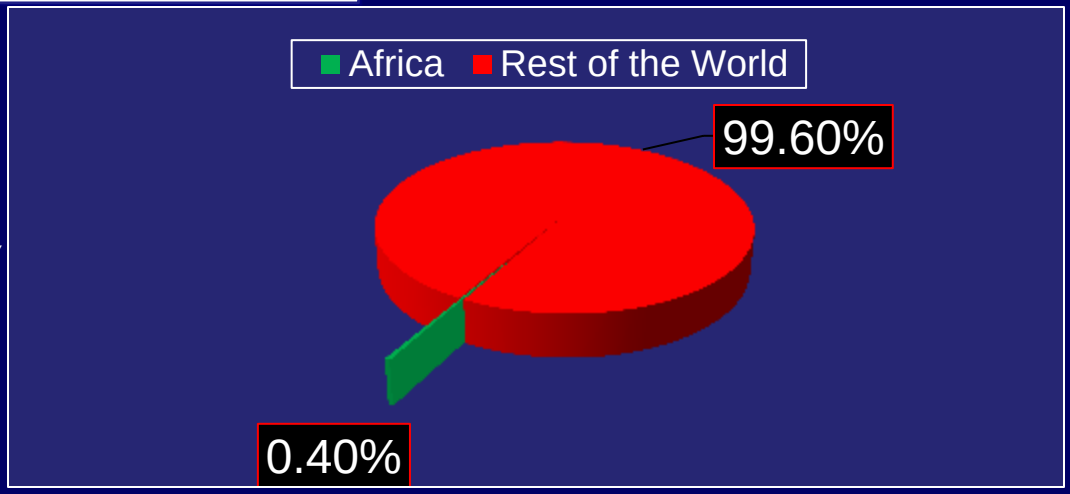
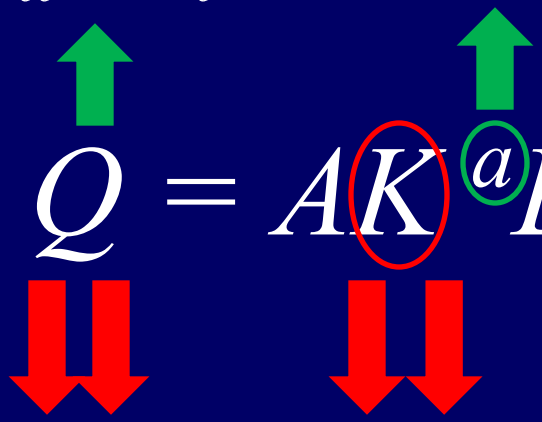


- Implication - Africa may not be able to fully utilize its natural resources as capital due to the intellectual property rights on them

$$Q = AK^{a}L^{b}$$

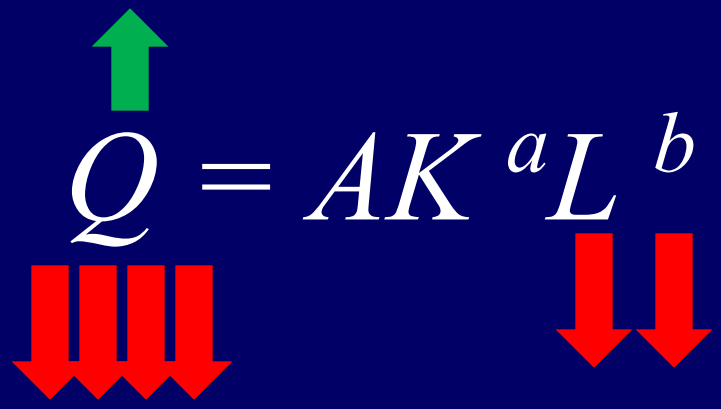
APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Output Elasticity for Capital

- *'K': Mainly influenced by availability of resources*
- *'a': Sensitive to technological development*
- *Advances in nanotechnology would likely lead to significant increases in 'a'*
- *However, need to spend heavily to pay for nanotechnology may further affect Africa's level of capital*



APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of Level/Output Elasticity of Labour

- *Envisaged desktop factories may lead to cuts in jobs and hence reduction in 'L' value*
- *Change in required skill level and type likely to lead to decrease in value of 'b"*



APPLYING THE COBB DOUGLAS PRODUCTION FUNCTION- Assessing the Impact of the Total Factor Productivity

- *Total Factor Productivity, A, is directly influenced by the long term level of technological growth within a society*
- *Differences in size of economy between developed and developing countries mainly due to value of 'A'*
- *Opportunity for Africa to determine the prosperity of its future*

$$Q = AK^{a}L^{b} \quad \text{OR} \quad Q = AK^{a}L^{b}$$

CONCLUSION

KEY POINTS

- *Advances in nanotechnology promises prosperity for economies that invest in its development*
- *Africa's backwardness in the nano-race would have significant economic implications*
- *Strategies for Africa to correct its deficiencies in nano-race*
  - *Increased funding for nanotechnology research*
  - *Increased attention to intellectual property rights*
  - *Formulation of enabling policies*
  - *Increased harmonization on nanotechnology by African countries*

Thank you very much for your attention